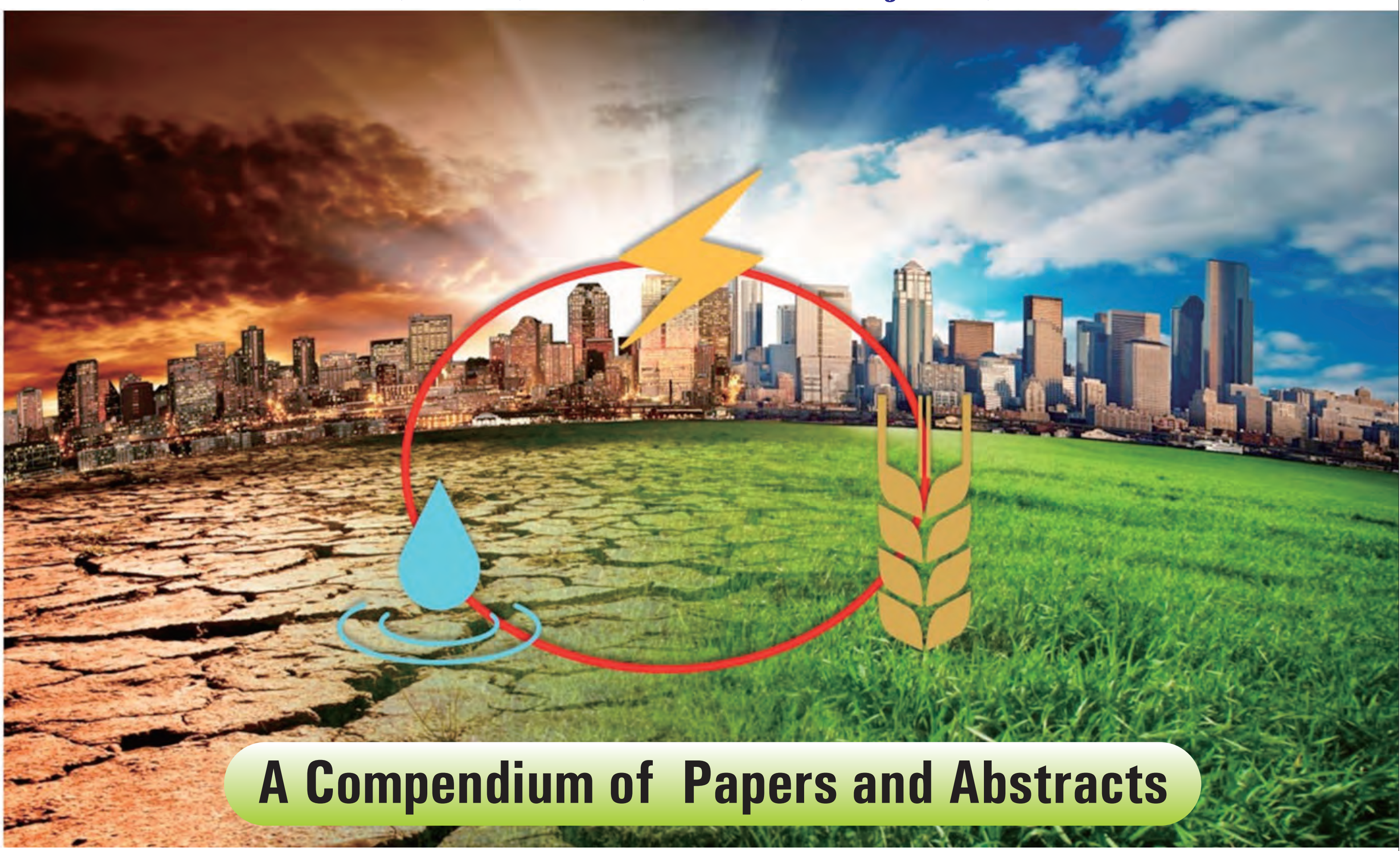
INTERNATIONAL CONFERENCE
on
Food, Water, Energy Nexus in Arena of Climate Change

October 14-16, 2016, AAU, Anand, Gujarat, India



A Compendium of Papers and Abstracts

Organized by

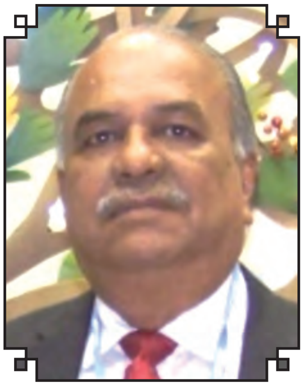
Anand Agricultural University
Anand

National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD), Ahmedabad

Shri O.P. Kohli
Hon. Governorshri of Gujarat

Shri Parshottam Rupala
Hon. Minister of State for Agriculture
& Farmers Welfare, Govt. of India

Shri Chimanbhai Saparia
Hon. Agriculture Minister
Govt. of Gujarat



Justice B.P. Singh
Formerly Judge
The Supreme Court of India&
President of NCCSD

Dr. Kirit N. Shelat
Executive Chairman, NCCSD

Dr. N.C. Patel
Vice Chancellor, AAU

INTERNATIONAL CONFERENCE
on
Food, Water, Energy Nexus in Arena of Climate Change

October 14-16, 2016

at

Anand Agricultural University, Anand, Gujarat, India

Editors

Dr. Vyas Pandey
Dr. N. V. Soni
Mr. V. B. Vaidya
Dr. Nikhil Joshi
Dr. A. K. Mishra

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Anand

National Council for Climate Change Sustainable Development and Public Leadership, Ahmedabad

International Conference on
Food, Water, Energy Nexus in Arena of Climate Change

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Anand Agricultural University, Anand, Gujarat, India

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Anand Agricultural University, Anand
and
National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) Ahmedabad

This compendium is a compilation of the key papers, invited papers and abstracts of papers to be presented in the International Conference on "Food, Water, Energy Nexus in Arena of Climate Change".

The papers/abstracts have been directly taken from the authors submissions and views mentioned therein are that of the authors. The publishers are not responsible for errors, if any.

Publisher
Anand Agricultural University, Anand
National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) Ahmedabad

First Printing : October 2016

Printed By:
Sahitya Mudranalaya Pvt. Ltd.
City Mill Compound, Kankaria Road,
Ahmedabad-380 022

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CONFERENCE PROGRAMME

PROGRAMME SCHEDULE (Tentative)

INTERNATIONAL CONFERENCE

on

“Food, Water, Energy Nexus in Arena of Climate Change”.

during October 14-16, 2016

at

Anand Agricultural University, Anand, Gujarat, India

SCHEDULE AT A GLANCE

DAY-1: FRIDAY, OCTOBER 14, 2016

Time (h)	Activity	Venue
07:30 – 09:00	Breakfast	Gymkhana Ground, AAU, Anand
08:00 – 09:30	Registration	Gymkhana Ground, AAU, Anand
09:30 – 11:00	Inaugural Function	Pendal - Gymkhana Ground, AAU, Anand
11:00 – 11:30	High Tea	Gymkhana Ground, AAU, Anand
11:30 – 13:30	Plenary Session-I	Auditorium, BA College of Agriculture
	Farmers’ Session-1	Radhakrishnan Hall, Dairy Science College, Anand
13:30 – 14:30	Lunch	Pendal- Gymkhana Ground, AAU, Anand
14:30 – 16:00	Plenary Session-II	Auditorium, BA College of Agriculture
	Farmers’ Session-2	Radhakrishnan Hall, Dairy Science College, Anand
16:00 – 16:30	Tea / Coffee Break	At the respective place
16:30 – 18:00	**Parallel Technical Sessions**	
	Technical Session-1 Theme: Green Energy, water sectors	Auditorium, BA College of Agriculture
	Technical Session-2 Theme: Agriculture and Food	Examination Hall, Ground Floor, BACA
	Technical Session-3 Theme: Resource Conservation Technology	Microbiology Department Hall, BACollege of Agriculture
	Technical Session-4 Theme: Biotech and Biodiversity	Seminar Hall, BACollege of Agriculture
18:00 – 19:00	Visit to Poster Session (From P001 to P080)	Besides the Auditorium, BACollege of Agriculture – In front of Dept. of Agri. Economics
19:00 – 20:30	Cultural Programme	Pendal - Gymkhana Ground, AAU, Anand
20:30 – 22:00	Dinner	Gymkhana Ground, AAU, Anand

DAY-2 : SATURDAY, OCTOBER 15, 2016

Timing (h)	Activity	Venue
07:30 - 09:00	Breakfast	Gymkhana Ground, AAU, Anand
08:30 - 09:30	Visit to Poster Session (From P081 to P156)	Besides the Auditorium, BA College of Agriculture – In front of Dept. of Agri. Economics
09:30 - 11:00	Plenary Session-III	Auditorium, BA College of Agriculture
11:00 - 11:30	Tea / Coffee Break	Besides Auditorium near Bio-control, B A College of Agriculture
11:30 - 13:30	**Parallel Technical Sessions**	
	Technical Session-5 Theme: Current Systems and Challenges	Auditorium, BA College of Agriculture
	Technical Session-6 Theme: Soil Health & Input	Examination Hall, Ground Floor, BA College of Agriculture
	Technical Session-7 Theme: Livestock and Fisheries	Microbiology Department Hall, BA College of Agriculture
	Technical Session-8 Theme: Global Situation and Market	Seminar Hall, BA College of Agriculture
11:30 - 13:30	Farmers' Session-3	Radhakrishnan Hall, Dairy Science College, Anand
13:30 – 14:30	Lunch	Gymkhana Ground, AAU, Anand
14:30 – 16:00	Plenary Session-IV	Auditorium, BA College of Agriculture
16:00 - 16:30	Tea / Coffee Break	Besides Auditorium near Bio-control, B A College of Agriculture
16:30 - 18:00	Valedictory Function	Auditorium, BA College of Agriculture
20:00 - 21:30	Dinner	Gymkhana Ground, AAU, Anand

DAY-3, SUNDAY, OCTOBER 16, 2016

Timing (h)	Activity	Venue
07:30 - 09:00	Breakfast	Gymkhana Ground, AAU, Anand
09:00 onwards	**Field Visit**	

MINUTE TO MINUTE PROGRAMME OF INAUGURAL FUNCTION

Venue: Gymkhana Ground, AAU, Anand

FRIDAY, OCTOBER 14, 2016

Time (h)	Particulars
09:30	Arrival of dignitaries on the dais
09:30 – 09:33	Invocation – *Ganesh Stuti* Students of BACA
09:33 – 09:36	Welcome Address by Dr.K.B.Kathiria, Director of Research, AAU, Anand
09:36 – 09:38	Floral welcome of dignitaries
09:38 – 09:40	Inauguration - Lighting of Lamp
09:40 – 09:45	Address by Dr. N.C. Patel, Vice Chancellor, AAU, Anand
09:45 – 09:50	Address by Dr.K.N. Shelat, IAS (Retd.) Executive Chairman, NCCSD
09:50 – 09:55	Address by Dr.Trilochan Mohapatra, Secretary, DARE & DG, ICAR
09:55 – 10:05	Address by Mr.Shyam Khadka, FAO Representative
10:05 – 10:10	Address by Dr. O.S. Mbuya, Professor, Florida A&M University, USA
10:10 – 10:15	Address by Justice B. P. Singh, Formerly Judge, Supreme Court of India & President of NCCSD
10:15 – 10:25	Address by Guest of Honour – Shri Chimanbhai Sapariya, Hon. Minister of Agriculture, Gujarat State
10:25 – 10:38	Address by Chief Guest – Shri Parshottam Rupala, Hon. Minister of State (Agri.), Govt. of India
10:38 – 10:40	Release of Publication
10:40 – 10:55	Presidential Address by Shri O.P. Kohli, Hon. Governorshri of Gujarat and Hon. Chancellor, AAU, Anand
10:55 – 10:58	Vote of Thanks by Dr.K.P. Patel, Organizing Secretary & Dean (Agri.)
10:58	National Anthem

SCHEDULE OF PLENARY SESSIONS

Venue : Auditorium, B. A. College of Agriculture

DAY 1: FRIDAY, OCTOBER 14, 2016

Time (h)	**Speaker/Particulars**	
11.30 - 13.30	**Plenary Session 1**	
	Chair : Dr. Trilochan Mohapatra, DG, ICAR, New Delhi **Co-Chair** : Dr.N.C.Patel, VC, Anand Agricultural University, Anand **Rapporteurs** : Dr. M K Jhala, ADR, AAU, Anand Dr. Vyas Pandey, Professor, AAU, Anand	
11.30-11.43	Key Note Address	Dr. Trilochan Mohapatra, DG, ICAR, New Delhi
11.43-11.56	Address	Shyam Khadka, FAO's representative to India
11.56-12.09	Recent Initiatives in Agriculture: Improving Efficiency in Markets, Energy and Water Use	Prof. Mukul Asher and Stuti Rawat, LYK School of Public Policy, Singapore
12.09-12.22	WATER: The Common Denominator	Prof. O.S. Mbuya, FAMU
12.22-12.35		Michelle S. Gale de Oliveira, Director, Green Economics Institute
12.35-12.48		Dr.Pramod Joshi, Director South Asia, IFPRI, New Delhi
12.48-13.01	Improving Water Use Efficiency to Sustain Crop Production under Climate Change Scenario	Prof. M B Skeikh, FAMU, USA
13.01-13.14	Climate variability and food security: the role of targeted climate forecasts	Prof. Roger Stone, ICACS, University of Southern Queensland, Australia
13.14-13.27	Organic Food & Farming in the Context of Climate Change, and Food, Water & Livelihood Security	Mr. Robert Jordan, USA
14.30-16.00	**Plenary Session 2**	
	Chair : Shri Sanjay Prasad, IAS, Principal Secretary Agriculture, Gandinagar **Co-Chair** : Dr. O. Mbuya, FAMU, USA Dr. K N Shelat, Executive Chairman, NCCSD, Ahmedabad **Rapporteurs** : Dr. D. M. Korat, ADR, AAU, Anand Dr. R. V. Vyas, Professor, AAU, Anand	
14.30-14.41		Dr. Srinivasa Rao, Director, CRIDA, Hyderabad
14.41-14.52		Andrew Enow, Director FAO, Rome
14.52-15.03		Dr. Robert Taylor, Dean, College of Agriculture and Foood Sciences, FAMU, USA
15.03-15.14	Adapting to Climate Change while Securing Food and Water: A New Challenge for Research, Policy and Business	Dr. Mohamed Behnassi, ibnZohr University of Agadir, Moroccco
15.14-15.25	Enhanced oil Recovery and Reduction of Global Warming by CO_2 Sequestration	Dr. V.P. Dimiri, Distinguished Professsor, CSIR, New Delhi
15.25-15.36	Sustainable Development and Public Leadership	Dr. R. C. Maheshwari, Foremer Vice-Chancellor, SDAU, SK Nagar

15.36-15.47	Recent technological advances in water management in relation to changing climate scenario	Dr. N. C. Patel, Vice chancellor, AAU, Anand
15.47-16.00	Geospatial Technology for Climate Change Impact Assessment on Mountain's Agriculture	Dr. N. R. Patel, Scientist, IIRS, Dehradun

DAY 2: SATURDAY, OCTOBER 15, 2016

9.30 - 11.00	**Plenary Session 3**	
	Chair : Dr. A.R. Pathak Vice Chancellor, JAU, Junagadh **Co-Chair** : Harriett Paul, Director, IAP,FAMU, USA **Co-Chair** : Govind Hariharan Professor Kennesaw State University **Rapporteurs** : Dr. K. N. Wadhvani, Professor, AAU, Anand Dr. R. N. Pandey, Professor, AAU, Anand	
09.30-09.41		Dr. Govind Hariharan, Kennesaw State University, USA
09.41-09.52		Dr. Verian Thomas, Professor of Food Science and Associate Dean , FAMU
09.52-10.03	Balancing the food, water and energy nexus for climate resilient in Indian Agriculture.	Dr. Arunachalam, Principal scientist, ICAR, New Delhi
10.03-10.14		Dr. Kinkini D Misra, Scientist-F, Vigyan Prasar, New Delhi
10.14-10.25		Dr.Tushar Shah, Fellow, IWMI, Anand
10.25-10.36		Dr. Devi Prasad Juvvadi, Director CGG, Hyderabad
10.36-10.47		Er. Anuj Sinha, Formerly Head, Vigyan Prasar, New Delhi
10.47-11.00		Dr. K.V.Raju, DMI, Patna
14.30 - 16.00	**Plenary Session 4**	
	Chair : Justice B P Singh, President, NCCSD **Penalists** : Ms. Harriett Paul, Director, IAP,FAMU, USA Dr. Mohamed Behnassi, ibnZohr University of Agadir, Morocco Dr. GovindHariharan, Kennesaw State University, USA, Michelle S. Gale de Oliveira, Director, Green Economics Institute Dr. V. V. Sadamate, Formerly Advisor, Planning Commission Prof. M. C. Varshneya, VC, Kamdhenu University, Gandhinagar Dr. N. C. Patel, VC, AAU, Anand Dr. A. R. Pathak, VC, JAU,Junagadh Dr. C. J. Dangaria, VC, NAU, Navsari Dr. Ashok Patel, VC, SDAU, SK Nagar Dr. A. M. Shekh, Ex-VC, AAU, Anand Dr. Kirit N Shelat, Executive Chairman, NCCSD, Ahmedabad Justice B.P. Singh, Chairman, NCCSD, Ahmedabad Tushaar Shah IWMI Anand Dr. M. H. Mehta, Ex-VC, GAU and Chairman, GLS, Vadodara Odemari Mbuya Ph.D. Professor Florida A&M University **Rapporteurs:** Dr.P.G. Shah, Residue Chemist, AAU, Anand Dr. Atanu Jana, Professor, AAU, Anand	
14.30-14.50	Presentations by rapporteurs – Plenary sessions	(1 to 3)
14.50-15.20	Presentations by rapporteurs – Technical sessions	(1 to 8)
15.20-15.40	Presentations by rapporteurs – Farmers sessions	(1 to 3)
15.40-16.00	Discussion	

16.30-18.00	**Valedictory Function**
	Guest of Honour : Mr. Vallabhbhai Vaghasiya, Hon. Minister of State for Agriculture, Urban Housing, Gujarat State, India **Chief Guest :** Mr. Babubhai Bokhiria, Hon. Minister of Water Supply and Animal Husbandry, Gujarat state, India Ms. Harriett Paul Director, International Agriculture Program, Dr. Mohamed Behnassi, ibnZohr University of Agadir, Morocco, Dr. GovindHariharan, Kennesaw State University, USA, Michelle S. Gale de Oliveira Director Green Economics Institute, Dr. V. V. Sadamate, Formerly Advisor, Planning Commission Prof. M. C. Varshneya, VC, Kamdhenu University, Gandhinagar Dr. N. C. Patel, VC, AAU, Anand Dr. A. R. Pathak, VC, JAU, Junagadh Dr. C. J. Dangaria, VC, NAU, Navsari Dr. Ashok Patel, VC, SDAU, SK Nagar Dr. A. M. Shekh, Ex-VC, AAU, Anand Dr. Kirit N Shelat, Executive Chairman, NCCSD Justice B.P. Singh, Chairman, NCCSD Dr. M. H. Mehta, Ex-VC, GAU and Chairman, GLS, Vadodara
16.30-17.00	Summary and Recommendations - Dr. Gopichandran - Director Vigyan Prasar
17.00-18.00	Concluding remarks by Chief Guest

SCHEDULE OF TECHNICAL SESSIONS

DAY 1: FRIDAY, OCTOBER 14, 2016

Time (h)	Paper#	Speaker/Author	Title
16.30 to 18.00		**Technical Session-1 : Green Energy and Water Sectors**	
Chair : Michelle S. Gale de Oliveira, Director Green Economics Institute **Co-chair** : Dr.GovindHariharan, Kennesaw State University, USA Dr. B. R. Shah, Director of Agriculture, Gujarat **Rapporteurs** : Dr.R. F. Suthar, Professor, AAU Dr.Pankaj Gupta, Professor, AAU			**Venue:** Auditorium, B A. College of Agriculture
16.30-16.45	A090	Perini Praveena Sri	The Electric Energy-Water Nexus in Energy Sector by Managing the Seasonal Linkages : An Empirical Analysis
16.45-17.00	A149	A. Afsal., GokulVijayan, S. R. Surabhi, K. A. Mary Agnus and P. Shaji James	Possibilities of Renewable Energy Technologies to Address the Pollution Hazard Due to Backwater Tourism in Kuttanad Area of Kerala, India
17.00-17.15	A298	P.S.Tarsikka, Jasleen Kaur and S.S.Sidhu	Ohmic heating - The green future technology applied over Soymilk
17.15-17.30	A301	D. C. Joshi and S. S. Kapdi	Global scenario on scope of biogas for mitigation of climate change
17.30-17.45	A305	Vyas Pandey and Rashmi Mehta	Climate projections and impact on evapotranspiration
17.45-18.00	A306	Mark Harvey, Shahbaz Mushtaq, Roger Stone, TekMaraseni, Erik Schmidt, Kate Reardon-Smith	The food-water-energy-climate nexus: greenhouse gas costs of achieving food and water security through investments in modern irrigation technology
16.30 to 18.00		**Technical Session 2 : Agriculture and Food**	
Chair : Dr. A. M. Shekh, Ex-VC, AAU, Anand Co-chair : Dr. K. B. Kathiria, DR, AAU Dr.R.A.Sherasiya, Director of Horticulure, Gujarat Rapporteurs : Dr. N. B. Chauhan, Professor, AAU Dr. H. R. Patel, Professor, AAU			**Venue:** Examination Hall, Ground Floor, B A College of Agriculture
16.30-16.42	A074	H. R. Patel, M.M. Lunagaria, B.I. Karande, S.B. Yadav and Vyas Pandey	Climate change impact and its adaptation measures of groundnut of Saurashtra region of Gujarat
16.42-16.54	A115	Le Khandu Thongdok, Sagar J. Patil, Rathwa Alpeshbhai Damabhai, Vikas Ramteke, Kapil Mohan Sharma	Challenge posed by climate change on mango flowering in tropics and subtropics in India
16.54-17.06	A125	Manisha Tamta, A.S. Nain, Rajeev Ranjan and S. Saha	Assessment of climate change and its impact on mustard productivity in tarai region of Uttarakhand
17.06-17.18	A162	Ritambhara Singh, Ganga Devi, Vimal Mishra, D.J. Parmar, Snehal Mishra and Akarsh A.	How Sensitive is Gujarat's Agriculture to Climate Change: A Panel Data Analysis of Major Crops
17.18-17.30	A246	Harish Patil, R. V. Tank, Vikas Ramteke and Mutteppa Gotur	Utilizing the impact of climate change for floral induction in mango
17.30-17.42	A265	T.K.S Villalan and J Alagiriswamy	A study on the effect of climate change on agriculture in India

17.42-18.00	A296	M. C. Chopada and S. K. Chhodavadia	Trends and variability in evapotranspiration at Junagadh, Gujarat
16.30 to 18.00 Technical Session-3 : Resource Conservation Technology			
Chair : Dr.Tushar Shah, Fellow, IWMI **Co-chair** : Dr. D. C. Joshi, Dean (FPT), AAU Dr. J. B. Prajapati, Dean (Dairy Sci), AAU **Rapporteurs** : Dr. R. V. Vyas, Professor, AAU Dr. M. V. Patel, Professor, AAU			**Venue** Microbiology Department Hall, B A. College of Agriculture
16.30-16.45	A017	Biswanath Ganguly	Conservation System In Agriculture
16.45-17.00	A075	M L Gaur	Vision and Challenges for Clasping Factual Potential of "Internet of Things" towards Agricultural Water Management
17.00-17.15	A084	Alluri Venkata Nagavarma	Climate change and water cycle – agriculture, Food, Water and Energy: Know the Nexus
17.15-17.30	A210	Iwin K Augastian, Abhijit Asokan, Anandu S. Hari, Basil Abraham and K. M. Sunil	Impact of Climate Change on Crop Water Requirment of Banana in Thrissur District, Kerala
17.30-17.45	A213	Parul Maurya and Reena Kumari	Assessment of ground water quality and seawater intrusion along the coastal aquifers of Kachchh through ionic ratios and isotopic studies
17.45-18.00	A223	Gontia N. K., Kumar H. and Pandya P. A.	Micro-Level Land and Water Management Planning Using Remote Sensing and GIS
16.30 to 18.00 Technical Session-4 : Biotechnology and Biodiversity			
Chair : Dr. A. R. Pathak, VC, JAU, Junagadh **Co-chair** : Dr. V P Chovatiya, DR, JAU Dr. A M Thaker, Dean (Vet), AAU **Rapporteurs** : Dr.R. S. Fougat, Professor, AAU Dr.H. Dhaduk, Associate Professor, AAU			**Venue** Seminar Hall, B. A. College of Agriculture
16.30-16.45	A004	Lipika Patnaik	Plankton Variation in the coastal waters of Dhamra, Bay of Bengal [Odisha]
16.45-17.00	A300	K B Kathiria and Akarsh Parihar	Abiotic stress management through genetic improvement under changing climate
17.00-17.15	A013	Nitika Sandhu	Water-labor-energy saving, resource-efficient, mechanized, climate smart rice
17.15-17.30	A041	Pandya Janki and R. K. Patil	Ecofriendly management of dry rot of potato incited by Fusariumsolani (Mart.) Sacc.
17.30-17.45	A158	Mahantashivayogayya.K., Basavaraj.S.Lakkundi., Ramesha M.S., Mastahana Reddy B. G., Guruprasad G.S. and Pramesh D	Evaluation of Rice Genotypes for High Temperature Tolerance In Northern Part of Karnataka
17.45-18.00	A299	K G Modha	Crop improvement strategies in arena of climate change
POSTER SESSION			
16.30 to 19.00	P001 to P080		

DAY 2: SATURDAY, OCTOBER 15, 2016

11.30 to 13.30 — Technical Session-5, Current Systems and Challenges

Chair : Dr. M.H. Mehta, Ex.Vice Chancellor (GAU) & Chairman, GLS, Vadodara
Co-chair : Dr. Jitendra Kumar, Director, DMAPR, Boriavi
Dr. A. N. Sabalpara, DR, NAU, Navsari
Rapporteurs : Dr. M. L. Gaur, Professor, AAU, Anand
Dr. H. R. Patel, Research Scientist, BTRS, AAU, Anand

Venue Auditorium, B A College of Agriculture

11.30-11.47	A088	S. B.Yadav, H. R. Patel, A.K. Mishra, M. M. Lunagaria, B. I. Karande , D. D. Patil and V. Pandey	Adaptation strategies for minimizing adverse effect of climate change on rice yield in middle Gujarat agro-climatic region
11.47-12.04	A097	AavudaiAnandhi, OdemariMbuya	Developing scenarios for climate change adaptation in India using CMIP5 climate model simulations
12.04-12.21	A103	V. K. Gondalia, RachanaKumari Bansal and A. S. Shaikh	Diversification of Agricultural Crops to Adapt to Climate Change: A Case Study of Gujarat
12.21-12.38	A184	Drishya Nair, Kritee K., Richie Ahuja, Tapan Adhya, Terrance Loecke, Shalini Reddy and Obulapathi Dava	Drought adaptation and exponential decrease in nitrous oxide emissions from sustainable groundnut cultivation in semi-arid peninsular India
12.38-12.55	A204	Mrutyunjay Swain	Trends in Climate Change Impacts on Farmers and Their Livelihoods: Evidence from Western Odisha, India
12.55-13.12	A212	Prafulla K. Nayak, B. Lal, B. B. Panda, R. Tripathi and A. K. Nayak	Crop-livestock-agro forestry based integrated farming: A way to climate change resiliency
13.12-13.30	A280	S.S. Kalamkar	Climate Change, Natural Resource Degradation & Agriculture in India

11.30 to 13.30 — Technical Session-6, Soil health and input management

Chair : Dr. Robert Jordan, Africa
Co-chair : Dr.K. S. Detroja, MD, GLDC, Gandhinagar
Dr. D. M. Korat, ADR (Agri), AAU, Anand
Rapporteurs : Dr.V. R. Bhatt, Professor, AAU, Aannd
Dr. V. P. Ramani, Associate Professor, AAU, Anand

Venue Examination Hall, Ground Floor, B A College of Agriculture

11.30-11.50	A012	Ronak R. Prajapati	Development of methylotrophic bacterial consortium and its efficacy on paddy cv. Gurjari
11.50-12.10	A032	Yogeshvari K. Jhala	Description and record of native methanotrophicbacteria able to mitigate methane from wetland paddy
12.10-12.30	A118	R.K. Mathukia, M.A. Sheikh, B.K. Sagarka and P.R. Mathukia	Feasibility of Organic Farming for Groundnut-Wheat Cropping Sequence
12.30-12.50	A262	DharaSavsani, and Y. M. Shukla	Iron and zinc biofortification in rice (Oryzasativa L.) through genetic, transcriptome and crop management approaches in changing environment
12.50-13.10	A303	K P Patel	Carbon sequestration and climate change

13.10-13.30	A304	M V Patel, H. K. Patel and S. N. Shah	Role of Organic farming in mitigation of climate change
11.30 to 13.30	**Technical Session-7, Livestock and Fisheries**		
Chair : Dr. M. C. Varshneya, VC, Kamdhenu University, Gandhinagar **Co-chair** : Dr. Hitaben Patel, Director (Animal Husbandry), Gujarat, Gandhinagar Dr.M. K. Jhala, ADR (Vet), AAU **Rapporteurs :** Dr. M. M. Trivedi, Professor, AAU Dr. K. N. Wadhwani, Professor, AAU			**Venue** Microbiology Department Hall, B A College of Agriculture
11.30-11.50	A039	Chandrashekher Saraswat	Climate changes warrant the conservation and development of Indigenous cattle
11.50-12.10	A113	Kalyan De, Arpita Mohapatra, Krishnappa Balaganur, Davendra Kumar and S.M.K. Naqvi	Effect of Nutritional Restriction on Physiological Responses of AvishanSheep in comparison to Native Malpura Sheep under Hot Semi-Arid Tropical Environment
12.10-12.30	A183	C K Misra. Shri A K Chaudhari, Shri Sunil Kumar Ail and P Jayasankar	Impact of Climate Change on Freshwater Aquaculture Sector – A Case Study from Western India
12.30-12.50	A205	H. M. Vinaya Kumar,, M. Shivamurthy, G. S. Biradar	Fishery Based Farmers' Perception of Climate Change in Coastal Karnataka (India)
12.50-13.10	A211	RamkaranJat , MdTriq Aziz	Climate Change Impact on Agriculture, Livestock and Health & Education in Sahariya Tribal Community in Rajasthan
13.10-13.30	A302	K N Wadhwani, R. J. Modi, M. M. Islam and Y. G. Patel	Livestock management strategies under arena of climate change
11.30 to 13.30	**Technical Session-8, Global Situation and Market**		
Chair : Dr. C. J. Dangaria, VC, NAU, Navsari **Co-chair** : Dr. S. Acharya, DR, SDAU Dr. Y. C. Zala, Principal, IABMI, AAU **Rapporteurs :** Dr. V. K. Gondaliya, Assoc. Prof., AAU Dr. R. S. Pundir, Assoc. Prof., IABMI, AAU			**Venue** Seminar Hall, B A College of Agriculture
11.30-11.47	A086	Simi Mehta	Effects of Climate Change on Food Security in South Asia
11.47-12.04	A185	Kritee K, Drishya Nair, Daniel Zavala-Araiza, Jeremy Proville, Richie Ahuja, Joe Rudek, Tapan K. Adhyab, Steven P. Hamburga, Bruce Linquiste, Shalini Balireddygari, Obulapathi Dava, Malla Reddy, Karthik Ram, Abhilash Salai Athiyaman, Murugan Madasamy, Daniel Anandaraj	Discovery of high rice nitrous oxide emissions calls for integrated management of water, nitrogen and organic matter for reducing net greenhouse gas emissions due to rice cultivation
12.04-12.21	A226	L.Ganesan, Ananya Kashyap	Food Security in India: An Analysis through Food Production

12.21-12.38	A230	D.Gopal, J.N.Sharma, Ganapathy Venkatasubramanyam	Climate Change – Impact on Developing Countries – A Socio-Legal Study
12.38-12.55	A243	L.Ganesan and R.SenthamizhVeena	Changes Observed in Dietary Pattern in India
12.55-13.12	A289	S. Madhu, T.V. Lakshmi Kumar, Humberto Barbosa, K. Koteswara Rao and Som Sharma	Studies of major crop yields of India and their response to increased population's food demands
13.12-13.30	A297	Sunil Kumar, Ramesh Kumar and P.C. Sharma	Extraction of pectin from kinnow (Citrus reticulata L.) waste
POSTER SESSION			
8.30 to 11.30	P081 to P156		

SCHEDULE OF FARMERS' SESSIONS

DAY 1: FRIDAY, OCTOBER 14, 2016

Time(h)	**Particulars**	
11.30 - 13.30	**Farmers' Session-1**	
	Chair : Shri Sanjay Prasad, IAS, Principal Secretary (Agri), Gandhinagar **Co-Chair** : Dr. V.V. Sadamate, Formerly Advisor-Planning Commission Harriett A. Paul, Director, Office of International Agriculture FAMU, USA Dr. Arun A. Patel, DEE, AAU, Anand **Rapporteurs** : Dr. S. R. Patel, OSD, Jabugam Dr. G. G. Patel, Programme Coordinator, KVK, Devataj	**Venue** Radhakrishna Hall, Dairy Science College, AAU, Anand
11.30-11.45	Opening Remarks	Shri Sanjay Prasad, IAS, Principal Secretary (Agri), Gandhinagar Harriett A. Paul, Director
11.45-11.55	આબોહવાબદલાવઅનેઆકસ્મિકપાકઆયોજન ***(Contingent crop planning under changing climate)***	Dr. A. C. Sadhu, Professor (Agronomy), AAU
11.55-12.05	આબોહવાબદલાવઅનેસજીવખેતી ***(Organic farming in climate change mitigation)***	Dr. M. V. Patel, Professor (Agronomy), AAU
12.05-12.15	આબોહવાબદલાવઅનેપાકજીવાતનિયંત્રણ ***(Insect pest management under changing climate)***	Dr. P. K. Borad, Professor (Entomology), AAU
12.15-12.25	મહિલા ખેડૂતોની ભૂમિકા ***(Role of Women Farmers)***	MsNisha Shah, NCCSD
12.25-12.45	***Experience sharing talks***	Farmers
12.45-13.00	***Study Feedback***	Dr R .B Patel-NCCSD
13.00-13.30	ખેડૂતોનાપ્રતિભાવઅનેચર્ચા ***(Farmers' feedback and discussion)***	
Summing Up	Dr. V.V. Sadamate, Formerly Advisor-Planning Commission	
14.30 -16.00	**Farmers' Session-2**	
	Chair : Dr. Ashok Patel, VC, SDAU, S K Nagar **Co-Chair** : Nandkumar Divate, Program Coordinator, FAMU Dr. A.M. Parakhia, DEE, JAU, Junagadh Naranbhai Patel, NCCSD, Ahmedabad **Rapporteurs** : Dr. V.R. Boghara, Asso. DEE, AAU, Anand Dr. M. J. Patel, Associate Professor, AAU	
14.30-14.50	Opening Remarks	Dr K.V Raju,Ditector, DMI Bihar Dr. O Mbuya, FAMU Nandkumar Divate, Program Coordinator-FAMU Jay Prakash Gosaliya, Excel Industries
14.50-15.00	બદલાતા વાતાવરણમાં હવામાન આગાહીની ઉપયોગીતા ***(Uses of weather forecast in mitigation of climate change)***	Dr. S. B. Yadav, Asstt. Professor (Agril. Meteorology), AAU
15.00-15.10	આબોહવા બદલાવ અને પાક રોગ વ્યવસ્થાપન ***(Crop disease management under changing climate)***	Dr. R. N. Pandey, Professor(Plant Pathology), AAU

15.10-15.20	બદલાતા વાતાવરણમાં પશુધન વ્યવસ્થાપન ***(Managing livestock under changing climate)***	Dr. M. M. Trivedi, Professor(Animal Science), AAU
15.20-15.30	આબોહવા સ્માર્ટ કૃષિ ***(Climate Smart Agriculture)***	Shri Malay Joshi VRTI Mandvi
15.30-15.50	***Experience sharing talks***	Farmers
15.50-16.00	ખેડૂતોના પ્રતિભાવ અને ચર્ચા ***(Farmers' feedback and discussion)***	
Summing Up	Dr. Amrutlal M. Parakhia , Director, Extension Education, Junagadh Agricultural University	
DAY 2: Saturday, October 15, 2016		
11.00 - 13.30	**Farmers' Session-3**	
	Chair :Mr. Babubhai Jebaliya, Chairman, Gujarat Agro Ind. Corp. **Co-Chair** :Dr.G.R.Patel, Director of Extension Education, NAU, Navsari : Mr. B.M. Modi, MD,Gujarat State Seeds Corporation : Mr. K.S. Randhawa, IFS MD, Gujarat Agro Ind. Corp. **Rapporteurs** : Dr. J. B. Patel, Associate Prof. BACA, Anand : Dr. Ajay Bhanvadia, Associate Research Scientist, AAU	
11.00-11.15	***Opening Remarks***	Dr R.Gopichandran Dr. M.Behnassi, ibnZohr University of Alagir,Morocco Shri N M Patel- NCCSD
11.15-11.25	આબોહવાબદલાવઅનેઆકસ્મિકપાકઆયોજન ***(Contingent crop planning under changing climate)***	Dr. A. C. Sadhu, Professor (Agronomy), AAU
11.25-11.35	બદલતા હવામાનમાં "આબોહવાનું અનુમાન ***(Role of weather forecasting in arena of Climate change)***	DrRohit Shrivastva-ICCSIR
11.35-11.45	આબોહવા બદલાવ અને સજીવખેતી ***(Organic farming in climate change mitigation)***	Dr. M. V. Patel, Professor (Agronomy), AAU
11.45-11.55	આબોહવા બદલાવ અને પાક જીવાત નિયંત્રણ ***(Insect pest management under changing climate)***	Dr. P. K. Borad, Professor (Entomology), AAU
11.55-12.05	બદલાતા વાતાવરણમાં હવામાન આગાહીની ઉપયોગીતા ***(Uses of weather forecast in mitigation of climate change)***	Dr. S. B. Yadav, Asstt. Professor (Agril. Met), AAU
12.05-12.15	બદલાતા વાતાવરણમાં પશુધન વ્યવસ્થાપન ***(Managing livestock under changing climate)***	Dr. M. M. Trivedi, Professor(Animal Science), AAU
12.15-12.45	***Experience sharing talks***	Farmers
12.45-12.55	***Study - Feedback***	Dr. I. R. Rathod, NCCSD
12.55-13.05	Speaker from Industry	Dr. P.K. Shukla, Pidilite Industries, Mumbai
13.05-13.30	ખેડૂતોના પ્રતિભાવ અને ચર્ચા ***(Farmers' feedback and discussion)***	
Summing up	***Shri Bharat Modi - Managing Director Gujarat State Seed Corporation Limited***	

TITLES OF ABSTRACTS [POSTER PRESENTATION]		
Paper#	**Title**	**Authors**
P001A002	Performance improvement using Smart "Energy Enhancer"- 4 M Device and its effects on Flowing Waters for Agriculture ,Industrial as well as commercial applications.	Prof Gaurang Sharma
P002A003	APPLICATION OF LAND CONFIGURATION IN POORLY DRAINED FLAT LANDS OF GUJARAT FOR SUSTAINING COTTON CULTIVATION	M. D. Vora
P003A006	EFFECT OF SPLIT APPLICATION OF NITROGEN ON WHEAT UNDER NORTH GUJARAT CONDITION	DR. VINODKUMAR B. MOR
P004A010	COMPARATIVE BODY WEIGHT OF INDIGENOUS SHEEP BREEDS ON DEHYDRATION AND REHYDRATION IN MIDDLE GUJARAT DURING SUMMER SEASON	N.R. Patel, M.M. Islam, R.J. Modi, K.N. Wadhwani and R.S. Darji
P005A016	Effect of livestock production on climate and mitigation strategies under changing climate Scenario in India	Dr. Rajni Arora
P006A027	Impact of climate change on seasonal incidence of jassid, Empoasca kerri (Pruthi) in groundnut	Dr G M Parmar
P007A028	FEED INTAKE OF INDIGENOUS HOGGETS ON DEHYDRATION AND REHYDRATION IN MIDDLE GUJARAT AGROCLIMATIC CONDITIONS	N.R. Patel, , R.J. Modi, M.M. Islam and K.N. Wadhwani
P008A030	EFFECT OF WATER RESTRICTION ON NUTRIENT INTAKE OF INDIGENOUS SHEEP BREEDS	K.N. Wadhwani, N.R. Patel, M.M. Islam and R.J. Modi
P009A031	STUDY OF PHYSIOLOGICAL RESPONSES OF HOGGETS ON DEHYDRATION AND REHYDRATION IN MIDDLE GUJARAT AGROCLIMATIC CONDITIONS	N.R. Patel,, R.J. Modi, M.M. Islam and K.N. Wadhwani
P010A036	Potential impact of climate change on agriculture and food security	Elangbam Premabati Devi
P011A038	Effect of Rates of Iron Application on Growth, Yield and Quality of Rice Varieties under Aerobic and Submerged Conditions	OJEFKHAN IMDADALIKHAN PATHAN
P012A045	APPLICATIONS OF IMAGE PROCESSING TECHNIQUES FOR COUNTING WHITEFLIES AND THRIPS ON COTTON LEAVES	Tukaram Annasaheb Nikam
P013A048	CLIMATE CHANGE PROJECTION BY STATISTICAL DOWNSCALING METHOD	Leimapokpam Netajit Singh
P014A051	Effect of Sulphur and Zinc on Yield and nutrient uptake by summer Greengram (Vigna radiata L.) under Middle Gujarat Conditions	Dr. N. J. Jadav
P015A054	Impact of Biotechnology on Food Security	Gopal Wasudeo Narkhede
P016A057	Impact of Climate Change on Crop Pollinators	Amarcholi Jaykishan Jivraj
P017A058	REHABILITATION OF WASTELAND BY MEDICINAL PLANTS A REVIEW	CHAUDHARI LAV
P018A061	Food security a major challenge in agriculture - Perspectives and Options	NIKKI BHARTI
P019A066	Development of linkage map and mapping for MYMV resistance in Mungbean	THAKUR PRANITA PRABHAKAR
P020A068	STUDIES ON EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY ON BIOLOGY OF RICE MOTH Corcyra cephalonica (STAINTON)	Pankaj S. Wadaskar
P021A069	STUDIES ON BIOLOGY AND FEEDING POTENTIAL OF Chrysoperla zastrowi sillemi (ESBEN-PETERSON) ON EGGS OF Corcyra cephalonica (STAINTON)	Dharmesh V. Jadav

Paper#	Title	Authors
P022A070	BIOLOGY AND PARASITIZATION ABILITY OF Trichogramma chilonis ON EGGS OF Corcyra cephalonica AT DIFFERENT TEMPERATURE CONDITIONS	Tushar K. Balas
P023A071	Effect of climate change on planting dates of preseasonal sugarcane (Var. CoM 0265)	Dr. Pramod Manikrao Chaudhari
P024A078	BIOCHAR FOR ENHANCING AGRICULTURAL SUSTAINABILITY UNDER CLIMATE CHANGE	HANSA LAKHRAN
P025A079	HOST RANGE OF RICE BLUE BEETLE LEPTISPA PYGMAEA BALY (COLEOPTERA: CHRYSOMELIDAE) IN KONKAN REGION	MAHADEV SHANKAR MASAL
P026A080	Insect Pest Problems in groundnut: Changing Trends	Dr G M Parmar
P027A081	ENERGY SAVING AND RURAL DEVELOPMENT IN ARENA OF CLIMATE CHANGE	RAJNI RAJAN
P028A087	Development of Sustainable Livelihood Security Index for Agricultural Sustainability in Gujarat	Mahima Ghabru and Ganga Devi
P029A089	Enzymatic, microbial, nutrient components estimation and its correlation study of soil samples from the coastal wetland of Gujarat	Disha Nayak, M.H. Fulekar
P030A094	Climate Change Adaptation: Real Time Nitrogen Management Using Leaf Colour Chart and Chlorophyll meter	B.B. Barad, K.H. Bodar, R. K. Mathukia
P031A095	Effect of integrated nutrient management on soil properties	K.H. Bodar, B. B. Barad, K. B. Parmar
P032A096	Effect of winged subsoiler on soil characteristics and subsoiler draft	Khole Priyanka R., Dr. k. k. jain and Saumya Shukla
P033A104	Constrains in Adoption and Operation of Drip Irrigation	P. A. Pandya and D. K. Dwivedi
P034A105	A Small Scale Briquetting Machine	Hardik Joshi, P. Mohnot, Saumya Shukla and Khole Priyanka R.
P035A108	VEGETABLE PRODUCTION USING PLASTICULTURE	Patel, U. V., Chaudhary, A. T., Chaudhary, R. R. and Patel, H. R.
P036A109	EVALUATION OF BOTANICAL EXTRACTS AGAINST JASSID [Amrascabiguttulabiguttula (Ishida)] AND WHITEFLY [Bemisiatabaci (Gennadius)] ON OKRA [Abelmoschus esculentus (L.) Moench]	Chaudhary, A. T.,Chaudhary, R. R.,; Patel, U. V., Patel, H. R. and Panchal, S. B.
P037A110	INTEGRATED FARMING SYSTEM IN NORTH GUJARAT REGION	Chaudhary, R. R, Patel, U. V., Chaudhary, A. T., Panchal, S. B. and Patel, H. R.
P038A116	Solubilization of phosphate and potash through bacterial inoculation in wheat (Triticum aestivum L.) on calcareous clayey soil	Savaliya NV, RK Mathukia and SJ Vekariya
P039A117	Integrated weed management in rabi popcorn (Zea mays var. everta)	BHAVNA BARAD, R.K. MATHUKIA, B.S. GOHIL AND S.K. CHHODAVADIA
P040A119	ASSESSMENT OF NITRATE (NO3-) LEVELS AND SOME HEAVY METALS IN DIFFERENT VEGETABLES AVAILABLE IN NAVSARI MARKET	S.M. Bambhaneeya, Sonal Tripathi and Ruplal Prasad
P041A120	EFFECT OF APPLICATION OF DIFFERENT ORGANIC MANURES ON PHYSICAL AND CHEMICAL PROPERTIES OF MAIZE GROWN SOIL	V.P. Parmar, R.D. Shinde, Dinesh Kumar and J.M. Kokani
P042A122	Nutrient Content and Uptake of Coriander is affected by Organic Manure and Bio Fertilizer	S. J. DONGA, P.K. CHOVATIA AND L. C. VEKARIA
P043A126	Reddening and physiological wilting of Bt cotton – a perspective on its management under field condition	R. N. Pandey, N. M. Gohel, R. B. Patel, K. P. Patel and M. V. Patel
P044A132	Effect of different insecticides and influence of abiotic factors on population of stem borer, Sesamia inferens Walker in durum wheat	Barad, A.H., Rathod, N. K. and Patel, N.B.

Paper#	Title	Authors
P045A133	Climate Change Affecting Crop Diversification in Gujarat	Khyati M Patel, Bipin M Padhiyar
P046A139	The activity of sucking pests on okra in relation to weather parameter	Patel P.B. and Borad P.K.
P047A140	Effect of bio-phos (Chaetomium globosum) on castor(Ricinus communis L.) yield at different levels of phosphorus under irrigated conditions	P. M. VAGHASIA V. B. BHALU AND M. K. GHELANI
P048A141	Effect of Integrated Nutrient Management on Yield of Groundnut under Rainfed Conditions	P. M. VAGHASIA, K. L. DOBARIYA AND V. B. BHALU
P049A142	Role of Information and Communication Technology in climate change	SHITAL H. BHOJANI, D.R. KATHIRIYA, R.S. PARMAR
P050A146	Maximum use of plastic for vegetable crop production in changing climate	Gajendra Singh Chouhan and Bhavesh Kothariya
P051A147	Impact of various abiotic factors on incidence of aphid, Uroleucon compositae (Theobald) in gaillardia transplanted in different periods	Jyoti Roul, Bharpoda T. M. and Zala M. B
P052A152	MICROBIAL CONSORTIA FOR PRODUCTION AND ENRICHMENT OF BIO-COMPOST FROM WHEAT STRAW	Dabhi Bhumika K., Vyas R V., Shelat H N.
P053A153	Effect of weather parameters on population fluctuation of major sucking insect pests in Bt cotton (BG II)	C. B. Dhobi, T. M. Bharpoda and R. K. Thumar
P054A157	Clean Energy Generation from Agricultural Biomass	Dr. R. R. Gajera and D.C. Joshi
P055A163	STUDIES OF WEATHER EFFECT ON FROG-EYE SPOT DISEASE IN BIDI TOBACCO USING LOGISTICS REGRESSION	Joshi K. R., Parmar D. J. and Rojasra Y. M.
P056A165	BIOCHAR FOR SUSTAINABLE AGRICULTURE	Patel, H. R.; Patel, U. V.; Vihol, V. J.; Chaudhary, A. T. and Chaudhary, R. R.
P057A167	PRESERVATION OF FRUITS AND VEGETABLES AT CHILLING TEMPERATURES	Govind Vishwakarma, Bhanu Pratap, Rashmi and Pradeep Kumar Vishwakarma
P058A182	Effect of drought stress on quality composition in upland cotton seed	S. Mandhania, R.S. Sangwan, S.S. Siwach, S.R. Pundir, O. Sangwan, and S. Nimbal
P059A186	ROLE OF GLOBAL CLIMATE CHANGE FOR INDIAN AGRICULTURE AND MITIGATION	Satyendra Kumar Gupta Kishan Kumar Sharma,Vidhi Garg,sourav choudary
P060A187	Performance of Soil Health Card Programme in Gujarat	Mrutyunjay Swain, S. S. Kalamkar & Kalpana Kapadia
P061A189	Mitigation Of Climate Change Through Cultivation Of Drought And Heat Tolerant Wild vegetable Species	Sagar Raj Nayak, Chaudhari Vibhuti L., Chaudhary Kamlesh V.
P062A191	Regression Analysis of rainfall, maximum temperature and bright sunshine in relation to yield of groundnut for Junagadh district in climate change context	B.B.Ramani, D.V.Patel and M.C.Chopada
P063A196	IMPACT OF CLIMATE CHANGE AND POPULATION GROWTH ON WATER RESOURCES IN INDIA	Sourav Choudhury, Stuti Debapriya Behera, Kishan Kumar Sharma, Lokesh Kumar Saini
P064A200	Women SHGs' Amelioration through Group Dynamic Effectiveness in Gujarat	R.M. Jadeja, S.J. Parmar and V.M. Chovatiya
P065A206	Measuring decision-making and economic performance of farmers to manage climate-induced crisis in Coastal Karnataka (India)	H. M. Vinaya Kumar, M. Shivamurthy, G. S. Biradar
P066A207	The Potential Impact of Climate Change on weeds and Corresponding Influence on Food Security	Vikas Vishnu, V. P. Usadadia and Anil Kumar Mawalia
P067A208	Performance of National Agricultural insurance Scheme in Gujarat	Kalpana Kapadia and Mrutyunjay Swain
P068A209	INVESTIGATION ON VARIATION IN BIOCHEMICAL PROPERTIES OF MANGO cv. KESAR DUE TO VARIOUS ENVIRONS AND EDAPHIC CONDITIONS OF SAURASHTRA REGION (GUJARAT)	V.M. Chovatiya, R.M. Jadeja and S.R. Aghera

Paper#	Title	Authors
P069A215	Modelling and simulating the weather variables on chickpea yield in Valsad district of Gujarat state	P.B. MARVIYA, R. M. JADEJA AND V. M. CHOVATIYA
P070A219	Burl intensity and incidence in mango diversity under different agro ecological zones of India	Parmeshwar Lal Saran, Riddhi P. Vasara and Jitendra Kumar
P071A220	Effect of weather parameters on incidence of major insect pest of brinjal	F. S. Khan, P. S. Borikar, P. M. Sangle and A. A. Motaphale
P072A222	Analysis of combining ability and gene action in Indian bean (Lablab purpureus (L.) Sweet)	Shreya Sen, Patel R. L., Patel R. A., Modha K. G. and Patel R. K.
P073A225	Climate change: Erase the genetic resource for foods and agriculture	Dipesh Borwal, Kishan Kumar Sharma, Dinesh Kumar and Jyoti Asati
P074A228	Performance of Summer Groundnut(Arachis hypogaea L.) under Drip Irrigation at different Plant Geometry	P. M. Vaghasia, V. H. Kachhadia and V. B. Bhalu
P075A229	Carbon Sequestration Through Agroforestry Systems- A Need More Than Option	Debiprasad Rout , Sumit Mohanty and Sagar Raj Nayak
P076A231	GENETIC ARCHITECTURE FOR YIELD AND ITS COMPONENTS IN BRINJAL	Jyoti Asati , Dhirendra Kumar and Patel R. K
P077A234	Production Technology of Cucumber under Changed Climatic Conditions	Atish N. Patel
P078A240	Effect of iron on growth parameters contributing in increasing production efficiency of chickpea (Cicer arietinum L.)	KULDEEP, P. D. Kumawat and K. B. Parmar
P079A242	Farming under urban landscape for climate resilience: a review	Kapil Mohan Sharma, J. J. Amarcholi and Vikas Ramteke
P080A244	Effect of climate change on Livestock Production	Chaudhari Vibhutiben L.; Sheth Sachin G.; Sagar Raj Nayak; Kamlesh Chaudhary
P081A245	Climate Resilient Vegetable Production System For Nutritional And Food Security – A Review	Sagar Raj Nayak , Chaudhari Vibhuti L., Chaudhary Kamlesh V.
P082A247	FOOD SECURITY THROUGH THE LENSES OF LAW	Anubhuti Dungdung , Dhanya Mahesh, Nikita Koradia ,
P083A248	jurisprudential Study on Climate Change with Special emphasis on Indian Constitution	VIGNESH.T
P084A252	Long Term Effect of Integrated Nutrient Management on Yield andCarbon Mineralization under Groundnut-Wheat Cropping System in Medium black Calcareous soil	Gaurav U. Karad, N.B. Babariya, M.B. Viradiya and S. P. Deshmukh
P085A254	Climate change: A curse for global water imbalance	Dinesh Kumar, Dipesh Borwal and Vikas Vishnu
P086A260	Effects of Climate Change on Agriculture a Case Study in Delhi region, India	Surendra P. Singh, Mahesh K. Jat
P087A261	Integrated nutrient management imparts the climate change	Santosh Onte, Dipesh Borwal, Deep Singh Rajpurohit and Ritesh kumar
P088A264	Increased incidences of Microbial Contamination And Disease Outbreak In Fresh Vegetables Due to Climate Change - A Review	Chaudhary Kamlesh V., Sagar Raj Nayak , and Utkal Ranjan Sahoo
P089A269	Population of major natural enemies in Bt cotton grown in Vadodara district	H. C. Patel, R. K. Thumar, T. M. Bharpoda, M. R. Dabhi, P. K. Borad and M. G. Patel
P090A274	A plant biotechnology and biodiversity	Panchal, S.B.,Chaudhary, R.R. and Chaudhary, A.T.
P091A281	Organic Farming in India: Strategy for Climate Change Mitigation	Yamuna R. Pillai and S.S. Kalamkar
P092A282	Floriculture: A Viable Option of Diversification in Climate Change	B. M. Padhiyar, J. J. Amarcholi, S. G. Sheth, V. J. Chaudhary

Paper#	Title	Authors
P093A283	COMPARATIVE PERFORMANCE OF BIVOLTINE SILKWORM HYBRIDS FOR DIFFERENT ECONOMIC TRAITS UNDER LATUR (MAHARASHTRA) CONDITION	S. R. Dhandge, C. B. Latpate, P. S. Wadaskar and A. B. Gore
P094A287	Association of various physical factors on activity of aphid, Uroleucon compositae (Theobald) infesting gaillardia grown at different periods	Jyoti Ranjan Roul, Bharpoda T. M. and Suthar M. D.
P096A290	Quantify the relationship of meteorological parameters for white fly population over cotton	Anil Kumar, Raj Singh, J Beniwal, Diwan Singh and Anurag
P097A294	Protected cultivation as a tool against climate change	B. L. Dudhat and B. N. Satodiya
P098A295	Assessment of accuracy of medium range weather forecast at Junagadh	M. C. CHOPADA and S. K. CHHODAVADIA
P099A307	Response of Kharif and Rabi Crops to Urea Phosphate for application in Pearlmillet-Wheat Cropping System In Typic Ustochrepts Soil of Anand District, Gujarat	K.C. Patel, V. R. Bhatt and B. A. Patel
P100A308	Effect of Diatomaceous Earth as a Source of Silicon on yield and chemical composition of Bt cotton in sandy clay loam soil of middle Gujarat	K.C. Patel, N. B. Prakash, G. J. Patel and Ashwin S. Patel
P101A309	Bio-efficacy of botanical and microbial insecticides for the control of teak skeletonizer, Eutectona machaeralis, infesting on teak in Anand region	N. R. Chauhan, M. G. Patel and T. M. Bharpoda
P102A310	SULPHUR AND MOLYBDENUM EFFECT ON NUTRIENT CONTENT AND UPTAKE OF KHARIF FORAGE COWPEA (Vigna unguiculata (L.) Walp.)	N. N. Chaudhary, S. V. Rathod and V.R.Bhatt
P103A009	Efficiency of C5 (B. cereus) for reduction in COD of dairy waste effluent	Kanchan Mogha
P104A011	Screening of Promising Genotypes for Blast Disease Resistance In Rice (Oryza sativa L.) Over Environments	Dr. Jaydeep P. Bhatt
P105A037	DEVELOPMENT OF FINGERPRINTS AND THEIR UTILIZATION IN SEED GENETIC PURITY ASSESSMENT OF FLAX (LINUM USITATISSIMUM L.) CULTIVARS OF CHHATTISGARH STATE OF INDIA	Dr. Vikas Pali
P106A040	Role of Dairy Industry in arena of climate change	Istiyakhusen A Chauhan
P107A064	EFFECT OF DIFFERENT GROWING MEDIA ON GERMINATION, SEEDLING GROWTH OF PAPAYA (CARICA PAPAYA L.) CV. MADHU BINDU	SANJAY KUMAR NAGAR
P108A065	Identification of differentially expressed genes in roots and shoots of maize germplasms for drought tolerance	WAWGE MOHAN NIVRUTTI
P109A085	Efficient Irrigation Schedule, Seed Rate and Sowing Method for Maximum Wheat yield under Semi-arid Inceptisols	Dr. Vijendra Shantaram Baviskar
P110A091	Microalgae - A multidirectional tool to combat with climate change	Panpatte D. G., Shelat H. N., Jhala Y. K. and Vyas R. V.
P111A099	Inter-Relationships between rainfall distribution and groundnut yield in Bhavnagar and Junagadh districts of Gujarat State	R.S. PARMAR, D.R. KATHIRIYA and D.K.PARMAR
P112A100	Web-Based Irrigation Scheduling System	Sowmyaa Guptaa, D.R.Kathiriya , R.S.Parmar and H.K.Patel
P113A101	Empowering Agricultural Extension with RS & GIS information	M. P. Raj
P114A102	Succession of major insect pests in okra, Abelmoschus esculentus (L.) Moench	Naziya P. Pathan and T. M. Bharpoda
P115A114	Impact of meteorological factors on activity of major insect pests in tomato Lycopersicon esculentumMill. under middle Gujarat condition	SUSHMA DEB AND T. M. BHARPODA

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P116A135	Impact of Climate Change on Ground Water Resources in India	Rachana Kumari Bansal, V. K. Gondaliya, K. S. Jadav, A. S. Shaikh
P117A136	Weed management options to manage complex weed flora in onion (Alium cepa L.) nursery	S. P. KADU, D. D. CHAUDHARI, B. D. PATEL AND H. K. PATEL
P118A138	Biopharming: Innovative approach to natural resources utilization	D.B. Minipara
P119A150	IMPACT OF CATASTROPHIC HAILSTORMS ON MAHARASHTRA'S CROPS, LIVE STOCK AND HUMAN BEINGS	Kore Prabhakar N., Barot Himanshu R., Pradeep Kumar Vishwakarma, Sumit Singh and Patel Hiral R.
P120A154	Effect of different irrigation scheduling on soil moisture, water production function and simulated yield of mustard by using CROPWAT model	D. D. Patil, H. R. PateL, S. B. Yadav, R. Dave and V. Pandey
P121A155	Chitosan: An Emerging Tool for Sustainable Agriculture	Aravind.T and A. B. Brahmbhatt
P122A160	Hi-tech pre-harvest horticulture technology in banana cultivation	T. Tsomu and H.C. Patel
P123A177	EFFECT OF WEATHER ON FROG-EYE SPOT DISEASE IN BIDI TOBACCO NURSERY	Y. M. ROJASARA, D. J. PARMAR AND H. R. PATEL
P124A178	ROLE OF entomophage bio-diversity park IN TOBACCO BASED AGRO ECOSYSTEM	N A Bhatt
P125A179	Herbicides combinations for control of complex weed flora in wheat	D.D. Chaudhari, B.D. Patel, H.K. Patel, V.J. Patel and A. Mishra
P126A180	Diversity and Efficacy Study of Native Rhizobium Sp. on Summer Groundnut from Sukhi River Command Area of Middle Gujarat	Patel H. K., Patel S. R., Vyas R.V., Shelat H. N., Chaudhari D. D. and Patel B. D.
P127A199	Efficacy of organic amendments extract against Damping-off (Pythium aphanidermatum) of Tomato in vitro and in vivo	Priya P. Sheth,Subhash J. Patel
P128A201	WEATHER BASED RELATIONSHIP OF ADULT MOTH CATCHES OF PINK BOLLWORM AND LEAF EATING CATERPILLAR IN COTTON GROWING CROP AREA	and Borad P. K.Kalola A. D., Parmar D. J., Motka G. N., Vaishnav P. R., Bharpoda T. M.
P129A233	CURRENT SYSTEM FOR MEETING CHALLENGES IN FARMING SUGGESTIONS OFFERED BY NEEM TREE OWNER FARMERS TO POPULARISE NEEM-AN INDIAN PERSPECTIVE	Kishan K., N.B. Chauhan and J.B.Patel
P130A236	Morphological and Biochemical Screening of Guava (Psidium guajava L.) Hybrids	Pawan K. Nagar and Saddam husain
P131A241	Dissipation of Imidacloprid, Acetamiprid and Fenpyroximate on chilli fruits	P. M. Sangle; D. M. Korat; and P. G. Shah
P132A249	Impact of Climate change on fruit production	Pawan K. Nagar and B. N. Satodiya
P133A267	BIODIVERSITY OF ARTHROPOD PREDATORS OF INSECT PESTS AND THEIR ENHANCEMENT STRATEGIES IN AGRO ECOSYSTEM	N. B. Patel and J. P. Lodaya
P134A270	Incidence of leaf reddening in Bt cotton grown in Vadodara district	P. K. Borad, T. M. Bharpoda, R. K. Thumar, H. C. Patel, M. R. Dabhi and M. G. Patel
P135A271	Study of sucking insect pests infesting Bt cotton in Vadodara district	T. M. Bharpoda, H. C. Patel, R. K. Thumar, M. R. Dabhi, P. K. Borad and M. G. Patel
P136A272	Effect of Magnesium sulphate against leaf reddening in Bt cotton	M. R. Dabhi, H. C. Patel, R. K. Thumar, T. M. Bharpoda and P. K. Borad
P137A273	GENETIC RESOURCES OF FRUIT CROPS IN INDIA, THEIR CONSERVATION AND UTILIZATION	Kore Prabhakar N., D. A. Patel, Pradeep Kumar Vishwakarma, Lokesh Yadav, Vasara Riddhi P.
P138A275	ROLE OF BIOTECH CROPS IN RELATION TO MITIGATING EFFECTS ON CLIMATE CHANGE	Pradeep Kumar Vishwakarma, Govind Vishwakarma, Vasara Riddhi P., Minipara Dipal

Paper#	Title	Authors
P139A277	Impact of Climate Change on Yield of Pigeonpea	Snehal Mishra, Ritambhara Singh, R. Kumar, Abhishek Kalia and S.R.Panigrahy
P140A284	Activity of pink bollworm in Bt cotton grown in Vadodara district through pheromone traps	M. V. Patel, R. K. Thumar, M. B. Zala, T. M. Bharpoda and P. K. Borad
P141A285	Incidence of bollworms in Bt cotton grown in Vadodara district	R. K. Thumar, T. M. Bharpoda, H. C. Patel, M. R. Dabhi, P. K. Borad and M. G. Patel
P142A286	WASTE LAND MANAGEMENT THROUGH PLANTING OF FRUIT PLANTS	Pradeep Kumar Vishwakarma, Kore Prabhakar N., Barot Himanshu R., Vasara Riddhi P. and Lokesh Yadav
P143A292	Impact assessment of climate change on groundnut in north-Saurashtra Agro-climatic zone of Gujarat	P. K. PARMAR, H.R. PATEL, S.B.YADAV and V. PANDEY
P144A293	A Review on study the impact of climate change on cereal crop production by using DSSAT model	B. M. Mote, Vyas Pandey and Neeraj Kumar
P145A005	MANAGEMENT OF CROPPING SYSTEMS FOR RESOURCE CONSERVATION AND CLIMATE CHANGE	A.M. Patel, P.K. Patel, A.K. Saini and K.M. Patel
P147A129	MONITORING OF RESISTANCE IN FIELD POPULATIONS OF Aphis gossypii Glover TO CONVENTIONAL INSECTICIDES	R.S. Khandar, U.S. Kulkarni, S.S. Madankar
P149A164	EFFECT OF TYPE OF CUTTING AND GROWTH REGULATORS ON ROOTING OF 'WAX APPLE' (Syzygium samarangense L.)	Chaudhary, H. L.; Chaudhary, A. T.; Patel, U. V.; Chaudhary, R. R.; Patel, H. R.
P150A195	PERFORMANCE OF MUSTARD (Brassica juncea L.) TO DIFFERENT PLANTING METHODS AND WEED MANAGEMENT UNDER SOUTH GUJARAT CONDITION	Rameti Jangir, L. K. Arvadiya and Sunil Kumar
P152A235	Bananas and climate change: what is going to happen to one of the world's favourite fruits?	P. R. Patoliya and A. N. Patel
P153A257	Assessment of Soil Microbial Activity and Biodiversity in Soil	Neha Sankle, Gaurav U. Karad, Neeta Rathor
P154A278	Development of statistical model for sucking pest forecasting in Rainfed Bt Cotton	P. R. Jaybhaye, C. B. Latpate, M. B. Karhale and P. R. Zanwar
P155A279	PREDICTION OF WHITEFLY AND THRIPS INCIDENCE BY USING MULTIPLE REGRESSION MODEL	P. R. Jaybhaye, V. M. Wagh, P. M. Sangle and P. B. Shinde
P156A291	Effect of Phytoherb Withania somnifera (Ashwagandha) on Haematological Parameters in Normal and Synbiotic Supplemented Broiler Chickens under Semi-arid Climatic Conditions	Sonal Thakur, Tribhuwan Sharma, Meenakshi Sareen, Anil Moolchandani, Vijay Kumar Agrawal

Justice B. P. Singh
Former Judge Supreme Court of India
Chairman

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FOREWORD

Greetings from National Council for Climate Change Sustainable Development and Public Leadership (NCCSD).

I welcome all to this third International Conference organised by NCCSD in collaboration with Anand Agricultural University, Anand for promoting Sustainable Livelihood to our farmers in arena of climate change. The first was held at New Delhi in partnership with Indian Council of Agricultural Research (ICAR) on Climate Change, Sustainable Agriculture and Public Leadership" between 7th -9th February 2012 at National Agricultural Science Centre (NASC), Todapur, New Delhi. This was followed by second international conference in Ahmedabad in partnership with NIRMA University, Institute of LAW, on "Strengthen Climate Justice Initiatives at the local level, the special focus on Agriculture productivity and related livelihood challenges" held on 8th to 9th November, 2014

NCCSD is very active as a Think Tank organization and its mission is to indentify issues related to farmers and work on solution. NCCSD is organizing Think Tank seminars, each of which we have 50% participants who are farmers and give voice to their experiences and problems. In this conference also we are expecting participation of large number of farmers and there are special farmers' interaction sessions.

We have value added presence of Florida Agricultural and Mechanical University (FAMU)- USA, their president and the team led by Dr. Odemari Stephen Mbuya. In fact FAMU has initiated Technology transfer from farmers to farmers in Mandvi Kutch Gujarat with NCCSD & VRTI. Another important International Partner is Global Alliance for Climate Smart Agriculture GACSA team led by Director Dr. Andrew Enow of FAO. NCCSD is working actively for promotion of Climate Smart Agriculture (CSA) with GACSA.

Water and energy is the key to Sustainable Livelihood and Food Security and their availability at ground level can make only farming success.

I am sure deliberation by national – international experts and their interaction with farmers will give insight in to newly emerging challenges and ways to meet them.

I take this opportunity to congratulate Dr. N.C. Patel, Vice Chancellor, Dr. K. B. Kathiria, Director Research and Dr. Kirit N Shelat, Executive Chairman, NCCSD for taking this initiative. I wish a grand success of this timely International Conference.

B P SINGH

Date: 17th May 2016

Dr. N.C. Patel

Vice Chancellor
Anand Agricultural University
Anand - 388 110

From the Desk of Vice Chancellor

With likely long-term changes in rainfall patterns, rising temperatures and shifting climate zones (IPCC 2013), climate change is expected to increase the frequency of climate-related shocks, which in turn will put pressure on food, energy and water supply. The impact will be amplified through the interconnections and interdependence among these three resources, popularly known as the Food Energy Water (FEW) Nexus. Climate change has the potential to both positively and negatively affect the location, timing, and productivity of crop, livestock, and fishery systems at local, national, and global scales. Countries differ in terms of exposure, vulnerability and their capacity to adapt to climate change. It will also alter the stability of food supplies and create new food security challenges as the world seeks to feed nine billion people by 2050. It is a challenging issue for entire world to cope with demand of food production in changing climate.

With the highest level of global concentration of 404.36 ppm of CO_2 in July 2016, $0.87^{O}C$ rise in global temperature since 1880, 17 centimeter (6.7 inches) raise in global sea level in last century and with the decline rate of 13.4% per decade in arctic sea ice, the earth's climate has changed throughout the history (source: NASA).

The world has also witnessed increasing numbers of extreme events. Evidence indicates that more frequent and more intense extreme weather events, rising sea levels and increasing irregularities in seasonal rainfall patterns are already having an immediate impact not only on food production but also on food distribution infrastructure (FAO, 2008). Water supply is impacted by rising temperatures through higher rates of evapotranspiration and decreasing run-off. Changes to the frequency and intensity of rainfall lead to the increased incidence of droughts and floods.

Although the concept of a water–energy–food nexus is gaining currency, and adaptation to climate change has become an urgent need, little effort has been made so far to understand the linkages between the nexus perspective and adaptation to climate change. The global community is looking for new approaches and solutions to adaptation to climate change and development challenges. To deal with the impact of climate change, the potential adaptation strategies are: developing cultivars tolerant to heat and salinity stress and resistant to flood and drought, modifying crop management practices, improving water management, adopting new farm techniques such as resource conserving technologies (RCTs), crop diversification, improving pest management, better weather forecasting and crop insurance and harnessing the indigenous technical knowledge of farmers.

In order to promote sustainable and climate resilient food, water , energy nexus it is essential to develop a portfolio or combined strategies that includes mitigation, adaptation, tech¬nological development and research on climate science. The present conference will help us to address the issues and suggest appropriate measures to be taken at national and global levels.

Dr. N.C. Patel
Vice Chancellor

Dr. Kirit N Shelat
Executive Chairman, NCCSD

PREFACE

Water, energy and food are inextricably linked. Water is an input for producing agricultural goods in the fields and along the entire agro-food supply chain. Energy is required to produce and distribute water and food to pump water from ground water or surface water sources, to power tractors and irrigation machinery, and to process and transport agricultural goods.

They are also the key to provide sustainable development, livelihood and for that matter for poverty reduction.

The demand for fresh water, energy and food will increase significantly over next decades under pressure of increased urbanization, growing middle income families, increased manufacturing activities, transportation, diversified diets, so on and so forth. As per FAO estimates, this situation is expected to be exacerbated in near future as 60 percent more food will be needed for the growing world population. The Global Energy Conception is projected to grow up by 50% by 2035. Total Global water withdrawals for irrigation are projected to increase by 10 percent by 2050.

As demand grows, there is competition between different stakeholders particularly agriculture, the farmers and urbanities within the village level for drinking purpose of families and livestock and for farming.

As a concerned citizen, we are aware of food, energy and water challenges, but addressed them in isolation, within sectoral boundaries. At district level, fragmented sectoral responsibilities, lack of coordination and inconsistencies exists. If water, energy and food security are to be simultaneously achieved, decision makers, need to understand. A nexus approach to sectoral management, through enhanced dialogue, collaboration and coordination, is needed to ensure that co-benefits and trade-offs are considered and that appropriate safeguards are put in place particularly in the arena of climate change is a serious threat to food, water and energy security and most important challenge in this millennium and sustainable livelihood.

Rationale

Worldwide impact of Climate Change is grave, as evidenced by the followings on International context:
In the U.S. alone, nearly 1,000 tornadoes have killed many people and inflicted $9 billion in damage.

- The 2010 heat wave in Russia killed hundreds of people and led to a 40% fall in the harvest of food grains.
- Floods in Australia and Pakistan killed thousands of people and devastated agricultural lands.
- Recurrent droughts in China have eroded millions of acres of farmland.
- Tsunami in Japan – Nuclear plant affected and played havoc to the local habitat
- Recurrent and continuous famines in Ethiopia, Somalia and riots for food by hungry millions.
- Recurrent floods in South East Asia, Philippines, Indonesia, Thailand.
- Almost all nations small or big are affected, one way or another, with increasing intensity.

Such impacts create:

- Severe famine or heavy floods
- Loss of life and livelihood
- Loss of agriculture crops and animals
- Increased risk of disease outbreaks and challenges of new microbial pathogens

- Damage to infrastructure and communication particularly in rural areas.
- Setback to social and economic development and emergence of social turmoil with increased rural urban divide.
- Pushing farmers in rural areas again back below poverty line.

Ensuring FOOD SECURITY is therefore of paramount significance as although there is enough food, in 2010-12, almost 870 million people were estimated to be undernourished (Food and Agriculture Organization of United Nations, 2012). In addition, another billion people are malnourished. The paradox is that concomitantly a large number of people mainly in richer countries are over eating, resulting in long-term health issues. For poor farmers, food is not only a basic need but it is the single, and often fragile, support for maintaining livelihood. What is true at the household level is also true at the macroeconomic level. There are 32 countries, 20 of them in Africa, facing food crisis and in need of international emergency support. In most of these countries, agriculture is an important source of employment.

Objective of the Conference is to deliberate on food and nutritional security. Between now and 2050, the world's population will increase by one-third. Most of the additional 2 billion people will live in developing countries and more people will be living in cities. FAO estimates that production will have to be increased by 60 percent by 2050 to satisfy the expected demands for food and feed. Such a target is achievable provided the entire Agriculture sector is moved to adapt climate smart agriculture practices. The Conference will debate on how agriculture could be prioritized and come out with a declaration in that regard. About 400 participants/stakeholders which will include more than 100 farmers including women farmers will get together to deliberate on the aspects indicated at this International Conference.

Outcome

I. To suggest policy, programme and initiatives, a definite system which provides timely redressal to affected families and empower individuals, communities and nation to develop effective response to climate related challenges

II. To come out with a Declaration & Booklet on over all perspective

III. To suggest to add this as a subject relevant in educational curriculums

IV. To suggest effective framework of programmes, policies, rules and regulation for achieving food water energy nexus at local level for individual families and communications

V. To give voice to concern of farmers and rural poor and sharing their difficulties and facing same collectively at community level through leadership initiatives by sharing knowledge, technologies and provide needed financial support by way of direct assistance at local level.

VI. To design and develop sustainable development with built in legal framework to ensure effective implementation and accountability of those in public and private Governance System who are responsible to provide it.

VII. To lead a smooth transition process through which income does not become less, but it grows gradually like that of other non-farm sector despite adverse impacts.

VIII. To prepare future generation of farmers and leaders to convert these adversities in to opportunity.

Thus, AAU and NCCSD propose to raise concern of farmers in context of food security of hungry millions.

Dt. 15-9-2016

Dr. Kirit N Shelat

Executive Chairman, NCCSD

MESSAGES

शमीमा सिद्दिकी
SHAMIMA SIDDIQUI
भारत के राष्ट्रपति की उप प्रेस सचिव
Deputy Press Secretary
to the President of India

सत्यमेव जयते

राष्ट्रपति सचिवालय,
राष्ट्रपति भवन,
नई दिल्ली-110004.
PRESIDENT'S SECRETARIAT,
RASHTRAPATI BHAVAN,
NEW DELHI - 110004.

MESSAGE

The President of India, Shri Pranab Mukherjee, is happy to know that the National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) in association with Anand Agricultural University, Anand, Gujarat is organizing an International Conference on "Food, Water and Energy nexus in arena of Climate change" from October 14-16, 2016 at Anand.

The President extends his warm greetings and felicitations to the organizers and the participants and wishes the Conference all success.

Deputy Press Secretary to the President

Tel. (O) : 91-11-23793528 (Direct), 91-11-23015321 Extn. 4442 , Fax : 91-11-23010252

भारत के उप-राष्ट्रपति के विशेष कार्य अधिकारी
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MESSAGE

The Hon'ble Vice President of India is happy to learn that National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) in association with Anand Agricultural University is organizing an International Conference on 'Food, Water and Energy nexus in arena of Climate Change' from October 14 – 16, 2016 at Anand, Gujarat.

The Vice President extends his warm greetings and congratulation to the organizers and the participants and wishes the event all success.

(Anshuman Gaur)

New Delhi
29th April, 2016.

सत्यमेव जयते

प्रधान मंत्री

Prime Minister

MESSAGE

I am happy to learn that the National Council for Climate Change, Sustainable Development and Public Leadership in cooperation with Anand Agriculture University is organizing an International Conference on "Food, Water and Energy nexus in arena of Climate Change."

On this occasion, I extend my best wishes for the success of the Conference.

(Narendra Modi)

12 September, 2016
New Delhi

O. P. Kohli
Governor of Gujarat

सत्यमेव जयते

Raj Bhavan
Gandhinagar. - 382 020.

2 JUL 2016

Message

I am happy to learn that the Anand Agricultural University, Anand and the National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD), Ahmedabad are jointly organizing an International Conference on "Food, Water Energy Nexus in the Arena of Climate Change" during October 14-16, 2016 at Anand.

The topic of the Conference is a very relevant in the context to the present day threats due to local/regional/global climate change. The climate is closely related to the water, energy and agriculture. Further, the climate does not have any state or national boundaries. As a result, changes in one part of country or globe are bound to affect other parts of the country and globe. Hence, the deliberations on the subject at the international level will provide some clues to tackle the problem at various levels and magnitude to protect the environment.

I congratulate the Anand University and the NCCSD for organizing such an international event. I am sure that the Conference would suggest some concrete ways and means, not only to conserve the natural resources but also to safeguard the interest of farmers and public for generations to come, while dealing with energy and development.

I wish the Conference all success.

(O.P. Kohli)

राधा मोहन सिंह
RADHA MOHAN SINGH

D.O. No...1589.....AM

सत्यमेव जयते

कृषि एवं किसान कल्याण मंत्री
भारत सरकार
MINISTER OF AGRICULTURE
& FARMERS WELFARE
GOVERNMENT OF INDIA

13 JUL 2016

संदेश

मुझे यह जानकर प्रसन्‍नता हुई है कि जलवायु परिवर्तन, टिकाऊ विकास एवं सार्वजनिक नेतृत्व के लिए राष्ट्रीय परिषद (NCCSD) एवं आणंद कृषि विश्वविद्यालय, आणंद द्वारा संयुक्त रूप से दिनांक 14–16 अक्तूबर, 2016 को **"जलवायु परिवर्तन के संदर्भ में खाद्य, जल एवं ऊर्जा का आपसी सम्पर्क"** विषय पर एक अंतर्राष्ट्रीय सममेलन का आयोजन किया जा रहा है।

विश्व स्तर पर किए गए अध्ययनों से पता चला है कि जलवायु से होने वाले परिवर्तनों का इस सदी के उतरार्द्ध में विशेषकर कृषि पर व्यापक प्रभाव पड़ने की संभावना है। जलवायु परिवर्तन के प्रति अनुकूलनता का तात्पर्य प्रतिकूल एवं अनपेक्षित पर्यावरण परिस्थितियों को कम करने की क्षमता और इसके कारण विगत में पड़े नकारात्मक प्रभावों को प्रभावी ढंग से कम करना है। व्यापक कृषि अर्थव्यवस्था वाले भारत जैसे विकासशील देश के लिए जलवायु भिन्‍नता के प्रति कृषि को अनुकूल बनाकर अपनी विशाल जनसंख्या के लिए खाद्य सुरक्षा सुनिश्चित करने के साथ–साथ वैश्विक स्तर पर इसके न्यूनीकरण प्रयासों में योगदान करने की चुनौती भी बनी हुई हैं

मुझे विश्वास है कि जलवायु परिवर्तन जैसे सारगर्भित एवं प्रासंगिक विषय पर आयोजित उक्त सम्मेलन में राष्ट्रीय एवं अंतर्राष्ट्रीय कृषि विशेषज्ञों, हितधारकों एवं किसानों के बीच गहन विचार–मंथन होगा जिससे इस मुद्दे पर नई रणनीतियां बनाने में मदद मिलेगी।

सम्मेलन की सफलता के लिए मेरी शुभकामनाएं।

(राधा मोहन सिंह)

Office : Room No. 120, Krishi Bhawan, New Delhi-110 001 Tel.: 23383370, 23782691 Fax : 23384129

सत्यमेव जयते

Apro/kp/2016/09/07/dt

Vijay Rupani

Chief Minister, Gujarat State

Dt. 07-09-2016

Message

Life is a complex mixture of good and bad thing that follow each other. Good, And positive atmosphere prevailed on earth till the middle of 21st century, but the negative effects of imbalance started taking effect on the environment as well as human life. The result of this imbalance is climate change which is affecting our daily lives. It is high time to undo what wrong we have done so far to the earth and our environment.

It is heartening to learn that the National Council for Climate Change Sustainable Development and Public Leadership is organizing an International Conference on **"Food, Water and Energy nexus in arena of Climate Change"** jointly with Anand Agricultural University of Anand during **14th to 16th October 2016.** My heartiest best wishes to the organizers and the participants for the glittering success of the event.

(Vijay Rupani)

To,
Dr. Kiritbhai N. Shelat, *IAS (Rtd.),*
Executive Chairman, NCCSD,
Patel Block, Rajdeep Compound,
Nr. Stadium Six Roads, Ahmedabad – 380014.
Email: drkiritshelat@gmail.com

परशोत्तम रूपाला
PARSHOTTAM RUPALA

सत्यमेव जयते

कृषि एवं किसान कल्याण और
पंचायती राज राज्य मंत्री
भारत सरकार
**Minister of State For Agriculture &
Farmers Welfare and Panchayati Raj
Government of India**

D.O. No. ....MoS(AC&FW)/PR/VIP/2016/

MESSAGE

I am happy to know that National Council for Climate Change Sustainable Development and Public Leadership (NCCSD) in association with Anand Agricultural University, Anand, Gujarat is organizing an "International Conference on "Food, Water, and Energy nexus in arena of Climate change" on 14th to 16th of October 2016 at Anand, Gujarat.

The impact of climate change is now concern of one and all with increase in temperature. Even if we get normal rain, agricultural productivity and production are going to be affected. Water is the key input and energy is needed for pulling out water or for post harvest. Hence they are inter-connected and all three need integration. In this context, Ministry of Agriculture is implementing a very successful programme known as 'National Innovations on Climate Resilient Agriculture – (NICRA) through Central Research Institute for Dryland Agriculture (CRIDA) - Indian Council of Agricultural Research (ICAR). It is important that we, along with all stakeholders, with farmer in centre understand the changes in the climate and change our behavioural approach to cope up with adversities. NICRA has developed successful adaptation model including that of Climate Smart Village. This is required to be transferred to all villages of our country.

I am sure, we will benefit from knowledge and experience of International experts who are attending this conference and we will have recommendation from research scientists and their interaction with farmers.

I congratulate Dr. Kirit Shelat, Executive Chairman of NCCSD and Vice Chancellor Dr. N. C. Patel, Anand Agricultural University for organizing this important meet and I am sure we will all benefit from it.

(Parshottam Rupala)

To:
DR. KIRIT N SHELAT, IAS (RTD.)
Executive Chairman, **National Council for Climate Change Sustainable Development and Public Leadership (NCCSD)**
Patel Block, Rajdeep Electronics' Compound,
Navrangpura, **Ahmedabad-380 0014.**

Delhi Office : Room No. 322, 'A' Wing, Krishi Bhawan, Dr. Rajendra Prasad Road, New Delhi-110001
Tel. : +91-11-23383975/76 Fax: +91-11-23383971, E-mail : mosrupala@gmail.com, p.rupala@sansad.nic.in
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SHUBH SANDESH/ -901- VIP

CHIMANBHAI SAPARIYA

सत्यमेव जयते

No. Agriculture, Energy
Minister,
Agriculture, Energy,
Government of Gujarat,
1st Floor, Swarnim Sankul-1,
Gandhinagar-382010.
Phone No.: 23250211, 23250212
Fax No. : 23250215,
Date : / /20
27 SEP 2016

MESSAGE

I am glad to know that Anand Agricultural University and National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) are organizing the "International Conference on Food, Water, Energy Nexus in arena of Climate change" during 14th – 16th October 2016 at Anand Agricultural University.

I wish the three days conference will bring fruitful recommendations for combating the effects of climate change in agriculture. I extend my best wishes to all the participants.

Further, I am sure that this event will benefit Indian agriculture and particularly the farmers of Gujarat State. I congratulate the organizers for bringing awareness to the farmers regarding the climate change. I wish the International Conference a grand success.

(Chimanbhai Sapariya)

To,
Dr. N. C. Patel,
Vice Chancellor,
Anand Agricultural University,
Anand – 388 110

Resi.: Minister Bungalow No 5, Sector-20, Gandhinagar. Ph : 59660, 61, 23232453

सत्यमेव जयते

Additional Personal Secretary

Minister of Water Supply, Animal Husbandry and Cow Breeding
Fisheries, Civil Aviation, Salt Industry
Govt. of Gujarat
1st Floor Swarnim Sankul-1,
New Sachivalaya, Gandhinagar

Message

I Congratulate Anand Agriculture University and National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) for organizing this very important inter-actionmeet by "International Conference on Food Water Energy Nexus in arena of Climate change" on 14th-16th October 2016 at Anand Agriculture University.

Infact now one and all are aware about global warming and are affected by increase in temperature. In Gujarat we had two consecutive droughts and heat weave in the current year. All there is very disturbing to concerned Citizen.

But with participative efforts- we had taken number of initiative and have met their adverse situation. Infact Narmada Canal Pipe line water supply scheme now makes available drinking water to more 11000 villages from Kutch to Okha modal.

Similarly, on agriculture front we have participative program under Sardar Patel Sahbhagi Jal Sinchai Yojna for construction of check dams. It is because of these efforts that ground water table of Gujarat has gone up. This is an outstanding achievement of our Engineers, Scientist and of course Farmers.

I am sure deliberation in this three days' conference will give us new insight in to problem that we are likely face in future and ways to meet them.

(Babubhai Bokhiria)

To,
Dr.Kirit N. Shelat I.A.S.(Rtd.)
Executive Chairman,
National Council for Climate Change,
Sustainable Development & Public Leadership (NCCSD),
Ahmedabad.

Telephone No. 079-23256428, 23250131 to 34, 23238109, 23243502
Fax : 079-23250135,

V. V. Vaghasiya

सत्यमेव जयते

No.-MOS/Agri. & U.H.D./VIP/02/2016
Minister of State,
Agri. & Urban Housing
Swarnim Sankul-2, 2nd Floor, Sardar Patel Bhavan, Sachivalaya,
Gandhinagar-382 010.
T. No. : (079) 232 50231 to 34
Fax No. : (079) 232 50235
Date : 3 OCT 2016

MESSAGE

It is a matter of great pleasure to know that Anand Agricultural University and National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) are jointly organizing the **"International Conference on Food, Water, Energy Nexus in arena of Climate change"** during 14th – 16th October 2016 at Anand Agricultural University, Anand.

Water, energy and food are inextricably linked. Water is an input for producing agricultural goods in the fields and along the entire agro-food supply chain. Energy is required to produce and distribute water and food to pump water from ground water or surface water source, to power tractors and irrigation machinery, and to process and transport agricultural goods. They are also to key provide sustainable development, livelihood and for that matter for poverty reduction. Particularly in the arena of climate change which is a serious threat to food, water and energy security and most important challenges in this millennium and sustainable Livelihood.

I hope that the deliberations will result in a clear vision to achieve the objectives. I congratulate the University for taking the initiative to host the International Conference on such an important topic and wish it a great success.

વી. વી. વઘાસીયા.
(V. V. Vaghasiya)

To,
Dr. N. C. Patel,
Vice Chancellor,
Anand Agricultural University,
Anand – 388 110
Email : vc@aau.in

त्रिलोचन महापात्र, पीएच.डी.
एफ एन ए, एफ एन ए एस सी, एफ एन ए ए एस
सचिव एवं महानिदेशक
TRILOCHAN MOHAPATRA, Ph.D.
FNA, FNASc, FNAAS
SECRETARY & DIRECTOR GENERAL

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली 110 001
GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
KRISHI BHAVAN, NEW DELHI 110 001
Tel.: 23382629; 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

MESSAGE

It is a pleasure to learn that an International Conference on 'Food, Water and Energy Nexus in Arena of Climate change' is being organized by the National Council for Climate Change Sustainable Development and Public Leadership, Ahmedabad and Anand Agricultural University during 14-16 October, 2016 at Anand, Gujarat.

The theme of the Conference is of immense relevance in the present context where the sustainability of agriculture is strongly linked to the natural resources and energy. The issue holds importance, particularly in the developing world, where meeting the requirements of food is becoming a major challenge. This situation is further compounded under the present scenario of climate change. Thus, it is important to have climate resilient agricultural systems appropriate for different agro-climatic conditions and provide timely scientific inputs to enhance the capacity of the Indian farmers.

I am sure, this International Conference will debate on the prevailing situations of stress agriculture globally and also take into account local case studies for developing strategies and actionable points.

I wish the Conference a grand success.

(T. Mohapatra)

26th April, 2016
New Delhi

SANJAY PRASAD, I.A.S.
Principal Secretary

सत्यमेव जयते

GOVERNMENT OF GUJARAT
AGRICULTURE AND CO-OPERATION DEPARTMENT
Block No. 5, 1st Floor, Sardar Patel Bhavan,
Sachivalaya, Gandhinagar-382 010.
Phone : 079-23250801,
Fax : 079-23252365
E-mail : secagri@gujarat.gov.in

MESSAGE

I am delighted to note that Anand Agricultural University (AAU), Anand in collaboration with National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) is organizing an International Conference on "Food, Water, and Energy Nexus in the Arena of Climate Change" during 14 to 16 October 2016 at Anand.

The demand for fresh water, energy and food will increase significantly over the next decades under pressure of increased urbanization, growing middle income families, increased manufacturing activities, transportation and diversified diets. As concerned citizens, we are aware of food, energy and water challenges and it is required to address them with sectoral and also interdisciplinary research.

I hope that the conference shall provide valuable opportunities to National as well as International scientists, NGOs, representatives of various State and Central Government agencies and concerned farmers and citizens to deliberate on a wide range of issues confronting climate change and to formulate strategies to mitigate the emerging challenges. The conference will also help to suggest effective frame work of programmes, policies, rules and regulations for achieving sustainable food, water, and energy nexus at the local level.

I congratulate Dr.N.C. Patel, Vice Chancellor, AAU and Dr.K.N. Shelat, Executive Chairman, NCCSD for organizing this event. I wish the International Conference, a grand success.

4-10-16
(Sanjay Prasad)

To,
Dr. N. C. Patel,
Vice Chancellor,
Anand Agricultural University,
Anand – 388 110
Email : vc@aau.in

MESSAGE

I am glad that the National Council for Climate Change, Sustainable Development and Public Leadership is organizing an international conference on Food, Water and Energy nexus in the arena of climate change. I congratulate the NCCSD on this timely initiative. Climate change will affect not only food and ecological security, but also water and livelihood security. It is important to initiate anticipatory action to adapt to adverse changes in temperature, precipitation and sea level. I hope the conference will provide a road map for the sustainable management of climate risks. I wish the conference great success.

Dr. M. S. Swaminathan,
Founder, Swaminathan Foundation.

MESSAGE

The Food and Agriculture Organization of the United Nations (FAO) stands for food security, sustainable management of natural resources and poverty eradication. FAO's work aims to ensure food security especially under the given impacts of climate change, and overcoming the challenges of sustainable development.

Food production has direct correlation with water and energy utilization. Furthermore, the complex dynamics of the coupled systems of water, energy and food has a direct impact on poverty reduction, food security and sustainable development. This interdependent complex system perhaps needs immediate focus especially in developing countries, like India, that put immense pressure on these resources from their large population, its growing food needs and changing consumption patterns, in the background of climate change and a fast developing economy.

The Food-Water- Energy nexus approach is thus a holistic recognition of the urgent need to achieve a balancein our development trajectory towards accomplishing our goals of sustainable development. It is thus imperative that they are addressed as an integral part of the overall development agenda.

It is commendable that Anand Agriculture University, in collaboration with National Council for Climate Change Sustainable Development and Public Leadership is making efforts to deliberate on food and nutritional security issues in India and globally. I am certain the discussions of this timely conference on ways through which a sustainable development agenda could be prioritized will come out with a declaration in that regard.

Shyam Bahadur Khadka
FAO Representative, India

REDUCING CARBON FOOTPRINT OF AGRICULTURE

Climate change is no longer a distant reality. The increasing frequency of recurrent droughts, unseasonal rains and dry spellsisalready taking a toll on smallholder farmers.

According to a CGIAR research report, by 2050 climate change could cause irrigated wheat yields in developing countries to drop by 13%, and irrigated rice yields could fall by 15%. In Africa, maize yields could drop by 10–20% over the same period. To ensure food security, farmers across the globe will probably have to switch to cultivating more climate-hardy crops and farming practices.

The 2015 United Nations Climate Change Conference (COP 21) has negotiated on limiting global warming to less than 2°C. This requires zero net anthropogenic greenhouse gas emission to be achieved between 2030 and 2050.

CGIAR research[1]shows that the global food system, from fertilizer manufacture to food storage and packaging, is responsible for up to one-third of all human-induced green house gas emissions. Hence reducing the carbon footprint of agriculture is a priority. In this context, getting policy makers and influencers, academicians and researchers to brainstorm on a timely and important topic like “Food, water, energy nexus in the arena of climate change” is a step in the right direction.

Climate-smart agriculture and maximizing water use efficiency have always topped ICRISAT’s research agenda. Issues now being discussed in the context of climate change have been our research focus for more than 40 years. The lessons we have learnt over the years has shaped our holistic approach to addressing climate change using both adaptation and mitigation strategies.

Climate Smart Villages/Communities

We are using multi-modeling frameworks to generate computer simulated future scenarios on climate change impact on crops, livestock and socio-economic conditions and strategies to lessen negative impacts. This is a great tool to help policy makers take the right decisions. Meanwhile, ICRISAT is tapping the potential of digital agriculture – including cloud computing, analytics, breeding informatics, drones and UAVs to provide cropping advisories to help smallholder farmers take the best decisions under climate variability.

ICRISAT mandate crops – sorghum, millets, groundnut, pigeon pea and chickpea – are inherently climate smart as they have a lower carbon and water footprint, can survive high temperatures and poor soils, and are high in nutrition. In keeping with our motto of demand-driven innovation, our scientists have developed new varieties based on farmers’ requirements, including those with enhanced nutrition, drought and heat tolerance, pest resistance and machine-harvestable varieties.

Building on the success of the watershed management approach, we are equipping communities to restore/conserve their environment and at the same time build climate resilience.

In partnership with state and national governments, farmers’ organizations, non-governmental organizations (NGOs) and private corporates, ICRISAT is working on scaling-up, climate smart technologies for building the resilience of the farmers and to empower them to cope with the impacts of climate change. ICRISAT is pursuing science of delivery for achieving the impact on millions of farmers like Karnataka, Andhra Pradesh and Jharkhand etc.,

From measuring groundwater levels, using weather data for cropping decisions to figuring out for themselves what crop varieties, intercrops, soil and water conservation technologies are best suited for their conditions, farming communities are being empowered through science-led interventions.

For reducing chemical fertilizer usage (a major contributor of greenhouse emissions) we have developed technologies like micro dosing and are propagating the use of vermin compost, green manure, tank silt and intercropping with nitrogen-fixing legumes.

Partnerships have always been our strength. The success of the watershed management approach has prompted companies to adopt it for their Corporate Social Responsibility (CSR) activity given its holistic approach that includes market linkage.

Above all creating awareness has been a key component of our work. An informed community, we believe, is best equipped to make necessary changes to adapt to climate change.

David Bergvinson

Director General, ICRISAT, Patancheru, Hyderabad

Florida Agricultural and Mechanical University
TALLAHASSEE, FLORIDA 32307-3100

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SUSTAINABILITY INSTITUTE
http://sustainability.famu.edu

TELEPHONE: (850) 599-8231
FAX: (850) 599-8242

International Conference on
Food, Water, and Energy Nexus in the Arena of Climate Change
Anand, Gujarat
October 14-16, 2016

Greetings conference attendees,

It is our pleasure to welcome your participation in this year's conference. The topic of Food, Energy and Water Nexus, is indeed an important and timely topic. All across the world, communities large and small are contending with issues of food, energy and water insecurity. It is especially exasperated in areas of great poverty but it is also a challenge in the so-called "developed", high GDP countries. Everyone needs access to healthy food, and it takes precious energy and water resources to produce food. As we race to address climate change and try to solve other socio-economic issues, it is imperative that we understanding and operate within the interdependency of the three areas so that we do not create unintended harm.

At Florida A&M University, we have been contending with issues in food production to promote development in balance with human and ecological health. Our scientists, students and staff have been working on issues of food and water quality for over 120 years. The Sustainability Institute helps to bring many of these strengths and expertise across the university together in order to create even greater impact, both locally and around the world.

It is encouraging to have sc many experts gathered in Anand for this discussion and we are proud to be partnering with NCCSD for such an important work.

Abena Ojetayo
Chief Sustainability Office
Florida A&M University
Sustainability Institute

ORGANIZING COMMITTEE

Patron	:	Justice B P Singh, Former Judge, the Supreme Court of India Dr. N.C.Patel, Vice Chancellor, AAU , Anand Dr. K.N.Shelat, IAS (Rtd),Executive Chairman, NCCSD, Ahmedabad
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Organizing Secretary	:	Dr. K.P. Patel, Dean & Principal, B.A. College of Agriculture, AAU, Anand
Co- Organizing Secretaries	:	Nisha Shah, NCCSD, Ahmedabad Dr. M.M. Lunagaria, Deptt. of Agril. Meteorology, AAU Anand

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Dr. Vyas Pandey, Prof & Head, Agril. Meteorology

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		Sh. R D Mahida	Hostel Supervisor , College Hostel , BACA
		Dr. N M Gohel	Asstt.Prof. (Pl. Pathology), BACA, AAU

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		Mr. Jigar Mistry	Asstt. Prof (Biotech), BACA, AAU
		Mr. Viral Dave	SRF (Ag. Met), BACA, AAU

CULTURAL PROGRAMME

Convener	:	Dr. Sanjay Akbari	DSW, AAU
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		Mr. V B Vaidya	Asstt. Prof. (Ag. Met), BACA, AAU

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		Dr. J S Patel	Asstt. Prof. (Horticulture)

POSTER PRESENTATION

Convener	:	Dr. P K Borad	Professor (Agril.Ento), BACA, AAU
Members	:	Dr. M Viradiya	Assoc.Prof. (Soil Sci.), BACA, AAU
		Dr. S N Shah	Assoc.Prof. (Agron), BACA, AAU
		Mr. B I Karande	Asstt. Prof.(Agril. Met.), BACA, AAU

CONFERENCE ANCHORING

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Members	:	Dr. V P Ramani	Res. Scientist (Micronutrient)
		Mrs. Rucha Dave	Asst. Prof (Physics)

TRANSPORT

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Members	:	Prof. R S Gupta	Assoc.Prof. (Animal nutrition)
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		Sh. Pratik Panchal	Asstt.Prof (Agri Polytechnic)

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		Dr. R A Patel	TO, DR, AAU
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PENDAL			
Convener	:	Mr. B.N. Bhalia	Executive Engineer
Members	:	Mr. H. R. Patel	Deputy Engineer
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	:	Mr. P. S. Modi	Jr. Engineer
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Convener	:	Dr. C.P. Desai	Director, EEI
Members	:	Dr. A. C. Patel	Professor, EEI
	:	Dr. B. D. Patel	Assistant Professor, EEI
	:	Mr. N. S. Charpot	Photographer

THE ORGANIZERS

Anand Agricultural University, Anand

Anand Agricultural University (AAU) is the premier agricultural educational and researchinstitute in India. It was established by Sardar Vallabhbhai Patel with the initiation of agricultural school awarding the diploma in agriculture in 1939. Subsequently the degree programmes in various disciplines started with support from Government of Gujarat under Gujarat Agricultural University (GAU) as the Anand zone of the university. The Anand zone of GAU was converted into the full-fledged Anand Agricultural University (AAU) from May 01, 2004. The AAU has 9 degree colleges and one PG institute, five polytechnic colleges, 25 on campus and 23 off campus Research Stations spread over nine districts viz., Ahmedabad, Anand, Botad, Chhottaudepur, Dahod, Kheda, Mahisagar, Panchmahal and Vadodara of Gujarat state.The university is undertaking agricultural education, research and extension education (www.aau.in) for important crops of central Gujarat. Its Vice Chancellor is Dr. N. C. Patel Since August 7, 2014. So far the university has released 57 new varieties of different crops and 898 recommendations for the farmers. The varieties and technology developed in different disciplines disseminated to farmers through scientists and extension staff as well as officers of the line department.
www.aau.in

National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD), Ahmedabad

National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD) is a nonprofit organization. Its Mission is to promote sustainable livelihood for Farmers in arena of Climate Change with involvement of Public-leadership-both elected and Non-elected members of public Governance system. It is involved in developing /Building Climate Smart farmers and also is a think tank organization

Its President is Hon'ble Justice B.P. Singh, formerly Judge, Supreme Court of India. Sarvshri Dr. M.S. Swaminathan, Shri Kantisen Shroff, Dr.Y S Rajan, Shri Parshottam Rupala are the patrons of the Council and Dr. Kirit N. Shelat(Rtd. IAS) is Executive Chairman.
www.nccsdindia.org

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AAU

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PROFILE OF KNOWLEDGE PARTNERS

Indian Council of Agricultural Research (ICAR)

The Indian Council of Agricultural Research (ICAR), New Delhi, India is an autonomous organization under the Department of Agricultural Research and Education, Ministry of Agriculture, government of India. Formerly known as the Imperial Council of Agricultural Research, it was established in 1929 as a registered society under the Societies Registration Act, 1860 in pursuance of the report of the Royal Commission on Agriculture. ICAR has its headquarters at New Delhi.

The Council is the apex body for coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the country. It has 101 ICAR institutes and 71 agricultural universities spread across the country.

The ICAR has played a role in enabling the country to increase the production of food grains by four, horticultural crops by six, fish by nine (marine five and inland 17, milk six times and eggs 27 times since 1950.

Central Research Institute for Dryland Agricutlure (CRIDA)

CRIDA was established during 1985 by upgrading the All India Coordinated Research Project for Dry land Agriculture (AICRPDA), Hyderabad centre to work on development of suitable technologies to enhance the productivity in rain fed areas. CRIDA, along with two All India Coordinated Research Projects namely on Dry land Agriculture and Agro meteorology with about 25 centers each located in different parts of the country, strives towards development and popularization of location specific rain fed technologies for productivity enhancement. CRIDA is a constituent organisation of Indian Council of Agricultural Research (ICAR), an autonomous body of Ministry of Agriculture, Government of India. The Institute is one of the major organisations with in the Natural Resource Management Division of ICAR, responsible for carrying out the research for improvement of rain fed areas through resource management .

International Food Policy Research Institute (IFPRI)

The International Food Policy Research Institute (IFPRI) provides research-based policy solutions to sustainably reduce poverty and end hunger and malnutrition in developing countries. Established in 1975, IFPRI currently has more than 600 employees working in over 50 countries. It is a research center of theCGIAR Consortium, a worldwide partnership engaged in agricultural research for development.

IFPRI's vision is a world free of hunger and malnutrition. Its mission is to provide research-based policy solutions that sustainably reduce poverty and end hunger and malnutrition.

Florida A&M University (FAMU)

FAMU's academic achievements are what set it apart as a unique learning experience. In 2014, FAMU was recognized among the 2014 U.S. News & World Report's "Best National Universities." The U.S. News & World Report lists FAMU as the top public historically black college or university in the nation for 2015. It is also listed among The Princeton Review's "Best in the Southeast" colleges and is one of the top picks for providing a high quality education at an affordable price in Florida, according to The College Database (2013).

FAMU values diversity in thought, perspective, and culture. The University enrolls nearly 10,000 students hailing from across the United States and more than 70 countries, including several African countries, the Bahamas, Brazil, Indonesia, China, and the United Arab Emirates, to name a few. The student body includes representatives from all ethnic, socio-economic, and religious backgrounds.

Kennesaw State University, USA

Kennesaw State University has been known for its entrepreneurial spirit and sense of community. Offering campuses in Marietta and Kennesaw, the university is located just north of Atlanta and combines a suburban setting with access to one of the country's most dynamic cities. As Georgia's third-largest university, Kennesaw State offers more than 150 undergraduate and graduate degrees, including a growing doctoral program. Designated by the Board of Regents of the University System of Georgia as a comprehensive university, Kennesaw State is committed to becoming a world-class academic institution positioned to broaden its academic and research missions and expand its scope on a local, regional and national level.

The Kennesaw State University combines the best from two of Georgia's most respected institutions in higher education. A comprehensive university, Kennesaw State is a destination campus offering students a broad spectrum of quality academics, a growing and vibrant campus life, award-winning dining facilities, and a wide array of athletic offerings. With nationally ranked degrees in business, engineering and first-year programs, as well as premier teaching, nursing, architecture, science and math programs, the new Kennesaw State University is poised to become Georgia's next world-class institution.

Junagadh Agricultural University (JAU)

Junagadh Agricultural University is an agricultural university at Junagadh in the Indian state of Gujarat. Junagadh Agricultural University offers education in agriculture and allied sciences, i.e., agriculture, agricultural engineering and fisheries. It is among top 10 universitiesin India for biological research. The teaching in the university consists of four faculties: agriculture, agricultural engineering, fisheries and postgraduate studies. The graduate programmes have an intake capacity of 75 in agriculture, 70 in agricultural engineering and 30 in fisheries faculty. The postgraduate level studies are offered in agriculture and agricultural engineering according to the intake capacity of the various faculties.

There are seven multidisciplinary Main Research Stations; five Main Research Stations for various crops; and eleven sub-Research Stations/Testing Centers for the development of new varieties/hybrids of crops, vegetables and fruits. These centers also work for the development of economical and sustainable production technology packages for newly developed varieties/hybrids with modification every year. The first hybrid bajra and hybrid castor were developed by scientists of this university.

Navsari Agricultural University (NAU)

Commencing with a college of agriculture established in 1965, the Navsari campus gained the status of a separate agricultural university with effect from May 1, 2004. The university caters to the needs of the farmers of the plantation crops in the heartland of Gujarat; the Kanam zone of cotton, sorghum and pigeon pea and hill millets of tribal belt. Besides the above, this area is also well known for its forest tree species like teak, Khair, Kalam and bamboo. To provide technological backup for the agricultural development in its domain (Map of Districts Covered) the Navsari Agricultural University has four fully developed faculties of agriculture, horticulture, forestry and Veterinary, 2 Zonal Research Stations (Navsari and Bharuch), three main crop based research station (cotton, sorghum and mango), 3 regional research station (Waghai, Vyara and Gandevi) and 6 verification/testing centers. The extension component includes three Krushi Vigyan Kendras (Waghai, Vyara and Navsari), one Sardar Smruti Kendra (Navsari), and a T & V scheme. This university also offers vocational courses in horticulture at Navsari, home science at Vyara, agriculture at Waghai and Bharuch as well as Livestock Management, Bakery and Mali and extension education trainings at Navsari.

Sardarkrushinagar Dantiwada Agricultural University (SDAU)

Government of Gujarat repealed Gujarat Agricultural University act 1969(Gujarat Act.No.13 of 1969)and promulgated Gujarat Agricultural Universities Act, 2004 (Guj.Act No.5 of 2004). Accordingly four Agricultural Universities have been carved out from erstwhile Gujarat Agricultural University with effect from 1st May 2004 SDAU. The Sardarkrushinagar Dantiwada Agricultural University is devoted for location specific agricultural research. As such the mandate of the SDAU , Sardarkrushinagar is confined to six districts viz., Gandhinagar, Mehsana, Patan, Sabarkantha, Banaskantha and Kutch of North Gujarat predominantly encompassing arid and semi arid climate.

Kamdhenu University

Kamdhenu University has been established by the Government of Gujarat vide Gujarat Act No.9 of 2009 which is referred to as "the Kamdhenu University Act, 2009". The Act was assented to by Hon'ble Governor of Gujarat on 7th July, 2009

The University is established and incorporated by the state Government as teaching and affiliated University for the development of Veterinary and Animal Sciences and for furthering the advancement of learning, conducting of research and dissemination of findings of research and other technical information in Veterinary and Animal Sciences including Dairy, Fisheries and allied sciences in the State of Gujarat.

Vigyan Prasar- Department of Science and Technology

Vigyan Prasar (VP), an autonomous organisation under the Department of Science an Technology, Government of India, was set up in 1989 to take on large-scale science and technology popularisation programmes. Vigyan Prasar's mandate is to promote and propagate - as widely as possible - a scientific and rational outlook in the society. Its broad objectives include :

Undertake, promote and co-ordinate science popularization programmes and inculcation of scientific temper among the people.

Development of software for various media - audio, visual, audio-visual & print and different modes of communication to enable the masses to understand, appreciate and comprehend scientific principles and practices.

VP has established a network of more than 7000 science clubs in the country, called the VIPNET science clubs. VP regularly produces radio and television programmes in different languages. “Dream 2047”, Vigyan Prasar’s monthly newsletter-cum-popular science magazine reaches nearly 50,000 subscribers. Vigyan Prasar’s website is a repository of information on science and technology. VP has been utilising latest technologies like WorldSpace Satellite Digital Radio and Edusat. VP has established a network of Edusat interactive terminals for S&T communication throughout the country.

University of Mumbai

The profile of this University carved out in 156 years of its functioning attests to its manifold achievements as the intellectual and moral powerhouse of the society. The University has always given its best to the country in general and to the city of Mumbai in particular by enthusiastically shouldering an ever-growing load of social values and opportunities.

Initially, the University concentrated its efforts on controlling teaching at the undergraduate level and in conducting examinations. Later on it took up research and the task of imparting instructions at the Post-Graduate level. This resulted in the establishment of the University Departments beginning with the School of Sociology and Civics & Politics. The independence of the country led to the re-organization of the functions and powers of the University with the passing of the Bombay University Act of 1953.

It has two campuses of areas 243 acres and 14 acres at Vidyanagari and Fort respectively; sub-campuses/centers at Ratnagiri 20 acres, Thane 6.50 acres and Kalyan 6.26 acres with 60 University Departments & Institutes and 749 affiliated colleges. It has established its name in industrial & International collaborations and runs various professional courses.

At national level, it has excelled in sports, cultural and out-reach activities. In the last five years it has seen 104% increase in under-graduate students, 112% increase in post-graduate students and 147% increase in distance - education students. There is 156% increase in the number of research papers published in International journals. Twelve Department/sections are recognized under various national programmes, such as SAP/CAS/DRS/DSA/COSIST/FIST. More than eighty teachers are on various professional bodies. Eighteen National/International awards are won by teachers in the last five years. Every year about 20 teachers visit abroad for academic activities. Recently more than ten self-supporting courses have been started by the University.

Shroff Family Voluntary Organization Consortium, Kutchh (SFVOC)

Shri Kantisen C Shroff, veteran NGO has promoted Shroff Family Voluntary organizations. This includes-Shrujan Trust, Shroff Foundation Trust, Samarth Gram Vikas Trust, Vivekanand Research Training Institute (VRTI) Vivekanand Gram Udyog Society, Shroff Family Charitable Trust, Kisan Mitra, Atapi Seva Foundation. The Group Is working In more than 2,000 villages with 600 field workers in Maharashtra and Gujarat. It is involved in livelihood programmes apart from Water Shed Management, River Basin Management, Health and Sanitary Programmes, Rural Education, Women Empowerment etc. Mrs. Chandaben Shroff who heads Shrujan Trust was awarded by ‘Rolex Award of Excellence’ for promoting sustainable livelihood for women in Kutchh. The major contribution of the group is promoting sustainable livelihood by working in Kutchh and tribal areas of Gujarat where livelihood by working in Kutch and tribal areas of Gujarat where livelihood conditions were bad, with focus on agriculture and handicrafts. The group is supported by Excel Group Of industries.

Sadguru Foundation

Established in 1974, N M Sadguru Water and Development Foundation is a non-government, non-political, not for profit, secular organization, registered under the Public Charitable Trust Act and the Societies Registration Act (1860) and the Foreign Contribution (Regulation) Act. It is recognized by the departments of Rural Development of the Government of three states of Rajasthan, Gujarat and Madhya Pradesh. The organization is receiving funds from the states and central government, national and international funding agencies for its rural / tribal poverty reduction programmes centered around Natural Resources Management.

Its main objectives are to improve the living conditions of rural and tribal people by developing environmentally sound land and water resources programmes ; improve the environment and eco-system ; arrest the distress migration ; improve the socio-economic status of rural people and strive for their overall development. This is promoted by facilitating the growth of community based institutions that support and sustain the Natural Resources Management programmes.

The project area is classified as a drought prone semi-arid region of the country and is pre-dominated by tribals and rural poors representing the poorest section of our society. The project area is presently extended across three states in thirteen districts of Rajasthan, Gujarat and Madhya Pradesh, covering approximately 2,86,740 households and more than 17,22,487 people in

1,376 villages under various NRM activities. Another about 400 villages have been covered by other NGOs who were initially supported by the Organization during their infancy period.

Besides implementation of livelihood programmes centered around NRM, the organization has been at a great scale imparting training, capacity building and technical inputs to large numbers of government and non-government organizations at its state of art training institute at Chosala, Dahod, Gujarat, which has not only excellent physical infrastructure and facilities, but, manned by highly qualified and richly experienced staff known for their expertise and performance in the respective field. Usually, groups from the government and non government organizations from 21 Indian states take benefit of our training and capacity building and often international groups also come for the training-cum-exposure. Through our training and capacity building, we have influenced watershed development programme in about 66.20 lakh of acres (26.48 lakh ha.).

PROFILE OF SUPPORTERS

Reliance Industries Limited

Shri Parimal Nathwani

The Reliance Group, founded by Dhirubhai H. Ambani (1932-2002), is India's largest private sector enterprise,with businesses in the energy and materials value chain. Group's annual revenues are in excess of US$ 58 billion.The flagship company, Reliance Industries Limited, is a Fortune Global 500 company and is the largest private sector company in India.

Backward vertical integration has been the cornerstone of the evolution and growth of Reliance. Starting withTextiles in the late seventies, Reliance pursued a strategy of backward vertical integration - in polyester, fiberIntermediates, plastics, petrochemicals, petroleum refining and oil and gas exploration and production - to be fully integrated along the materials and energy value chain.

The Group's activities span exploration and production of oil and gas, petroleum refining and marketing,Petrochemicals (polyester, fibre intermediates, plastics and chemicals), textiles, retail, infotel and special economic zones.

Reliance enjoys global leadership in its businesses, being the largest polyester yarn and fibre producer in theworld and among the top five to ten producers in the world in major petrochemical products.

Major Group Companies are Reliance Industries Limited, including its subsidiaries and Reliance IndustrialInfrastructure Limited.

Excel Crop Care Limited

Shri Dipeshbhai Shroff

Established in 2002, Excel Crop Care Limited has risen out of the demerged portfolio of the agricultural Products segment of Excel Industries Limited. Today it has realized its pride of being the 'supplier of choice' byReaching out to millions of farmers in more than 50 countries.

Besides solutions in soil health, seed treatment, crop protection, pest management, Excel Crop Care also offersEffective post-harvest treatment that has ensured smooth supply and trade in agricultural commodities in many

Countries. We extend solutions developed through backward integration of technology. Our products and solutions are directed to secure returns for farmers on farm inputs while adhering to the company's policies that aim for environmental safety and sustainability.

Excel Industries Limited

Shri Ashwinbhai Shroff

Excel Industries Limited has come a long way since its origin in a kitchen laboratory in 1941.
Over the years, Excel came to be known as an industry leader in the area of agro-chemicals and agro-chemicalIntermediates. Using its expertise in Chemistry and Chemical technology, Excel also expanded its chemicals manufacturing range to include Water treatment chemicals and Polymer Additives and few other specialties
Chemicals.
Excel's commitment to sustainable development led us to venture into the field of Environment and Biotechnology.
Excel is a Pioneer and Technology leader in rapid conversion of Municipal Solid Waste to organicCompost. Our organic plant protection and soil/crop productivity enhancers are well accepted in the market.
In order to ensure focused attention to the expanded range of activities, the agro business division was spun off as a separate company, Excel Crop Care Limited in 2003. Today, Excel is organized into two divisions i.e. a.Chemicals, b. Environment and Biotech.
Ever since our inception, we have built up a solid history and reputation of developing, manufacturing andexporting chemicals. We have achieved over 100 product and process breakthroughs that even now are servingthe specific needs of various clients.
We have excellent research facilities in Mumbai and at our manufacturing locations.
During the last six decades, we have received numerous awards in recognition of our dedication and excellencein the field of chemicals.
From the very beginning, in 1941, when our founder Mr. C. C. Shroff established Excel, we have believed thatin every interaction we have with our clients, our individual as well as our corporate character, integrity andProfessionalism is under scrutiny.
We have always kept the virtues of high quality, cost effectiveness, consumer need fulfillment, fair prices andfair trade practices uppermost in our minds.

SAHITYA MUDRANALAYA PVT. LTD.

Shri Shreyas V. Pandya

Sahitya Mudranalaya Pvt. Ltd., wedded to the mantra 'Whare Printing is a Craft', is an ISO-27001 : 2013 certified company for effective Information Security Management System, the first Printing Press to have this global honour in India.
It has been awarded NSIC-CRISIL Credit Rating of 'SE 1A' for 'Highest performance capability and High financial strength.'
The average annual turnover of the Company in last 5 years is 25 crores and working as 'Zero Debt' Company since more than last 10 years.
With corporate outlook, co-operative attitude and dedication to quality, it has scaled higher peaks periodically and regularly. During its successful journey of 50 years towards fulfilment of Excellence in Printing it has reached many a milistones.
It has been conferred with two President of India Awards, the highest our nation can offer, along with several National and State level awards. It has received the prestigious 'Star Printer of SAARC Nations' Award at the First South Asia Print Congress. They all symbolize Sahitya Mudranalaya Pvt. Ltd.'s will to excel, always.
Sahitya Mudranalaya Pvt. Ltd. is recognized as one of the prestigious and outstanding Graphic Art Centres of India.
E-mail : smpl99@gmail.com

Gujarat State Seeds Corporation Limited

Gujarat Sate Seeds Corporation Ltd., established in April 1975 popularly known by its brand name "GURABINI" is serving in the larger interest of farmers from more than three decades with farmer's faith brand loyalty, quality assurance, dedicated service and sustainable contribution for upliftment of farmers with Glorious achievements.

GURABINI is primarily engaged in production, processing and marketing of seeds of more than 30 crops and 100varieties and hybrids in almost all categories i.e. Cereals, Pulses, Oilseeds, Fiber Crops, Fodder, Green ManuringCrops. GURABINI is having its Head office at Gandhinagar, and 13 Branches across the Gujarat and one Sales Depot.

The Chairman of Gurabini is Dr. Rajkumar, Principal Secretary (Agriculture) to Government of Gujarat andShri Bharat Modi, Managing Director is also a senior technical officer from Government of Gujarat.
The authorized share capital of Corporation as on is Rs.4 Crores divided into equally shares of Rs.100 each.As against that, the paid up share capital is Rs.3.93 Crores. The shares have been held by following categoriesof share holders:
Government of Gujarat : 95.00 % shares
Government of India : 5 % shares
The present strength of the Board of Directors is 8. The directors are appointed / nominated under theProvision contained in Article- 62 of the Article of Association of the Company.

Monsanto

Monsanto is a sustainable agriculture company. Monsanto deliver agricultural products that support farmers all around the world.

Monsanto are focused on empowering farmers—large and small—to produce more from their land while conserving more of our world's natural resources such as water and energy. Monsanto do this with our leading seed brands in crops like corn, cotton, oilseeds and fruits and vegetables. Monsanto also produce leading in-the-seed trait technologies for farmers, which are aimed at protecting their yield, supporting their on-farm efficiency and reducing their on-farm costs.

Monsanto strive to make our products available to farmers throughout the world by broadly licensing our seed and trait technologies to other companies. In addition to Monsanto's seeds and traits business, Monsanto also manufacture Roundup and other herbicides used by farmers, consumers and lawn-and-garden professionals.

Monsanto could not exist without farmers. They are Monsanto customers--the lifeblood of our company. More important, they are the support system of the world's economy, working day in and day out to feed, clothe and provide energy for our world.

NABARD

NABARD is set up as an apex Development Bank with a mandate for facilitating credit flow for promotion and development of agriculture, small-scale industries, cottage and village industries, handicrafts and other rural crafts. It also has the mandate to support all other allied economic activities in rural areas, promote integrated and sustainable rural development and secure prosperity of rural areas. In discharging its role as a facilitator for

Rural prosperity NABARD is entrusted with

- Providing refinance to lending institutions in rural areas.
- Bringing about or promoting institutional development and
- Evaluating, monitoring and inspecting the client banks.

Besides this pivotal role, NABARD also:

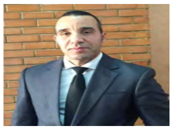
- Acts as a coordinator in the operations of rural credit institutions.
- Extends assistance to the government, the Reserve Bank of India and other organizations in matters relating to rural development
- Offers training and research facilities for banks, cooperatives and organizations working in the field of rural development.
- Helps the state governments in reaching their targets of providing assistance to eligible institutions in agriculture and rural development.
- Acts as regulator for cooperative banks and RRBs.

Mission:

- Promoting sustainable and equitable agriculture and rural development through effective credit support, related services, institution building and other innovative initiatives. In pursuing this mission.
- NABARD focuses its activities on:
    - o ***Credit functions:*** involving preparation of potential-linked credit plans annually for all districts of the country for identification of credit potential, monitoring the flow of ground level rural credit, issuing policy and operational guidelines to rural financing institutions and providing credit facilities to eligible institutions under various programmes.
    - o ***Development functions:*** concerning reinforcement of the credit functions and making credit more productive. ***Supervisory functions:*** ensuring the proper functioning of cooperative banks and regional rural banks.

KEY SPEAKERS

Sr.	International Speakers	Photos
1	Dr. Govind Hariharan, Kennesaw State University, USA	
3	Prof. Mukul Asher, LKY School of Public Policy, Singapore	
4	Dr. Robert Jordan, Parodi Group, Africa	
5	Dr. Mark Harvey, ICACS, University of Southern Queensland, Australia	
6	Andrew Enow, GACSA, FAO ,Rome	
7	Trynkova Olga, GACSA, FAO ,Rome	
8	Mehboob B. Sheikh, Florida A&M University, USA	
9	Prof. O.S. Mbuya, Florida A&M University, USA	
10	Dr. Nandkumar -Program Coordinator, Florida A&M University, USA	

11	Dr. Harriett A. Paul- Director, Center for International Agricultural Trade, Development Research and Training, Florida A&M University, USA	
12	Dr. William Hyndman III - Assistant Vice President, Florida A&M University, USA	
13	Dr. Robert Taylor- Dean College of Agriculture and Food Sciences, Florida A&M University, USA	
14	Dr. Mohamed Behnassi, ibn Zohr University of Agadir, Morocco	
15	Shyam Khadka, FAO	
16	Ms. Michelle S. Gale de Oliveira, Director, Green Economics Institute, UK	
17	Stuti Rawat, Lee Kuan Yew School of Public Policy National University of Singapore	
Indian Speakers		
18	Justice B P Singh- Formerly Judge, Supreme Court of India	
19	Dr. Trilochan Mohapatra DG - ICAR	

20	Dr. A. Arunachalam, Principal Scientist - ICAR	
21	Dr. V.P. Dimiri, Distinguished Professor -CSIR	
22	Dr. R. C. Maheshwari, former Vice Chancellor, SDAU	
23	Dr. R. Gopichandran, Director, Vigyan Prasar	
24	Dr. Kinkini D Misra, Scientist-F, Vigyan Prasar	
25	Er. Anuj Sinha, Formerly Head, Vigyan Prasar	
26	Dr. V.V. Sadamate, Formerly Advisor-Planning Commission	
27	Dr. K.V.Raju, DMI, Patna	
28	Dr. Devi Prasad Juvvadi, Director CGG, Hyderabad.	
29	Dr. A. R. Pathak, Vice Chancellor, Junagarh Agricultural University, Junagarh	

30	Dr. C. J. Dangaria, Vice Chancellor, Navsari Agricultural University, Navsari	
31	Dr. M.C. Varshney, Vice Chancellor, Kamdhenu University, Gandhinagar	
32	Dr Ashok Patel, Vice Canceller, Sardar Krushi Nagar Agricultural University, S K Nagar	
33	Dr. N.C. Patel, Vice Canceller –Anand Agricultural University, Anand	
34	Dr. K.B. Kathiria, Director of Research & Dean, Faculty of PG Studies, Anand Agricultural University, Anand	
35	Dr. D.C. Joshi , Dean Faculty of Food Processing and Bio-energy, Anand Agricultural University, Anand	
36	Dr. K.P. Patel, Dean Faculty of Agriculture, Anand Agricultural University, Anand	
37	Dr. K.N. Wadhwani, Professor and Head, Dept. of Livestock Production Management, Anand Agricultural University, Anand	

38	Dr. M. V. Patel, Professor and Head, Dept. of Agronomy, BACA, Anand Agricultural University, Anand	
39	Dr. Vyas Pandey, Professor and Head, Dept. of Agricultural Meteorology, BACA, Anand Agricultural University, Anand	
40	Dr. N.R. Patel, Scientist 'SG', Indian Institute of Remote Sensing, Dehradun	

KEY PAPERS

FUTURISTIC AGRICULTURE ENVISION FOOD, WATER AND ENERGY NEXUS

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Food, water, and energy are inextricably linked in a nexus, and actions in one sector influence the others. Food production requires water and energy; water extraction, treatment, and redistribution require energy, while energy production requires water as well (Bazilian*et al*., 2011 and Hussey and Pittock, 2012). Food production and freshwater services depend on water, land, and other natural resources, in other words a range of ecosystem services (FAO, 2014 and Rasul, 2014; Boelee*et al.*, 2011). The choice of food and agricultural practices influence water and energy demand. Similarly, water, energy, and land demand is influenced by dynamic nature of all the three as well by different policies.

South Asian countries face mounting challenges in this regard, particularly on account of a rapidly growing population. Countries have provided policy support to increase cereal production, including providing incentives by subsidizing water and energy and guaranteeing rice and wheat prices (Rasul, 2016). While such incentives have increased production of cereals,which in turn increased the demand for water and energy, led also to degradation of the resource base, and contributed to an increase in water-related problems. Despite the inherent interconnections between food, water, and energy production, agencies often work in a fragmented and isolated way. Free water and subsidized electricity have not only encouraged over-exploitation of resources, they have also led to under-investment in water and energy-saving technologies and approaches and hindered crop diversification and broad-based agricultural growth in line with the comparative advantages. Access to electricity, energy subsidies and affordable pumps allowed farmers to shift their dependence from surface irrigation (*via* canals) to groundwater (*via*wells and tube-wells). In principle, these developments empowered farmers by diversifying their irrigation options and insuring them against the rain shocks. However, the absence of a robust water management policy left the groundwater resources vulnerable to over-exploitation. Today, more than 70% of the groundwater has already been utilized and the available groundwater resources are under great stress.

The resource stability nexus goes more troubling while considering the long term consequences of climate change especially in developing countries like India. India having two-third of its area rain dependent *i.e* high monsoon dependency, having diverse seasons, crops and farming system with close link between climate and water resources. Climate change brings shift in rainfall pattern, variation in temperature, extreme weather events and wet and dry spell, cause significant impact on choice and duration of crops, which in turns disturb the water-food- energy nexus's stability. Because of uncertain and non-uniformly distributed rainfall,in spite of rethinking on the choice of crops suitable for the changed climate, farmers started exploiting groundwater more to suffice their crop water requirement and balancing production of crops. Pumping more groundwater increased pressure on energy availability thus continues the vicious circle.

In Andhra Pradesh/Telangana, groundwater use is, in turn, explained in part by cropping patterns in the area. Although dry rice varieties and semi-arid agricultural crops are viable in the area, water-intensive paddy cultivations are preferred by farmers due to the higher prices and government support (Kimmich, 2013). The genesis of this crisis can be traced back to the Green Revolution of the 1960s when the country's policy and epistemic communities, in order to raise agricultural yields multi-fold and make India food secure, as well as to support rural and low-income farmers, took to massive cultivation of high-yielding crops (mainly cereals), mostly employing flood irrigation (that uses relatively low levels of technology and labour). Flood irrigation has been criticized heavily for its contribution to water wastage through evaporation, run-off, soil erosion, leaching of fertilizers and so on. For instance, Maharashtra is a leading sugarcane producer, one of the most water-intensive crops and its cultivation is primarily rain-fed, unlike in Uttar Pradesh (another major producer) where it is irrigated. The state has been reeling under severe drought for the past few years due to inadequate rainfall. The farmers have been forced to depend to a great extent on groundwater (using tubewells and bore wells that pump water to the surface) to sustain yields, even at a time when drinking water is scarce. Karnataka's (not far behind Maharashtra in terms of sugarcane production) story remains the same. Ironically, the government policy of promoting the cane industry (by reducing duties in comparison to other crops and by providing incentives for exports, free/subsidized water and electricity) so far has led to its cultivation replacing other crops such as ragi and jowar with more and more farmers opting to plant it. Similarly, rice – another water-intensive and a staple crop is being grown in regions (the Punjab-Haryana belt) that experience depleting water tables. This brings to light the inherent irony in the farming practices followed in the country, especially in terms of cropping patterns, wherein water-intensive crops are grown and promoted in regions (to this day) that have historically been drought-prone.

The nexus approach can enhance understanding of the interconnectedness of the sectors and strengthen coordination among them. But it requires a major shift in the decision-making process towards taking a holistic view and developing institutional mechanisms to coordinate the actions of diverse actors and strengthen complementarities and synergies among the three sectors. Similarly, the ability to achieve the goal of water and energy security will largely depend on the ways in which food is produced, processed, transported, and consumed (Hussey and Pittock, 2012).By ignoring the underlying inter-dependence of the three sectors, policies sometimes have the unintended consequence of shifting a crisis from one sector to another (Tomain, 2011).

Greater policy coherence among the three sectors is critical for decoupling increased food production from water and energy intensity and moving to a sustainable and efficient use of resources. Eventually, water resources are over-exploited and wasted as yields do not increase proportionately to water usage. In the subsequent years, flood irrigation has given way to drip and micro irrigation in many parts of the country, but in the drought-hit areas, the former practice has not been completely abandoned. There is an immediate need to regulate unsustainable practices and promote technological and institutional innovations to all the three strong sector of food, energy water asthe goals are interlinked in different ways. Achieving the goal of food security and ending hunger, for example, depends strongly on achieving the goal of water and energy security which is needed to ensure water and energy is available for futuristic food production.

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FOOD, WATER, ENERGY NEXUS IN ARENA OF CLIMATE CHANGE

Kirit Shelat
I.A.S. (Retd) and Executive Chairman - NCCSD

Water, energy and food are inextricably linked. Water is an input for producing agricultural goods in the fields and along the entire agro-food supply chain. Energy is required to produce and distribute water and food to pump water from ground water or surface water sources, to power tractors and irrigation machinery, and to process and transport agricultural goods.

They are also the key to provide sustainable development, livelihood and for that matter for poverty reduction.

The demand for fresh water, energy and food will increase significantly over next decades under pressure of increased urbanization, growing middle income families, increased manufacturing activities, transportation, diversified diets, so on and so forth. As per FAO estimates, this situation is expected to be exacerbated in near future as 60 percent more food will be needed for the growing world population. The Global Energy Consumption is projected to grow up by 50% by 2035. Total Global water withdrawals for irrigation are projected to increase by 10 percent by 2050.

As demand grows, there is competition between different stakeholders particularly agriculture, the farmers and urbanities and within the village level for drinking purpose of families and livestock and for farming.

As a concerned citizen, we are aware of food, energy and water challenges, but and addressed them in isolation, within sectoral boundaries. At district level, fragmented sectoral responsibilities, lack of coordination and inconsistencies exists. If water, energy and food security are to be simultaneously achieved, decision makers, need to understand. A nexus approach to sectoral management, through enhanced dialogue, collaboration and coordination, is needed to ensure that co-benefits and trade-offs are considered and that appropriate safeguards are put in place particularly in the arena of climate change is a serious threat to food, water and energy security and most important challenge in this millennium.

The Complementarities and co-benefits from nexus-based adaptation are as under

Key Characteristic	***Nexus approach***	***Climate change adaptation***	***Complementarities and co-benefits from nexus-based adaptation***
Goal	Achieving water, energy, and food security objectives and sustaining resources through efficient use of available resources	Build resilience and enhance adaptive capacities against climate and other risks	Understanding adaptation to climate change is critical for addressing nexus challenges, and efficient use of resources is critical for effective adaptation
Core principles	Minimize resource waste and maximize economic efficiency, while accelerating the sustainable supply	Reduce vulnerability by managing climate risks and building response capacity	Since resource scarcity often increases people's vulnerability, the nexus approach may contribute to facilitating adaptation and vice versa
Main focus	Provide integrated solutions at Implementable policy Frame work with solution at multiple stage.	Minimize shock, risks, and vulnerability and address impacts and risks associated with climate change	Understanding vulnerability to climate change is crucial for assessing nexus challenges; equally, integrated nexus solutions can contribute to reducing vulnerability and poverty
Broad strategies	Policy integration, Harmonization of existing schematic local level planning and implementing by involving public governance system with multi by and crust cutting stakeholders with community partnership harmonization, and governance to build synergies and generate co-benefits across sectors by engaging multiple stakeholders, public–private partnership	Addressing the drivers of vulnerability to climate change in specific sectors through building adaptive capacity and resilience	Addressing the drivers of vulnerability to climate change in specific sectors through building adaptive capacity and resilience

Source: Adapted from Golam Rasul & Bikash Sharma (2015)

Synergies between the climate change adaptation and nexus approaches

	Sector-specific adaptation measures	*Positive implication for the Sector*	*Potential for synergies across the nexus*
Water	Increasing water use efficiency E.g. Switching to drip irrigating Switching from use freshwater to wastewater-recycle-water-for Farm-irrigating Switching from wet to dry cooling at thermoelectric power plants Desalinization New storage and conveyance of water to serve new demands Watershed and river basin management	Reduces water use per capita Reduces freshwater use per capita Reduces water use and associated thermal pollution Increase in brackish and freshwater supplies Increased water supplies to meet demand Increased water supplies to meet demand	Increased availability of water for energy and Agriculture Increased availability of freshwater for food, energy, and other uses Increased availability of water for energy and agriculture Increased availability of freshwater and overall water supply for energy, agriculture, and other uses Increased availability of freshwater and overall water supply for energy, agriculture, and other uses Increased water supply for energy and other uses, improved water quality, reduction in flood potential
Land	Switching to drought-tolerant crops and promote drought resistant original and breeds develop Sea-weed as a marketable product. Using waste or marginal land for grass land development to support Livestock development.	Increased/maintained cropyield in drought areas Increase in renewable energy	Reduced water demand Reduced pressure on non-renewable energy as some fossil fuels are replaced with biofuels
Energy	Increasing transmission capacity and reduce transmission losses Enhancing efficiency of existing renewable energy, like solar, wind, biogas, and bio energy at local level and replicating them on mass-scale.	Reduced economic and social impacts Increased clean energy and reduced pressure on energy	Potential for reduced emissions if new transmission and wind/solar power supplied to the grid Reduced GHG emissions, reduced water demand for cooling, thermal power

Source: adapted from Skaggs, Hibbard, Janetos, and Rice (2012).

The Indian Situation

Indian Economy is doing extremely well. The rate of growth of GDP is between 7 to 8%. Poverty in rural areas has declined from 80% to 20% prior to Independence. Country used to import food grains in the initial years, but since then it has gained self sufficiency and now exports.

Agriculture growth has been steady at the average of 2% to 4% except last two years. Although rural livelihood has improved, there are huge numbers who are behind poverty line. The farmers like to leave farming as it is not profitable – some wed

Naxalism – others migrate. Although Country has achieved Food Security and both Food Security and employment are now guaranteed to the poor people by an enactments but the sustainable livelihood is still an issue.

The Food Security and Livelihood are inter-related and there are problems.

Food Security: Due to rapid increase of non-agriculture activities like urbanization, industrialization and infrastructure development, area under agriculture and food production is getting reduced. With increasing urban middle class population, demand for food, Dairy and Meat products is increasing. There will be huge gap between demand and supply position in years to come.

Water Scarcity: Again due to enhanced urbanization and Industrial activity, even water meant for irrigation in Dams and Reservoirs– Lake are getting diverted to meet increased urbanities demand. Further big new Township are using huge pumps which draw out daily large quantity underground water which resource is becoming increasingly depleted.

Energy Scarcity: Deficient supply of Electrical energy in rural areas –There is only 30% to 40% of energy demands of rural household is met-with. The Farmers get supply from 6 to 8 hours – but there are frequent break downs. Due to delay in rain-Speed or drought- Farmers demand for energy is increasing –Further efficient energy supply (24 hours) is needed for local Processing of Agro-produce. There are huge transportation –losses and theft in electrical Supply lines

Impact of Climate Change: The Climate change has increased water and energy related, already existing shocks, in the arena of Climate Change, temperature is rising; monsoon is becoming more irregular with long dry spell and incidence of heavy rainfall in one day. This has adverse impact. The Agriculture productivity is directly related with Soil Moisture and availability of timely water and same is true for livestock, the milk yield, the poultry yield goes down. Country is already seeing this impact on decline of Food productivity and production and run for drinking water, both in urban and rural areas. Hence for Food Security, the water security is must and a prerequisite. It is this context; we need to examine availability Water and Energy and its use.

The Mint News paper has brought Out recently two interesting articles on 26-27of April 2016 which provides some interesting facts.

Drought in India –Current year affecting 33 cores in 256 districts. India's average water footprint both direct and indirect use of surface/ground water, for major crops – wheat, paddy, maize, sugarcane and cotton is higher than global average. And there is inefficient use of water.

The report observes that the important States have inefficient use of water of following major crops:

- Andhra Pradesh - Rice, maize, cotton
- Gujarat - Cotton
- Maharashtra - Maize, sugarcane, cotton
- Karnataka - Maize, sugarcane, cotton
- Punjab - Wheat
- West Bengal - Rice
- Madhya Pradesh - Wheat
- Uttar Pradesh - Rice

Country as a whole is using water insufficiently. Further India has less than average per capita water footprint.

The Mint News Paper – 27th April 2016, writes how India is virtual exporter of water. The study has calculated quantum of water used for production in Agriculture and by livestock.According to Water Footprint Network (WFN). It takes 2173 litres of water to produce a KG of rice. In 2014-15 India exported 37.2 lack tons of Basmati. To export this rice, Country used 10 trillion litres of water or alternatively it exported water equivalent to that quantity. Similar is the situation for Dairy and Meat products. E.g. in case of goat meat, per kg requirement goes up to 8763 litres.

Since we do want to Export our Agriculture produce, the major policy implication is to introduce efficient use of water resources.

As regards water availability various studies have revealed that underground water sources are depleting and enhancing penetration of saline water of sea through faults both underground and over ground. The impact is in Gujarat and elsewhere. The recent study by Prof. Jay Famiglietti using NASA Satellite called GRACE reveals that in India – Rajasthan, Punjab, Haryana region is losing about 17.7 kilo meters of ground water per year (Times of India – 1st May 2016) Hence water conservation and its efficient use is the key for solution of obtaining water security.

Some examples of other inefficiency in use of water resources are:

- Majority of farm irrigation is flood irrigation. Water gets wasted in soil- areas where it is not needed. Whether it is from underground tube well or canal irrigation, water gets spread through entire farm. Drip irrigation exists – but to very limited areas.

- The public irrigation system – Canals are all open subject to evaporation with increased temperature and long dry spells. Actually this reduces available water resources drastically.
- We do not have yet standardized actual need – quantum of water needed for first, second or third irrigation for crop, plant or fruit tree or for that matter livestock (depending on its weight). In many a cases, excess water is given then needed. There is a need to calculate this and give farmers Agro advisory.
- Another important factor is the entire canal irrigation water is almost free and energy charges for pumping water are heavily subsidized. Hence there is tendency to waste. The value of water as a scarce resource is unknown. Even in urban areas, there is no control in use of water – like having water meter.
- Further there are recurrent floods now even in dry land areas. Historically, Uttarakhand, Uttar Pradesh, Assam and many other parts were affected by floods. This is resulting into a huge lose to both of human beings, property and erosion of infrastructure and soil Apart from affecting livelihood of people. It also results into lose of sweet water every year. While the areas of Saurastra, Kutch, North Gujarat and Vidarbha Maharashtra are most often affected by water scarcity. But due to Climate change even in these areas there are days of heavy rain in last few years causing instant flood. Management of flood is an important policy matter. But due to lack of care, even water is wasted due to many other reasons which become the cause of flood!
- Silting in check dam/Dams
- Silting in river valley
- Silting in river bed
- Growth of bushes and leakage in canal
- In correct data about absorbing capacity of river
- Data about sea-water-level not coordinated
- Soil erosion in river basin area
- Data about sedimentation – old
- Flood level not marked
- Encroachment on river- side.

In fact all these Cause Flooding which did not exist.

Wastage of food

While we are producing enough Food-today-but in recent past there has been_decline of food production due to adverse climate condition. But on other head there is huge food wastage-at production stage and by consumers- When they are using it.

- **Farmers:**

  The Farmers with little more care, education and support can save 5% to 25% of his produce which is lost due to inefficient methods:
  - While harvesting.
  - Cleaning (thrashing on road side).
  - Packaging (in bags with holes).
  - Transporting-putting his produce with other item – like gasoline or kerosene or having his product at bottom and others piled up – resulting into spoilage.
  - Due to heat wave.
  - UN seasonal frost.

If proper inter-connected chain is developed-so that his produce is collected from farm to packaging station and then to market yard, these losses can easily saved and his income enhanced up to 25%.

- **Consumers:**

  There are several stages. Again improper storage and further transportation from market yard to whole-solar-to retailer due inefficient handling and improper packaging huge losses are taking place.

  The concerned citizens also make waste-by peeling of vegetables more than needed, cooking more than needs of Family and throwing away. But huge wastage is in parties- dinners- and in restaurant – people take more in their plate then they can consume. For last one – a regulatory framework needed.

Gujarat Approach

In fact, since seventies, country has excellent drought relief policy and introduced Drought Prone Area Programme backed by Watershed Approach. Gujarat went further and laid water pipeline connecting almost all affected villages with Narmada water and even inter linked rivers. These approaches have paid rich dividends very briefly:

Water

- Only 20% of area accounts for perennial rivers-80% is dependent on surface water. Gujarat is water starved state to Rajasthan in India.
- Gujarat adopted certain innovative approach to meet this challenge.

o Integrated approach for sustainable and efficient water resources development by

a) Water conservation –dams-check–dams, watersheds, borri bandh, village ponds-Farm ponds.
b) Inter linking of river and canals – like Narmada canal with Sabarmati River.
c) The Sardar Sarovar Dam on Narmada river- which is linked by canals water for irrigation to water-starved districts and also providing water to urban_areas and Narmada water pipeline is linked 11000 villages in water starved area to meet drinking water requirement of human beings and cattle.
d) Gujarat has adopted Participatory approach: The check – dams, water-sheds, minor-irrigation canals are under participating approach- right from construction to maintenance and management of its use by village community. More than 1, 00,000 check dams have been constructed under this approach.
e) Milro- Irrigation is propagated – Government has set up an independent organization for mass introduction of drip and sprinkler irrigation known as Gujarat Green revolution Co Ltd- which is providing subsidies for laying of drip irrigation and its maintenance for three year with insurance cover and guiding farmer for its use and maintains and monitors its implementation.

As a result of above approach while ground water level of many states have declined in recent years, the Gujarat is an exception.

Energy

Gujarat Introduced took a bold approach to provide electricity to rural areas under Jyotir Gram Yojana.

- It provided three phase power for 24 hours in rural areas. It introduced normal electricity terrif for residential area of village. It continued subsidized electricity to agriculture for eight hours. It crated two different greed- one for residential area and another agriculture area. Hence now its entire village has 24 hours electricity. This has encouraged local processing of agriculture products and improved quality of village life and that of students who can study at night also and has also reduced migration.
- Solar Pumps: This is an innovative project who can study can evening and night to use solar energy in Dhundi village of Anand district –by Setting up Dhundi Solar Pump Irrigation Cooperative.
  Install solar pumps for pumping of water.
  Use solar panels for producing electricity.

When pump is not used, panels are linked with local electrical greed and farmers are paid for electricity produced.

This provide permanent source of Income (case study at annextures)

The most important point to keep in view that despite all above and a very strong Climate Resilient Agriculture developed under Krishi Mahotsav approach –in last two years-due to drought and adverse Climatic Condition which included heat wave , Frost , the food production in Gujarat had declined so has position of water in major dams which got dried up and many village were required to be provided drinking water by tankers .

Way Forward

With increasing adverse climate events and rapid urban development, new challenges are required to be addressed and ways focused to meet them.

- **Add value to water:** Water is becoming very scares. It is the key requirement for Food Productivity hence how to make it as a commodity with value – price as of now both urbanities and farmers get it almost free.
- **Introduce compulsory water cycling in urban areas:** How to control new Urban Township – they consume huge underground and canal water resources? How to introduce compulsory recycling of water both in Urban – Rural areas and make it available irrigation. Where this is not feasible, can we have compulsory "Recharge of water?"
- **Micro Irrigation:** Make drip irrigation – a way of life in farming.
- Can we decide to have 'piped' canals instead of current open system or replace it? Can we learn from Israel or from our own traditional water conservation system like that of "step well or tunnels"?
- **Safe Drinking Water:** How to ensure safe drinking water even in years of drought.
- **Solar Energy:** The pilot project at Anand Show the way. It was solar energy initially to pump water-but more to produce

electricity which can be linked to local greed and farmers get paid first. The case Study is at annexative. This need to be replicated.

- **Use Biodiversity – Salinity Resistant/loving crops and trees:** How to use bio-diversity, identify salinity resistance crops and propagate them.
- **Village level water plan:** Can we introduce micro-level Water, Energy Agriculture production plan for every Village and Block.
- **Flood Prope Area Development Policy:** Every year we lose water in very many parts of our country, due to Flooding of rivers now even Fields.

CONCLUSION

Climate change impacts the extent and productivity of both irrigated and rain fed agriculture. Rising temperatures will translate into increased crop water demand, so will be demand of increasing Urbanities. Both the livelihoods of rural communities and the food security of a predominantly urban population are therefore at risk from water-related impacts linked primarily to climate variability. Increasing soil salinity is already affecting the root zone and hence productivity. Management of saline water ingress is the third dimension of impeding challenges. The rural poor, who are the most vulnerable, are likely to be disproportionately affected, so will be their livelihood. Various adaptation measures that deal with climate variability and build upon improved land and water management practices conservation and its efficient use have the potential to create resilience to climate change and to enhance water security. In order to meet the challenge of Food Security, first, there is a need to understand the need of efficient use of water and energy. In addition to existing programmes, there is a need to educate and make responsible citizen including our Public Leaders about value that water energy and reduction of wastage of food will have in years to come – its likely scarcity and impact on livelihood and Food Security both of urban and rural population. And also importantly on social tranquil and tensions resulting into water riots!

It must be mentioned that some of above approaches like above do exist – but time has now come to identify 'inefficiencies', 'Gaps' new technology serious understanding of problem related food , water and energy quality due to Climate Change inter connection. That is way Nexus approach is reduced.

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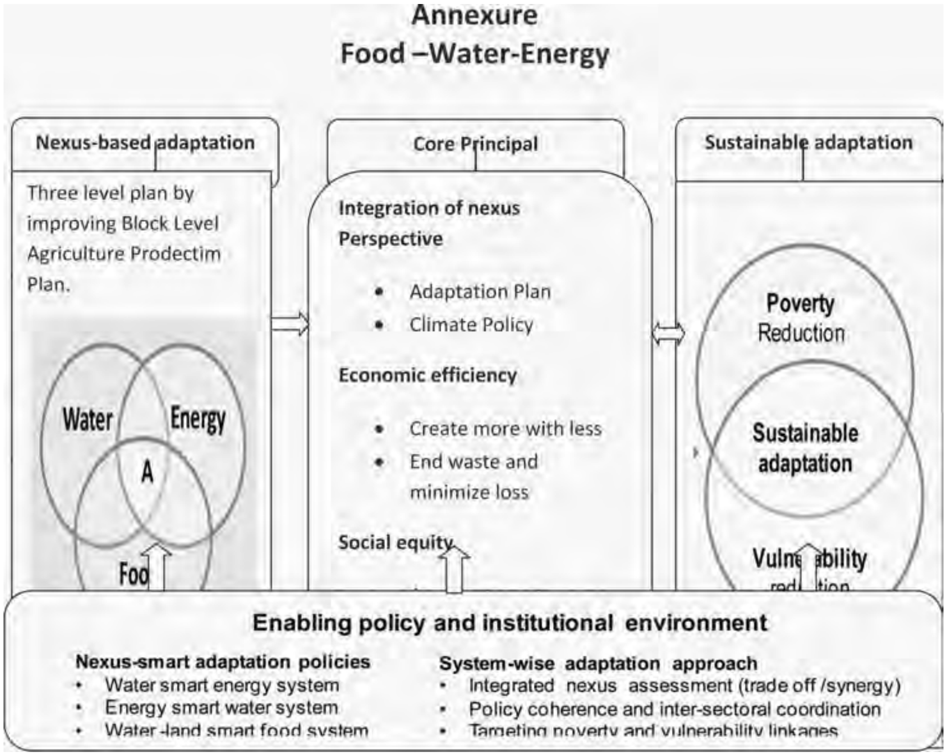

Annexure

PROMISE OF DHUNDI SOLAR PUMP IRRIGATORS' COOPERATIVE

Tushaar Shah, Neha Durga, OmkarJani, Akhilesh Magal

Next week, the world's first Solar Pump Irrigators' Cooperative Enterprise(SPICE) will be up and running in the village of Dhundi in central Gujarat. Solar pumps are not new in India. But this cooperative is the first of its kind. Its members will use solar energy to run irrigation pumps. But they will also pool their surplus solar energy and sell it to Madhya Gujarat Vidyut Company (MGVCL)at Rs 4.63/unit under a 25-year power purchase agreement. Six solar pumps, with a total of capacity of 56.4 kW, will generate some 85,000 kWh/year of solar energy, use 40,000 kWh/year[1] for irrigation, inject the remaining 45,000 kWh/yearto the grid and earnRs 2.00 lakh/year in net cash income from power sales.

Under the power purchase contract, these farmers have surrendered their right to apply for grid power connections for 25 years. They not only find solar power decidedly preferable to expensive diesel they used for irrigation, but also better than subsidized grid-power. Grid power comes for 7-8 hours with interruptions and voltage fluctuations, and is supplied during night half the days in a month. Solar power, in contrast, is uninterrupted, predictable, available during daytime and free of cost. Initially, farmers were worried about land-footprint of solar panels; but they are already experimenting with a range of high value crops such as spinach, carrots, garlic, beet and some medicinal plants that grow well under panels.

No wonder that International Water Management Institute (IWMI) and the Climate Change, Agriculture and Food Security (CCAFS) program, which have organized the Dhundi SPICE, are flooded with requests from farmers from near and afar to form similar cooperatives. Farmers are excited by the idea of' growing' and selling solar energy as a cash crop that needs no seeds, fertilizer, pesticides, irrigation and backbreaking labour. Income from the solar crop is free of risk from droughts, floods, pests and diseases. Moreover, in MGVCL, it has a ready buyer at their doorstep. All it needs is land for erecting panels; and that land too can be put to alternative economic uses.

Farmers hope that once the Dhundi experiment takes off, it will be clear why Dhundi pattern SPICE deserve a better feed-in tariff than MW-scale solar plants or even roof-top solar installations. MW scale plants require large public investments in transmission but Dhundi cooperative required no new investment from government. Even the micro-grid in Dhundi was erected by farmers at their cost. Rooftop solar plants will deprive MGVCL of business with its highest-paying consumer segments. In contrast, DhundiSPICE will liberate MGVCL and government from debilitating farm power subsidy without hurting farmers.

Had the Dhundi farmers got 56.4 kW of grid power connections instead of solar pumps, MGVCL would have been obligated to provide them over 162,000 units of grid electricity at Rs 0.7/unit against its cost of Rs4.5/unit to deliver. Even if only 2/3rd of the power supplied were used, MGVCL would bear a subsidy of over Rs 4 lakh/year. In addition, MGVCL would have also invested Rs 12 lakh on poles and cables to connect these tubewells to the grid, at an amortized annual cost of Rs 1.2 lakh. Finally, with regulatory changes proposed and stricter enforcement on DISCOMs of enhanced Renewable Purchase Obligation (RPO), the market for Renewable Energy Certificates (REC) by the DISCOM is already reviving. As a 'Renewable PurchaseObligated entity', MGVCL's will earn at least Rs 2.97 lakh for 85,000 units/year of solar generation by Dhundi SPICE under the contract.

Taken together, thanks to DhundiSPICE, MGVCL will be better off by Rs 8.17lakh/year for 25 years. Even if the DISCOM shared a third of these gains with the DhundiSPICE, its members would get additional feed-in tariff of Rs 6.05/unit . In buying solar energy from SPICE, MGVCL's break-even feed-in tariff offer can be anything up to Rs 6.05 plus its average power purchase cost (APPC) of Rs 3.5/unit, and the DISCOM will still be better off than supplying them grid power at Rs 0.70/kWh.

State governments have so far promoted solar irrigation pumps only by offering Rs 90,000/kW subsidy on capital cost to farmers who opt out of the queue for grid power connections. But a power purchase guarantee at an attractive feed-in tariff can be a more powerful USP to promote solar pumps.

Governments should scale down capital cost subsidy on solar pumps to around Rs 50,000/kW and instead offer farmers feed-in tariff of Rs 8-9/unit provided they shift to solar power. In fact, DISCOMs would be better off offering such a deal even to net metered grid connected farmers provided those farmers agree to pay the DISCOMs for their grid power use at the same rate as DISCOMs pay for buying solar power from them.

However, DISCOMs loathe the prospect of net-metering individual tube wells, of billing and paying individual farmers with small marketable surplus of solar power. Their transaction and vigilance costs would be too high for them. Dhundi SPICE is the answer. Even as new members join, MGVCL will meter the cooperative at a single evacuation point and pay the cooperative for pooled power sales. It will be the cooperative's responsibility to meter each solar pump and pay each member based on power evacuated by her.

India has some 15 million grid-connected irrigation tube wells claiming a quarter of our total power generation and some Rs 70,000 crore of farm power subsidies responsible for the financial mess in our DISCOMs. Cutting these subsidies will be hard for many years to come for the fear of farmers' backlash.Dhundi pattern SPICEcan painlessly eliminates farm power subsidies once and for all. As a bonus, solarizing tube wells can deliver our entire targeted 100 GW solar capacity. Given India's massive agricultural load, Dhundi pattern SPICE which get integrated at the tail-end of the grid, can contribute enormously in smart grid management.

Power subsidies drive groundwater overexploitation in western India. These mute farmer incentive to conserve power and water. Dhundi pattern SPICE can inject powerful antidote to perverse incentives driving our water crisis by weaning farmers off grid power and helping them make money by conserving energy and water. Moreover, metering energy will make it possible for measure water withdrawals to manage them better.

In stabilizing our small-farmer livelihood system, Dhundi pattern SPICE may be as impactful as Amul type dairy cooperatives have proved in many parts. A7.5 kW solar pump with a power buy-back contract at Rs 8/unit can help a 1 hectare farmer meet her irrigation needs and generate extra income at her farm gate of Rs 60,000/year. She will need 3 buffaloes to earn such net income.

The biggest bonus of Dhundi pattern is in making Indian irrigation climate-smart. Using electricity and diesel in groundwater irrigation accounts for 26 million mt of Carbon emissions/year, some 5 percent of India's total. Solarizing our groundwater economy will eliminate this huge carbon-footprint and help the country reduce carbon-intensity of our economic growth.

Dhundi SPICE is albeit a small experiment. But it holds out the promise of reconfiguring our power economy, our groundwater economy and our agrarian livelihoods.

RECENT INITIATIVES IN AGRICULTURE: IMPROVING EFFICIENCY IN MARKETS, ENERGY AND WATER USE

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Agriculture in India is constrained by input as well as output level factors. Recognising the challenges these factors pose against the spectre of climate change, two areas the National Mission for Sustainable Agriculture (NMSA) identifies for action are 'water use efficiency' and 'markets' ("National Mission for Sustainable Agriculture" 2016). This paper takes a detailed look at three recent government initiatives that are targeted at improving efficiency at the input and output side in this regard through their focus on energy, water usage and markets respectively.

Water availability for agricultural users has reached critical levels, with excessive reliance on free or subsidized electricity to pump out groundwater putting a severe strain on electric utilities and state governments (Sankar 2004; Birner et al. 2007). In addition, the current patterns of energy usage make the agricultural sector the second highest contributor to greenhouse gas emissions (Swain and Charnoz 2012). If current trends are to continue it is projected that availability of water for agricultural use in India may be reduced by 21 percent by 2020 (Indian Agricultural Research Institute 2016), while the energy demand for irrigation will grow by 7 percent until 2022, with diesel making up 20 percent of the total irrigation demand ("India Energy Security Scenarios: Demand for Agriculture" 2016). Given the rising population, strained resources, such a scenario will exacerbate existing pressures on the system resulting in lower productivity, production and a detrimental impact on the environment at large. With respect to markets it is recognised that high agricultural crop price dispersion i.e. the variation in price across states (National Sample Survey Office 2014) affects famers' incomes. Moreover farmers face multiple barriers in marketing their produce because of high levels of market charges and movement controls (Press Information Bureau 2016).

Three recent schemes have been introduced by the government that is aimed at tackling these challenges of inefficient energy, water use and inefficient markets. These schemes are the National Energy Efficient Agriculture Pumps Programme (NEAPP), the Pradhan MantriKrishiSinchayeeYojana (PMKSY) and the National Agriculture Market (NAM) programme. While the first two schemes focus on the input side by targeting energy and water use efficiency, the last scheme targets efficiency in agricultural markets. This paper analyses the potential impact of these schemes, the substantive challenges they face and the policy lessons that can be garnered from other programmes that are relevant for the successful implementation of the current initiatives.

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WATER: THE COMMON DENOMINATOR

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Water, food and energy are intimately interlinked. However, water is the common thread required to grow food and generate energy, making it key for global food and energy security. A significant amount of water is required and used to produce food and energy. Agriculture is the dominant user of freshwater using about 70% of global accessible freshwater drawn from rivers, lakes and aquifers for irrigation to produce food, feed, fiber and biofuels (the remaining 10% is used for domestic applications and 20% for industry). Conventional energy production (hydroelectric, thermoelectric and fracking) is largely dependent on abundant supply of freshwater. Conversely, about 8% of generated energy is used for pumping, treating and transporting water to consumers. Human population is putting unprecedented stress on global water resources and energy demand. Climate change is a new stressor disrupting the global water system, particularly availability and distribution of freshwater. Increasing climate variability is already testing the resilience of water and energy systems in many parts of the world. Shortage of freshwater shall threaten global food and energy security. Given the nexusamong water, food and energy, more attention should be given to w ater and energy policy where planning and management must be integrated to encourage conservation, innovation and sustainable use. Unfortunately, many proposed solutions for water shortages around the world require more energy and energy solutions require more water, quite a paradox. International policy initiatives on efficient and effective water and energy management is not only necessary but compelling for sustained food production.

IMPROVING WATER USE EFFICIENCY TO SUSTAIN CROP PRODUCTION UNDER CLIMATE CHANGE SCENARIO

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Water deficit, caused by lack of water has been a great problem for agriculture worldwide affecting virtually every aspect of plant physiology and metabolism impacting food production. This is especially serious considering other adverse factors such as the high levels of atmospheric CO_2, climate change scenarios and predictions of future global warming, all of which increase drought incidence, frequency and severity. To cope with these stresses plants execute various physiological and metabolic responses to sustain with water stress, which is reflected by the synthesis of specific transcripts and proteins. One way to overcome this adversity is to generate new stress tolerant varieties by identification of specific genes involved in given metabolic processes. Most of the stress-response traits are complex and are influenced by multiple genes and extensive genotype-environment interactions. The expression of genes in response to water deficit stress involves not only transcription of genes but its translation into a protein that must be targeted to a specific cellular location to perform its designated function. To understand the effect of gene regulation, a comprehensive study of gene expression accompanied by metabolic processes within a cell is needed. An in depth proteogenomics study would elevate our knowledge of the biological phenomenon involved with the development of resistance to water stress. In this regard our research is aimed at identifying genes and proteins associated with WS tolerance to develop cultivars with high water use efficiency to reduce water use without yield reduction.

Our studies on grape have shown that water stress impacts stomatal osmotic pressure and expression of CER 5 gene involved in encoding ABC transporter which is required for wax export to the cuticle genes involved in transportation. We have found that several genes associated with cell permeability, transportation and maintenance of osmotic potential such as sucrose synthase, actin, AP2 transcriptional activator, cytochrome b gene, WRK transcription factor, protein kinase, isoprene synthase, cell division protein, rab1, ABF3, ASR2 gene, AP2, xyloglucan endotransglucoxylase and glyoxalase I are suppressed due to water stress. In peanut, we have found over-expression, suppression, and appearance of new proteins in water-stressed seed compared to irrigated control. These data revealed that seed polypeptide composition of drought-tolerant peanut genotypes (Vemana and K-1375) was least affected while that of drought-susceptible genotypes (M-13 and JL-22) significantly altered due to water stress (WS). We have also found that in peanut leaf, ninety-six proteins were differentially expressed in response to water stress. Three proteins, glutamine ammonia ligase, chitinclass II and actin isoform B were found to be unique to tolerant cultivars. We have also discovered that four proteins, serine/threonine protein phosphate PP1, choline monooxygenase, peroxidase 43, and SNF1-related protein kinase regulatory subunit beta-2 which play a role as cryoprotectant through signal transduction and defense were induced in drought-tolerant (DT) cultivar following WS. Several of the leaf proteins that were overexpressed in DT cultivar followingWS were suppressed in susceptible cultivar. The comparative proteome analysis also revealed that inDT cultivar(Vemana)several enzymes involved in cell wall lignification such as methyl transferases, methionine synthases and peroxisome which function as a constitutive physical barrier to minimize the water loss were upregulated while in susceptible cultivar (Florunner)they were down-regulated resulting in weakening of cell wall during progressive dehydration. Further, in DT cultivar (Vemana), the photosynthesis mechanism seems to be least affected as is evident from the abundance of photosynthetic proteins of photosystem Iand II.These data suggest that an integrated approach using conventional as well as genetic engineering approaches are necessary to develop water stress-tolerant genotypes to increase water use efficiency of crop plants to improve productivity.

THE ENERGY-WATER-FOOD NEXUS AND CLIMATE CHANGE: IMPLICATIONS FOR POLICY-MAKING, RESEARCH, AND BUSINESS

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Energy, water and food resource systems are critically inter depended. Energy is needed to produce food and to treat and move water; water is needed to cultivate food crops and to generate many forms of energy; and food is vital for supporting the growing global population that both generates and relies on energy and water services. In addition, land availability is an important element in each of these three resource systems. Even if this interdependence is currently perceptible and defined as the "energy-water-food nexus", these three individual resource systems are still organized, managed and researched more or less independently. Yet, current pressing challenges, mainly environmental/climate threats and population growth, are increasingly generating more risks which have the potential to undermine the viability of these resource systems in interrelated way, thus jeopardizing the human security of many regions, especially in the Global South.

More precisely, these resource systems are currently in an uncertain shift and transformation with many security implications. Water scarcity and water supply-demand imbalance for instance already affects every continent and it is projected that an increased number of people in the Global South will be living in areas of high water stress with a likely impact on energy and food security. In addition, energy and water are inextricably linked. Non-renewable energy sources are still dominating the global energy generation landscape, and these thermal sources of energy generation mostly derived from fossil fuels are at present particularly water-intensive, mainly due to the cooling systems they use that require large amounts of water. A push towards a less carbon-intensive energy sector with a larger share of renewable, stimulated by global mitigation efforts, requires careful consideration of the potential impacts of such energy transition on the other nexus sectors. Energy and water are also interconnected to food and agricultural production systems which are the largest user of fresh water globally and a key source of both GHG emission and mitigation. An increasing population and shifting dietary trends, especially in developing and emergent countries, mean demand for food and feed crop cultivation is rising. Food production and its associated supply chain account for approximately one-third of the world's total energy consumption. Rising food production has led not only to agricultural land expansion, largely at the expense of forests, but also I n many regions an intensification of agricultural processes on existing land. This expansion and intensification places more stress on agricultural input resources, such as water and energy.

According to current scientific evidence and projections, climate change has the potential to severely impact these resource systems. Climate impacts are likely to reduce the agricultural production and to make water stress in many regions worse, threatening the livelihood and food and health security of vulnerable communities. The rise in the number of food insecure people in the world during the previous decade, coupled with incidences of crop failure due to adverse weather, have made world leaders increasingly aware that future climate scenarios may severely limit our ability to feed the growing population during the next decades. This may increase the risk of conflicts over scarce resources, and pushes people to experience additional water and food stress if temperatures increase by a few degrees.

Based on this, it is becoming increasingly perceptible that every policy option and action adopted with regard to these interrelated systems may meaningfully affect the others, positively or negatively. Thus, it seems growing lyimperativeand effective to adopt a "nexus approach" to analyzing these resource systems (energy-water-food), especially within a climate adaptation and mitigation perspective. Conventional policy- and decision-making with regards to each of these domains in isolation is not necessarily anymore the most optimal course of planning or action. A "nexus approach", which refers to a multidisciplinary type of analysis of the relationship between energy, water, food, and climate change, can help to reduce trade-offs and to build synergies across these different systems, thus leading to a better and more efficient resource use as well as cross-sectoral policy coherence. Such a perspective is also a source of transformation for the research and business spheres. Actors in these areas should adapt their values, practices and investments in order to subscribe in the nexus perspective, thus boosting the policy-making processes related to the resource systems mentioned above.

Keywords: Energy-Water-Food Nexus, Climate Change, Adaptation and Mitigation, Governance, Research, Business Actors

FARMER LED SOLUTIONS TO CLIMATE CHANGE, AND FOOD, WATER & LIVELIHOOD SECURITY

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Today's organic farming systems based on agro-ecology such as 'planting with space', 'push and pull' and 'pasture-cropping' are all highly productive and when combined with innovative low-cost marketing and quality guarantee systems help to put farmers back in control of their livelihoods. Based on the intentional intensification of symbiotic ecological functions and smart farming practices, organic farming systems are largely independent of expensive agricultural inputs and thereby free farmers from cycles of debt, increase profits and provide farming families, local communities and national and international markets with high quality chemical free nutrition. By harnessing natural ecosystems and their functions, such as photosynthesis, organic farming systems capture high levels of CO_2 from the atmosphere in the form of soil organic matter, which builds resilience to droughts, floods, storms and temperature extremes and significantly contributes to mitigation of climate change through carbon sequestration. For such farmer led solutions to climate change, and food, water & livelihood security to widely benefit farming communities in India significant training and extension services are required as well as research into the ongoing development of easily adopted highly productive and resilient organic systems.

ENHANCED OIL RECOVERY AND REDUCTION OF GLOBAL WARMING BY CO_2 SEQUESTRATION

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Injecting anthropogenic Carbon dioxide (CO_2) into hydrocarbon reservoirs will lead to two benefits: (a) enhanced oil recovery (EOR) for extending the production life of the field, and (b) reduction of atmospheric emission of anthropogenic CO_2 if sequestration is considered. It is now confirmed that global warming is taking place and its influence on the Earth's environment is found to be significant. CO_2 and other green house gases are noticed to be significantly contributing to enhance earth's surface temperature, affecting the climate, degrading the quality of our environment including agricultural production and enhancing climate related vulnerabilities and hazards. In the present work, a comprehensive exposition of the role of CO_2 and possible locations for CO_2 sequestration is presented.

BALANCING THE FOOD, WATER AND ENERGY NEXUS FOR CLIMATE RESILIENCE IN INDIAN AGRICULTURE

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World is facing the implications of climate change and serious food crises are adding about 200 million people to the 850,000 million people that are already facing absolute hunger and poverty. To mitigate this challenge, promotion of rain fed agriculture is the order of the day. For instance, the dry areas of the world, which occupy more than 40% of the earth's surface and are the home to more than 2 billion people, are not only the most food deficit areas in the world but also the most vulnerable to climate change given their fragile agro-ecosystems . Over all, sustainable agricultural development in dry areas faces major challenges:

- Rapid natural resource degradation and desertification, particularly water scarcity due to the variability in rainfall and groundwater depletion.
- Drought, which is becoming a more frequent phenomenon,
- Land degradation due to over grazing and inappropriate soil and water management, as well as salinization;
- Loss of biodiversity due to mono-cropping, overgrazing, incursion of cropping in rangeland areas, and mismanagement of uncultivated and forest areas;
- Biotic stresses including diseases and insect pests;
- Climate change implications, which are already evident in reduced precipitation, more frequent droughts, high temperatures and shorter growing seasons in many countries; emergence of new biotic stresses, including new diseases and insect pests, due to shifts in temperature regimes. As an example, we have recently seen new virulent races of stripe or yellow rust in wheat, resulting in losses of millions of tons of production;
- Climate change implications are not only affecting food production but all four dimensions of food security: food availability (production); access to food (affordability); food stability due to more a biotic and biotic stresses; and food utilization (nutritional problems and food safety).

The complex nature of these challenges requires an integrated approach encompassing the three major pillars for sustainable agricultural development:

1. Sustainable use of natural resources and inputs;
2. Crop and livestock genetic improvement;
3. Appropriate policies, social and economic considerations and institutional support.

The following strategies could make a difference in enhancing sustainable agricultural development in a changing environment:

- Political will and strong political support and an enabling policy environment for investment in agriculture development as a priority area;
- Enhancing the adoption of advances in science and technology (S & T) and supporting agricultural research for development to promote conservation technologies that meet global challenges to food security;
- Sustainable intensification of production systems
- An integrated approach to the sustainable use of natural resources for economic growth.
- Development of regulatory frameworks and adequate policies to ensure sustainable use of natural resources and produce high quality products to protect human health and natural resources.
- Public awareness of the long term benefits of conservation technologies must be strengthened for effective expansion to promote sustainable agricultural development.
- Capacity development and institutional support
- International and regional cooperation and partnerships based on complementarities and comparative advantages.

So, the need of the hour is to have,

a) A comprehensive National Level Strategy for Sustainable Agricultural Development taking into consideration the food-water-energy nexus in the available land and water resources and successful case studies;
b) A National Agricultural Research Policy to support the implementation of the Agricultural Development Strategy;
c) Five year action plans to implement both strategies;
d) Comprehensive regional or sub-regional cooperation programs to enhance food security;

Nonetheless, a strong political will to put agriculture as a top national priority to mitigate and adapt to the negative impacts of climate change, is the national focus these days, and India is striving hard to infuse institutional mechanisms to enable climate resilience in the country whereby we are able to equate agricultural production with farmers' income.

FOOD-WATER-ENERGY NEXUS GOVERNANCE – ADAPTION TO CLIMATE CHANGE

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Primary resources, water, energy, and food (WEF) represent the greatest global risks for agriculture in the twenty-first century because they are expected to be highly impacted by climate change. Management of these primary resources has traditionally been examined by researchers and addressed by policymakers in isolation of one another. However, there are numerous and multi-dimensional interdependencies and linkages among complex food, water, energy systems.

The interdependency among water, energy and food is often called the nexus, imply that the governance of these systems should be conducted in an integrated manner that seeks to minimise trade-offs and maximise synergies. The Nexus approach the interdependencies of the primary resources and their transitions and fluxes across spatial scales and between compartments. Instead of just looking at individual components, governance of nexus point to the need for coherence in policies and institutional structures that address resource supply and sustainable development.

Based on general definitions of governance, nexus governance could be defined as the social, political, economic and administrative authorities, organizations and institutions(formal and informal) and their relationships along with the mechanisms, processes, rules and practices that are related to water, energy and food sectors and their development and management

Coordination of policies in water-energy-food sectors and at multiple levels is a major task for governing the nexus. Nexus governance has to deal with plurality of policies that are in place. Institutional innovation is needed to develop democratic and participatory approaches that address the water-energy-food nexus. Since, the nexus operates at different spatial scales, including globally, regionally, nationally and locally, the policy options should examine three major components;

1. Governance of the nexus
2. Capacity building
3. Analytics

Key principles of the nexus governance

The nexus governance is based on certain key principles that include;

- Understanding the interdependence of subsystems.
- Promoting economically rational decisions for efficient use of these resources in sustainable manner.
- Identifying integrated policy solutions to minimize trade-offs and maximize synergies.
- Ensuring policy coherence and coordination across sectors and stakeholders to build synergies.
- Value the natural capital of land, water, energy, and ecosystems and encourage business to support the transition to sustainability.

Conceptual framework for the nexus approach in relation to climate change adaptation will be discussed with potential synergies and trade for making adaptation responses more effective.

RECENT TECHNOLOGICAL ADVANCES IN WATER MANAGEMENT IN RELATION TO CHANGING CLIMATE

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The world population is projected to increase substantially during few decades, demanding in a near-doubling of global food and fiber production. Doubling the production and sustaining it at that level are major challenges. Intensification of agriculture through the use of high-yielding crop varieties, fertilization, irrigation and crop protection remain the most likely options to combat these challenges. There have been enormous advances in agricultural production in recent past, but in doing so the environmental integrity and public health now present even greater challenges that to under arena of climate change. Thus new tools and techniques have to be adopted at farm levels to meet these challenges.

With the introduction of geographic information systems (GIS), global positioning systems (GPS) and remote sensing (RS), one can now refine nutrient recommendation and water management models to the site-specific conditions of each field. There exist substantial variation in soil properties and nutrient and water availability across most of the fields. Thus, the ability to apply site-specific nutrient and irrigation management to match spatially and temporally variable conditions can increase application efficiencies, reduce environmental impacts, while improving yields.

Precision farming technologies have now been developed to spatially vary nutrients and water prescriptions within a field based on various information sources (soil properties maps, terrain attributes, remote sensing, yield maps, etc.). Precision agriculture involves the integration of the new technologies (including GIS, GPS and RS) to allow farm producers to manage within field variability to maximize the benefit-cost ratio. Variable rate technology (VRT) available with farm implements has evolved rapidly and has fostered the growth of precision agriculture.

According to the Food and Agriculture Organization (FAO) of the United Nations, nearly 40 percent of the world's food is produced by irrigated agriculture, which covers about 250 million hectares (corresponding to 17 percent of total arable land) and is the major user of fresh water, accounting for 70 percent (on average, and up to 90 percent in many countries) of worldwide water taken up for human use. Since high-quality irrigation water is becoming increasingly scarce, it is becoming more important to use available water efficiently. One approach being adopted to overcome this constraint is the use of soil moisture sensors to control irrigation. Soil moisture sensors can detect when the substrate water content drops below a grower-defined set point and can be used to automatically turn on the irrigation when needed.

These emerging technologies are ushering in a new era that will affect farmers' day-to-day operations and improve their ability to compete in the global market. These innovations will also contribute to increased agricultural productivity and transformation of agribusiness infrastructure.

Crop simulation models are increasingly being used not only in in-season prediction of crop yield potential but also on real-time nutrient and water management in prescriptive and/or corrective concepts. The models are based on a quantitative understanding of underlying processes and integrate the effects of soil, weather, crop, pests and management factors on growth and yield.

Introduction

Per capita water availability of many river basins in India is declining over the years due to sustained population pressure, agriculture and industrial expansion, in addition to changing climate scenarios. It is a fact that the per capita availability has decreased from 1816 m^3/year in 2001 to 1545m^3/year in 2011. Particularly rainfed areas, which produce about 60 % of the total food produced in India, facing recurrent water shortages during dry seasons. Most of these lands are located in the arid or semiarid regions where rain falls erratically and irregularly. Recent droughts in several areas due to delay or failure of monsoon, at the same time floods due to sudden and extreme rainfall has highlighted the potential risks to crops, humans and livestock.

For the past many years, human activities like agricultural, industrial, deforestation, exploitation of land resources, etc. have greatly influenced the composition of the earth's atmosphere. These result in the increase of the emission 'greenhouse gases' (GHGs) like the Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), resulting in increasing atmospheric temperature. The global mean annual temperature at the end of the 20th century noticed increased temperature by 0.4–0.7°C above that recorded at the end of the 19th century. Intergovernmental Panel on Climate Change (IPCC) has projected the temperature rise between 1.1°C and 6.4°C by the end of the 21st century. This global warming affects other parameters of climate such as the extreme events of precipitation, mean sea level, melting of the glaciers, etc.

In several regions across the globe variability in climatic conditions causing broad-ranging impacts, especially on water resources and agriculture. Overall, climate change has the potential to erode the gains in development acquired over centuries in several parts of the world and to increase the susceptibility of humankind to climatic events for earning a sustainable livelihood across the world. Hence, efforts must be taken for mitigation and adaptation to these changes so that its adverse effects on water resources and agriculture can be dealt with. The adaptive capacity of the farmers in India to these climate changes is a major issue due to subsistence agriculture and lack of education. Hence, there is need to make adaptive strategies which are economically and socially effective and can be integrated with the existing resources of farmers.

Climate Change Impact on Water Resources and Agriculture Sector

Climate change threatens water management through changes in precipitation patterns (variability in terms of intensity and frequency) and agricultural production through variable temperatures, and increased occurrences of extreme events like droughts and floods. A brief discussion about the impact of climate change on water resources and agriculture sector is listed below.

(a) *Irregularities in the Arrival of Monsoon, Droughts and Flood*: Agriculture in India depends largely on the monsoon season and the amount of rainfall taking place during this season. IPCC reports and many climate modelers have presented a rising irregularity in the Asian Monsoon circulation in a warmer world. Climate change in India has resulted in inadequate and irregular rainfall in terms of its intensity and frequency of occurrence, which causes untimely droughts, adversely affecting the agricultural yield in several regions across India. Climate change has also resulted in untimely floods which destroy the irrigation field, thereby damaging the agricultural yield of the country.

(b) *Shortage of water*: The increased temperature results in the shortage of water, which affects agriculture, consequently increasing the demands of irrigation water supply. Increase in atmospheric temperature results in the rise of evapotranspiration in the areas, increasing the agricultural water requirement. On the basis of studies it is observed that the trending shortage of water would result in the net decline of rice yield in India by about 20%.

(c) *Crop Yield*: The increase in the atmospheric carbon dioxide results in a fertilization effect on crops with C_3 photosynthetic pathway, and hence increasing their growth as well as productivity. At the same time an increase in the temperature, depending on the present ambient temperature, can result in the reduction of crop duration, increase in the crop respiration, can alter photosynthate partitioning to economic products, can affect the pest population, and have the potential to disturb the existing equilibrium by creating a new equilibrium among crops and pests, that will further hasten nutrients' mineralization process in soil, reduce the efficiency of fertilizers and increase in the evapotranspiration. Moreover, it is observed that the change in the minimum temperature has more effects compared to change in the maximum temperature for several crops. For example, the grain yield of rice reduced by 10% for each 1°C rise in the minimum temperature during the growing season above 32°C. With all other climatic conditions remaining the same, increase in temperature by 1°C, 2°C and 3°C is likely to decrease the grain yield of rice by 5.4%, 7.4% and 25.1%, respective in the state of Punjab.

(d) *Productivity of Soil*: Soil temperature affects the rates at which the decay and decomposition of the organic matter, release and taking up of nutrients, plant metabolism, etc. take place. The accelerated decomposition of the organic matter may result in the release of nutrients but will affect the fertility of the soil in the later stage. The increase in the CO_2 results in the increase of plant biomass production, efficiency of soil water use by plants, and also the C/N ratio of plants, which influences the soil microbial processes. A change in the precipitation due to the climate change affects the surface moisture content, which influences the germination and the crop establishment in the rainfed regions.

(e) *Pests, Insects and Diseases:* Pests and insects significantly damage the yield as well as the quality of the crops. The increase in temperature results in the increase of the abundance of pests and insects due to numerous reasons like phonological processes, growth of population, migration, etc. The increase in the winter temperature may lead to the reduction of the hibernation time of the pests and insects, thereby increasing their damaging activities. The areas, presently not affected by the pests due to low temperature, are most likely to be affected by the pests with increase of their population if the temperature increases.

(f) *Loss of Biodiversity*: Drastic changes in climatic conditions will force many species of animals and plants towards extinction because of the lack of their necessary environment or loss of habitat caused by the climate change.

Strategies for Future Sustainable Water Supplies: Mitigation and Adaptation

Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities." People whose livelihoods depend on agriculture have to develop ways to cope with the changes in climate and adapt accordingly. Today, the climate is changing at an alarming rate. As a result, if timely and proper adaptation strategies are not planned, it would be difficult to handle the changes in the altered climatic conditions, and hence would affect them significantly. Adaptation will lead to food security, which is one of the main criteria's for the effectiveness of adaptation at local as well as national levels. Awareness should be raised by policy makers, and the most resilient food production systems should be promoted and made available to the people. Mitigation primarily referred to the steps taken up to permanently get rid of or decrease the long-term adverse effects of climate change to nature and society. This, like adaptation, should be analyzed and discussed at the local, as well as global level because the need of the hour is to neutralize the effects of climate change. Mitigation tackles the factors that cause climate change and hence a successful mitigation technique is very necessary. The United Nations Frame-work Convention on Climate Change (UNFCCC) mentioned the conditions specifically while dealing with stabilization of Green House Gases in the atmosphere:

1. It should take place within a time frame which will be enough to allow ecosystems to adapt to climate change naturally;
2. The food production should not be threatened; and
3. The economic development should proceed in a sustainable manner.

Adaptation and mitigation techniques are the only Panacea to tackle and eliminate or reduce the adverse effects of climate change to life and property.

Precision Farming: Minimum Input Maximum Output Approach

Precision agriculture is about collecting timely geospatial information on soil-plant-animal requirements and prescribing and applying site-specific treatments to increase agricultural production and protect the environment. In the past, it was difficult for farmers to correlate production techniques and crop yields with land variability. Today, more precise application of pesticides, herbicides, and fertilizers, and better control of the dispersion of those chemicals are possible through precision agriculture, reducing expenses, producing a higher yield, and creating a more environmentally friendly farm.

The development and implementation of precision agriculture or site-specific farming has been made possible by combining the Global Positioning System (GPS) and geographic information systems (GIS). These technologies enable the coupling of real-time data collection with accurate position information, leading to the efficient manipulation and analysis of large amounts of geospatial data. GPS-based applications in precision farming are being used for farm planning, field mapping, soil sampling, tractor guidance, crop scouting, variable rate applications, and yield mapping. GPS also allows farmers to work during low visibility field conditions such as rain, dust, fog, and darkness.

There is need to develop inexpensive and easy-to-use methods and techniques that can be used by all the farmers. Through the use of GPS, GIS, and remote sensing, spatial and temporal information needed for improving land and water use can be collected. Farmers can achieve additional benefits by combining better utilization of fertilizers and other soil amendments, determining the economic threshold for treating pest and weed infestations, and protecting the natural resources for future use.

Remote Sensing and GIS for Water Resources Management

With the introduction of the earth observing satellites, remote sensing has become an important tool in analyzing the Earth's surface characteristics. For example valuable information necessary for the crop yield monitoring, evapotranspiration estimation, soil moisture estimation can be obtained by remote sensing and GIS, in a real time condition covering a very vast area simultaneously. Due to their capability to capture the spatial variations of the hydro-meteorological variables and frequent temporal resolution is sufficient to monitor the dynamics of the hydrologic processes. Remote sensing techniques have significantly changed the water resources assessment and management methodologies. Remote sensing and GIS techniques have been widely used to delineate the surface water bodies, estimate meteorological variables like temperature and precipitation, estimate hydrological state variables like soil moisture and land surface characteristics, and to estimate fluxes such as evapotranspiration. Today, near-real time monitoring of food, drought events, and irrigation management are possible with the help of high resolution satellite data.

Water management: Micro-irrigation technologies

Modern irrigation is one of the success stories of the 20th century. Technology must also make effective and sustainable use of ecosystem services. Whereas many services to society come from man-made infrastructure, these come from the 'green infrastructure' healthy rivers and watersheds that filter out pollution, mitigate floods and droughts, recharge groundwater, and maintain fisheries. Technologies which maintain and enhance such services build resilience into our water delivery systems and water use. 'Modern' irrigation technologies, such as sprinklers and micro-irrigation are often seen as one of the keys to increasing food production on smallholder farms. Micro-irrigation can be targeted at selected environments where water costs are high; soil, topography and water quality make surface irrigation impracticable; high value cash crops can be grown and marketed; and where the farmer desires to increase his/her income.

Drought Relief and Rainwater Harvesting

In some places, mainly western India, people frequently face droughts. These droughts are bound to increase with the recent climate change, due to reduction in rainfall and increase in temperature. Therefore, it is the time to focus on suitable crop insurance, drought relief funding and aid schemes to help out the people. Moreover, nowadays with the evidence of very much untimely rainfall, rainwater harvesting structures such as farm pond, roof top rain water harvesting, trenching, etc., have become important tools to make way for sufficient water in times of water crisis. At a domestic level, rainwater harvesting from roofs is an effective way of augmenting drinking water and watering gardens. Rainwater harvesting techniques can be installed on the roofs of houses, and the collected rainwater can be stored in huge tanks. Moreover, farm ponds at the farmers land can help provide supplemental irrigation for improving crop production. This will further ensure the additional recharge of the aquifer by storing water due to more opportunity time and due to reduced runoff.

Reduction of Seepage and Leaks

Due to improper management of canals, seepage from the canals, leaks in pipes of the water distribution systems and other water storage devices result in a lot of loss of water causing a lot of wastage. It results not only in wastage of water, degradation of lands but also in revenue as then extra budget is required for distribution and additional treatment. The measures such lining, proper management of canals, detection of leaks, repairing visible and reported leaks, adequate and proper zoning of the distribution systems, programme should be recommended to different water departments to cope up with these loss of water.

Water Education, Water Tariff Structures and Reuse of Grey Water

One of the most effective ways is to educate people about the water and to encourage consumers to use water more efficiently through tariff mechanisms. Efforts should be made to influence their consumption behavior. The goal of implementation of an education campaign is to make people aware of water saving practices. Grey water utilisation at a domestic level can be beneficial for irrigating lawns and small gardens. Such initiative will help in reducing the water demand and relieves the volume on the waste water treatment works.

Developing Climate-Ready Crops and Crop Diversification

The development of crops which have higher yield potential and resistance to drought, flood, cold, etc. will play an important role in tackling the effects of climate change in agriculture. Efforts should be taken so that there can be improvement in the germplasm of important crops which are more tolerant to heat stress, abiotic stress, oxidative stress, etc. Also, studies have been going on since long for better water-use and nitrogen-use techniques. They are important because, with climate change, the water quantity is sure to fall in the future. High temperature and heavy rainfall may also reduce the efficiency of nitrogen use causing loss by volatilization and leaching. Cultivators need to be provided with the modern technology of producing climate-ready crops so that they can stabilize their production system against climate change.

Crop diversification refers to the replacement of the existing crops and livestock with a new variety that is more tolerant to drought, heat, extreme climatic conditions, etc. This will result in a better productivity during the period of various stresses than the existing crops. Diversification of the genetic structure and composition of the seeds lead to better defence against various pests, insects and plant diseases as well as hazardous climatic conditions. However, there is a negative side to it because keeping in mind the economic condition of most of the farmers in India, crop diversification turns out to be a costly affair for them.

Improved Weather Forecasting and Crop Insurance Planning

With an early weather forecasting, using the General circulation models (GCMs), regional circulation models (RCMs) along with downscaling methods, very accurate weather forecasts can be available at micro scale, and the farmers can be benefitted by early warnings about the forthcoming climatic conditions. It would help the farmers to better prepare for tackling the adverse situation. Further, suitable public and private insurance schemes and policies should be provided or made easily available to these farmers to help them reduce the problems in case of crop failure during these hazards.

Conclusion :

It is obvious that the climatic changes along with increasing climatic variability are expected to exaggerate the problems of future water availability and food security by putting forth burden on agriculture and human life. It is therefore inevitable that policy makers, stake-holder and water managers take into account the possible consequences of climate change on the water resources and at the same time adopt strategies and new technologies to ensure the long-term sustainability of the water supplies and the local resources.

GEOSPATIAL TECHNOLOGY FOR CLIMATE CHANGE IMPACT ASSESSMENT ON MOUNTAIN'S AGRICULTURE

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Abstract

This article presents an overview of geospatial technology and its role in assessing climate change impacts on agriculture in the mountain ecosystem which is more or less constrained in terms of climate observing network and resources availability. Major emphasis laid on exploiting complementary power of geographical information system (GIS) and crop simulation models to strengthen climate change research and applications for decision making in mountain agriculture. Few successful applications of geospatial tools (GIS and crop model) for predicting crop yield responses to climate change and possible shift in agro-climatic suitability of some dominant crops of north-western Himalaya are discussed. Integrated use of climate scenario from Global Circulation model (GCM), crop models and geospatial data (e.g. topography, soil and land cover) within GIS could improves spatial representation of climate induced projection of crop productivity and land suitability changes in future climate scenarios. Model simulation using GEPIC revealed decline in crop yields (%) in 2080s without CO2 fertilization for Maize, Rice and Wheat to the tune of 14, 20 and 40%, respectively in Doon Valley. However, the GEPIC model simulation for Himachal Pradesh showed wheat yield decline in 2020s and 2080s, however yield may increased in 2050s compared to baseline (1960-90) period. Multi-criteria evaluation within GIS in Himachal Pradesh depicts that overall suitable areas for summer maize and winter wheat increasing trend in future climate. Chill unit accumulation has decreased significantly from 1997 to 2013 and this decreasing trend is continued to affect apple cultivation. Suitable areas for apple cultivation shifting towards high-altitude in Himachal Pradesh

Keywords : Geospatial technology, climate change, Mountain Agriculture, crop models, crop planning

Introduction

The Himalayan mountain ecosystem is vital to the ecological security of the Indian landmass and occupies the strategic position of entire northern boundary (North-West to North-East) of the country. The region has a discrete geographic and ecological entity. The Himalayan landscape systems are unique. These systems, with their steep slopes and sharp gradients, are heterogeneous and exhibit sharp and most often systemic changes in climatic variables over very short distances. The vulnerability of the biological and physical features of the Himalayan Ecosystem towards natural and human induced disturbances is well recognized. Ecologically sensitive mountainous areas, like the Himalaya, are prone to adverse impacts of global climate changes on account of both natural causes and anthropogenic emissions.

Further, in view of the pressing need for conservation of biological diversity in totality, sustainability of Himalayan Ecosystems has gained paramount importance. Hence, the National Mission for Sustaining Himalayan Ecosystems (NMSHE) is one of India's eight missions under National Action Plan on Climate Change (NAPCC). Climate change is likely to adversely impact the Himalayan eco-system through increased temperature, altered precipitation patterns, episodes of drought, and biotic influences. Mountain regions have experienced above-average warming in the 20th Century (IPCC 2007), which has significant implications for mountain environments and environmental processes. In the Himalayas, for example, progressive warming at higher altitudes has been three times greater than the global average The impact of climate change in the context of the western Himalayan regions has already started surfacing. In general, consequence of climate change may have serious implications for the country's food security and economy. Mountain ecosystem experiencing shifting of temperate fruit belt upward, adversely affected productivity of food grains and apples, shifting and shortening of *rabi* season forward, disrupted rainfall pattern and more severe incidences of diseases and pests over crops

Model-based projections of climate change impacts indicate near certainty that global crop production will decrease as a result of climate change. Based on a meta-analysis of 1700 model simulations, the most recent IPCC assessment demonstrated that, despite uncertainties, on average, global mean crop yields of rice, maize and wheat are projected to decrease between 3% and 10% per degree of warming above historical levels. The effect of climate change scenario of different periods can be positive or negative depending upon the magnitude of change in CO2 and temperature (Aggarwal, 2003). As of now, literature reports reveals that research on climate change and its impact on various sectors (e.g., forests, water, agricultural resources, etc.) is meagre and still in infancy stage in the Himalayan mountains. Agro-ecosystems of mountain are highly prone to deterioration by various forces of degradation such as water erosion, landslides and frequent occurrence of extreme events. The natural fragility of these ecosystems makes them highly susceptible to small changes in temperature and water availability. Crop growth and development processes are highly sensitive to changes in temperature and water availability and as a result the effect of climate change on agriculture in western Himalaya has become reality. In the past few decades, crop models have been widely used to assess climate change impact on crop yields at station level in mountain region (Rana et al., 2016). Such models simulate crop growth and crop yield levels at experimental field scale by means of input variables (eg. daily weather parameters, soil characteristics, crop characteristics, cropping system management options). Crop model projections from these experiments may be in accurate in diverse mountain region with large degree of heterogeneity in topography, soils and crop management practices. It is well conceived that modern geospatial tools have great role to play in effective monitoring and management of fragile mountain ecosystem. Many successful applications of these technologies have been made to map and monitor natural resource base and subsequently characterization of agro-environments to improve sustainability of mountain agriculture (Patel, 2009).

Geospatial technology : Key roles in climate impact assessment

Climate and its impacts vary over space, and this pattern of variation is likely to change as the climate changes. These aspects are of crucial importance for policy makers operating at regional, national, or international scale, because changes in resource patterns may affect regional equity, with consequent implications for planning. Thus the geographical analysis of climatic changes and their impacts in geospatial format has received growing attention in recent years. This growing trend of projecting climate change (CC) impact on agriculture and forestry sector in particular has been paralleled by the rapid development of satellite imaging, computer-based GIS and open-source data/tools. Firstly, the geographical information system (GIS) is extensively used to store, analyze, display both spatial and non-spatial and thus it provide spatial dimension to solve problems related to agriculture in mountain ecosystem. Secondly, the land use/land cover, soil information and Digital Elevation Model (DEM) from satellite data are now-a-days easily available at fine resolution grid from public geo-data portals e.g. Bhuvan in India (http://www.bhuvan.nrsc.gov.in). Such spatially-explicit and geographically representative database helps to incorporate the spatial heterogeneity of landscape units and to drive agro ecosystem models on grid. basis. The *Fourth Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC) has heavily emphasized the use of crop models within GIS environment for regional climate impact assessments (Easterling *et al.,* 2007; Thornton *et al.,* 2006). The integrated use of GIS and crop models combine the spatial perspective of GIS with more stronger representation of temporal plant processes by simulation models. Thirdly, the output from Global Circulation Models (GCMs) on various climate scenarios are now-a-days available in GIS data formats and it helps to simulate crop performance over space by using process-based crop models in both current and future climate scenario (Lobell et al., 2008; Neelin et al., 2006). In addition, an increase in computer processing power has been improving the feasibility of conducting detailed modeling studies at a regional scale or global scale. Salient features of integrated technologies viz. GIS, remote sensing and GCM based climate change scenarios have greatly improved scientific capability to address issue of crop model projections and optimized crop planning in changing climate.

A number of different approaches to the assessment of the impacts of climate change on agriculture have been developed from many studies conducted to date. Approaches used to assess biophysical impacts include (i) Agroclimatic indices and geographic information systems (GIS) (ii) Statistical models and yield functions (iii) Process-based models (e.g. DSSAT family/EPIC/WOFOST) and (iv) large area climate-coupled crop model (e.g. GLAM). The capability of geospatial tools and models to support climate change impact studies is summarized as under:

Geographical information system

A GIS represents a computer-based system for the management of geographically referenced data. The major functionality of a GIS includes the input, storage, manipulation, analysis and display (often in the form of maps or graphs) of geo- referenced data. Historically, GIS has seen widespread use for delineation of suitability zones for crop planning and agro- ecological zonation (Patel et al.2005; Kumar et al., 2013). The geographic aspect of GIS makes it an interesting option for application to agricultural problems and priority setting because so many of the environmental and socio-economic factors that impact agriculture or agricultural research vary greatly over regions (e.g. Benson, 1996). With availability of continuous environmental variables in grided format from various GCM models (e.g. HadCM3, CSIRO MK3), it has become easier to implement agroecosystem models on cell by cell basis.

Process-based crop models for climate impact assessments

Process-based models are the simplified functions or in-built program that simulate behavior of plant as a function of environmental and management conditions (i.e., climate, soils, and management). These dynamic models have emerged as versatile tools for climate impact assessments. Most were developed as tools in agricultural management, particularly for providing information on the optimal amounts of input (such as fertilizers, pesticides, and irrigation) and their optimal timing. The ICASA/IBSNAT models have been used widely for evaluating climate impacts in agriculture at different levels ranging from individual sites to wide geographic areas (Rosenzweig and Iglesias, 1998). These models are structured as DSSAT (Decision Support System for Agrotechnolgy Transfer) family of models with graphical-user interface that allows input and output analysis. Other generic models viz., WOFOST (Supit et al., 1994), EPIC ((Sharpley and Williams, 1990) and WTGROWS were also established based on simplified crop growth functions in order to study crop responses to varying climate, soil and management. EPIC (Erosion Productivity Impact Calculator) is a daily time-step field scale model and it has been used in some climatic impact assessments. Crop simulation models when integrated with GIS showed immense capability to assess the impact of climate change in agricultural systems. These models are modern tools and publicly available for assisting in assessing vulnerability and adaptation to climate change

GIS based agro-climatic indices generation

Simple agro-climatic indices combined with GIS have been used to provide an initial evaluation of both global agricultural climate change impacts and shifts in agricultural suitable areas in particular regions. The agro-climatic indices are based on simple relationships of crop suitability or potential to climate (e.g. identifying the temperature thresholds of a given crop or using accumulated temperature over the growing season to predict crop yields; e.g., Holden, 2001). This type of empirically derived coefficient is especially useful for broad-scale mapping of areas of potential impact.

GIS based crop modeling and climate change impact studies

Framework and databases

GEPIC is a GIS based interface of a bio-physical EPIC model (Environmental Policy Integrated Climate) and aimed at simulation of the spatial and temporal dynamics of the major processes of the soil crop atmosphere management system (Liu et al., 2007). The EPIC model is designed to simulate crop-related processes for specific sites with site-specific inputs of weather, soils and management information. However, GEPIC has versatile capability for assessing agricultural systems at regional, continental and global scale. The framework of spatial database within the GEPIC model is expressed in Fig. 1. In the GEPIC model, ArcGIS is used as an application framework, input editor, and map displayer. As an application framework, ArcGIS provides the main programming language VBA to design the interface of GEPIC, and to design programs for input data access, text output data generation, and output map creation. By integrating EPIC with a GIS, the GEPIC model treats each grid cell as a site. It simulates the crop-related processes for each predefined grid cell with spatially distributed inputs. The inputs are provided to the model in terms of GIS raster maps as well as text files. Necessary maps include land-use maps, elevation and slope maps, irrigation maps, fertilizer maps, climate code maps, and soil code maps.

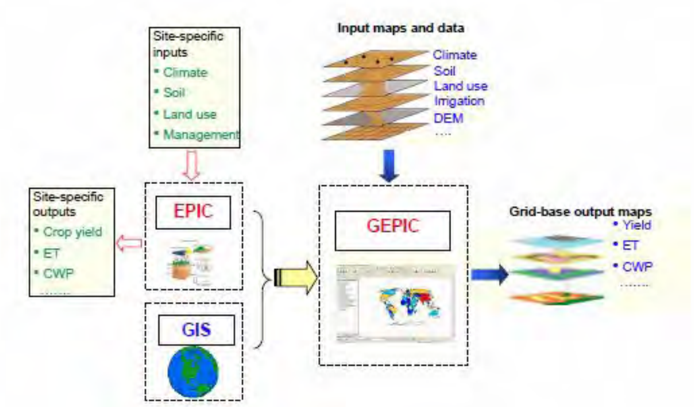

Fig. 1. Frame-work and spatial databases of GEPIC model (Source: Liu et al., 2007)

The land-use maps provide information on crop distribution (code 0 indicates absence of a specific crop, while 1 and 2 indicate existence of the crop under rain fed and irrigated conditions, respectively).The elevation and slope maps show the average elevation and slope in each grid cell. The irrigation and fertilizer maps show the annual maximum irrigation depth and fertilizer application rate. The climate and soil code maps indicate the code numbers of the climate and soil files in each grid cell. These code numbers correspond to the text files of climate and soil data. Climate files contain daily weather data (e.g. daily precipitation, daily minimum and maximum temperatures) and monthly weather statistics. Soil files contain several soil parameters (e.g. soil depth, percent sand and silt, pH, organic carbon content, etc). Annual irrigation and fertilizer inputs are provided in the Irrigation and fertilizer maps. Model parameters were selected from the literature *(Doraiswamy et al., 2003), (Ren et al., 2010)*.The outputs of the GEPIC model are raster GIS maps representing the spatial distribution of output variables such as crop yield and evapotranspiration.

Climate Change impact on Productivity of food grains in Dehradun Valley

The pilot study was carried out to test the applicability of biophysical model GEPIC on a regional scale, to assess the impact of climate change on crop productivity of Major crops (Rice, wheat and Maize) in an agricultural landscape of a mountain ecosystem. The study area selected was Doon valley in Uttarakhand, a perfect example for a mountainous agro ecosystem, due to its vulnerability towards extreme climatic conditions. The first objective was achieved through model sensitivity analysis and calibration based on field observations. The site specific calibration and validation result shows the capability of the model to predict crop productivity based on local conditions. The calibration and validation of the model are performed for rice and wheat crop in the study area with an RMSE of 0.38 t ha^{-1} and modeling efficiency of 0.78 for rice. LAI correction strategy is performed for wheat crop calibration, which in turn led to RMSE of 0.24 t ha^{-1} and a modeling efficiency of 0.88.

The applicability of the model to predict impact of climate change on crop productivity was investigated in the study area on grid basis. The monthly climate data (maximum temperature, minimum temperature, precipitation and number of rainy days) with a spatial resolution of 30 arc-seconds (~1 km) obtained from worldclim-global climate data archive for baseline period (1950 -2000) and future three time frames; 2020s (2010 -2039) , 2050s (2040-2069) and 2080s (2070-2099) were used for climate change impact assessment. The soil physiographic units are integrated with major soil series and codes are assigned to each series. This consists of layer wise information such as soil pH, EC, bulk density, sand, silt, clay, soil organic carbon, Rock fragment and $CaCO_3$. The digital elevation model (DEM) of SRTM (Shuttle Radar Topography Mission) data with a spatial resolution of 90 m was acquired from USGS earth explorer archive. Elevation and slope map for the study area were prepared from this dataset. All these data sets such as LULC, soil, climate, elevation and slope maps were extracted based on 1 km × 1 km grid cells and used as input to EPIC model (**Table 1**). Due to large variability in topography, climate and soils in the study area, simulations are performed with a spatial resolution of 1 km × 1 km by incorporating same resolution datasets under baseline conditions and future scenarios.

Table 1. Spatial and non-spatial input databases of GEPIC model

Sr. No.	Input Data	Parameters	Source
1	**Climate (Current & Future scenario)**	Tmin, Tmax, Precipitation	World Clime (1x1 km) • Base line (1960-90) • HADCM3- A2a & B2a Scenario data for 2020,2050,2080
2	**Soil**	Depth, Texture, OC, CaCO3, pH, EC,CEC, Bulk density, Coarse Fragment.	• 1:50000 scale (NR-Census Report,Doon valley) • Field Measurement & laboratory analysis. • 1:250,000-NBSS-LUP soil map + 68 soil pedon databases (Himachal Pradesh)
3	**Management**	Date of planting and harvesting , fertilizer use , tillage practices	Field observations and queries to farmers
4	**Topography**	Elevation , slope, geo-location	DEM (SRTM 90m)
5	**Crop**	Crop area and distribution , LAI	LULC map

The results obtained were promising and shows distinct spatial variability of modeled yield of crops during baseline and changes during three time-line of climate change scenarios (**Fig. 2**). The study shows that there could be a continuous reduction in rice yield under A2a scenario without CO2 fertilization ranging from -1.03% in 2020s to -19.22 % in 2080s.

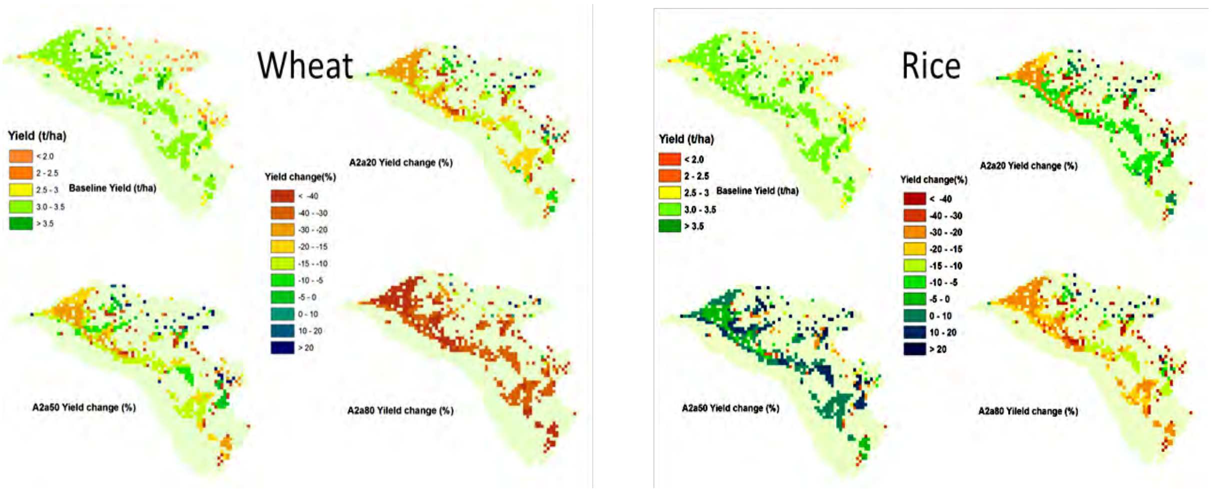

Fig. 2. Changes in productivity of rice and wheat under various scenarios without CO2 ferti

While under A2a scenario with CO2 fertilization, Rice crop showcasing an improvement in yield of about 5 % till 2050 but there is a slight reduction of 2.4% afterwards. Under B2a scenario both in 2020s and 2050s, there could be a reduction in yield of about 3 % because the atmospheric CO2 concentration is not sufficient to compensate the increase in temperature. After 2050s, there could be a slight improvement in yield of about 1.3 %. To assess the vulnerability, wheat crop simulations were performed by considering un-irrigated conditions. Under A2a scenario without CO2 fertilization the results shows a large reduction in wheat yield with 42 % in 2080s. The vulnerability of wheat crop to climate change is less if we consider CO2 fertilization, as evident from improvement in yield of about 4 % in 2050 due to increase in rainfall (+20%). But in 2020s and 2080s, there could be a reduction in productivity of about 13% and 23 % respectively. The results shows that even increasing CO2 would not be able to offset losses incurred due to extreme rise in temperature in 2080s. Decline in crop yields (%) in 2080s without CO2 fertilization for Maize, Rice and Wheat in order of 14, 19 and 42%, respectively in Doon Valley (**Fig. 3**).

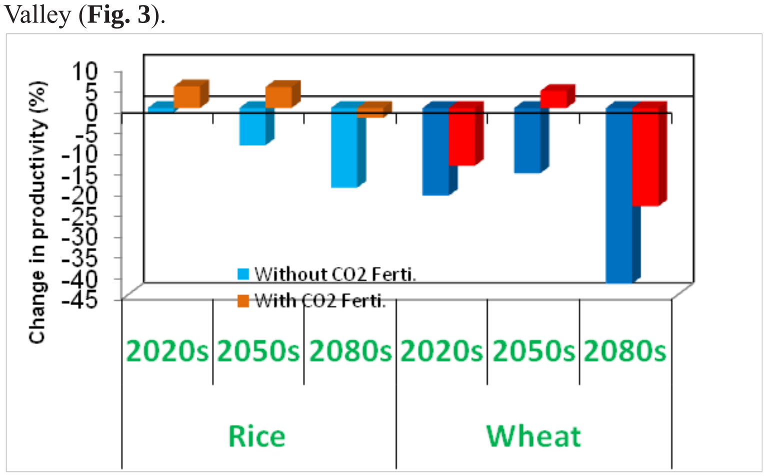

Fig. 3. Percent changes (negative/positive) of crop productivity in Doon valley

The vulnerability of wheat crop to climate change is less if we consider CO2 fertilization, as evident from improvement in yield of about 4 % in 2050 due to increase in rainfall (+20%). But in 2020s and 2080s, there could be a reduction in productivity of about 13% and 23 % respectively. The results shows that even increasing CO2 would not be able to offset losses incurred due to extreme rise in temperature in 2080s. Decline in crop yields (%) in 2080s without CO2 fertilization for Maize, Rice and Wheat in order of 14, 19 and 42%, respectively in Doon Valley (**Fig. 3**).

Climate change impact on wheat productivity in Himachal Pradesh

Impact of climate change on productivity of major food crops is well understood at district level but studies on climate change impact on crop's productivity over high resolution grids are limited. In this study, a high resolution gridded climate data (Statistically downscaled HadGM2 GCM) are used from Worldclim. We used GIS based crop model namely GEPIC (GIS based Environmental Policy Integrated Climate model) to simulate the productivity of wheat during baseline (1960-90) and future climate periods (2020s, 2050s and 2080s) under A2a scenario of IPCC. The spatial data in study area is divided into homogeneous grids. The grid is taken as the basic simulation unit, and each grid has a complete set of input data (meteorological, soil, cultivar and management). The spatial monthly climate data of 30 arc seconds (~1 km) for the baseline period and future projected scenarios were obtained from worldclim global climate data archive (Hijmans et al., 2005). The GEPIC model runs on 1km grid with monthly weather inputs comprising maximum temperature, minimum temperature, solar radiation, and rainfall parameters. Similarly static terrain and management databases (soil, elevation, slope, land use, irrigation and fertilizer) created in grid format and used for GEPIC simulation.

Simulated wheat yields in Himachal Pradesh was found to be declined in 2020s and 2080s as evident from negative changes in 2020s and 2080s (Fig. 4). In addition, it showed that wheat yield could be increased in 2050s due to positive impact of increased atmospheric CO2 and favorable rainfall conditions. Decline in 2020s and 2080s by 9 and 11 %, respectively. However, wheat yields in HP as a whole will be increased by 15% in 2050s as compared to baseline period.

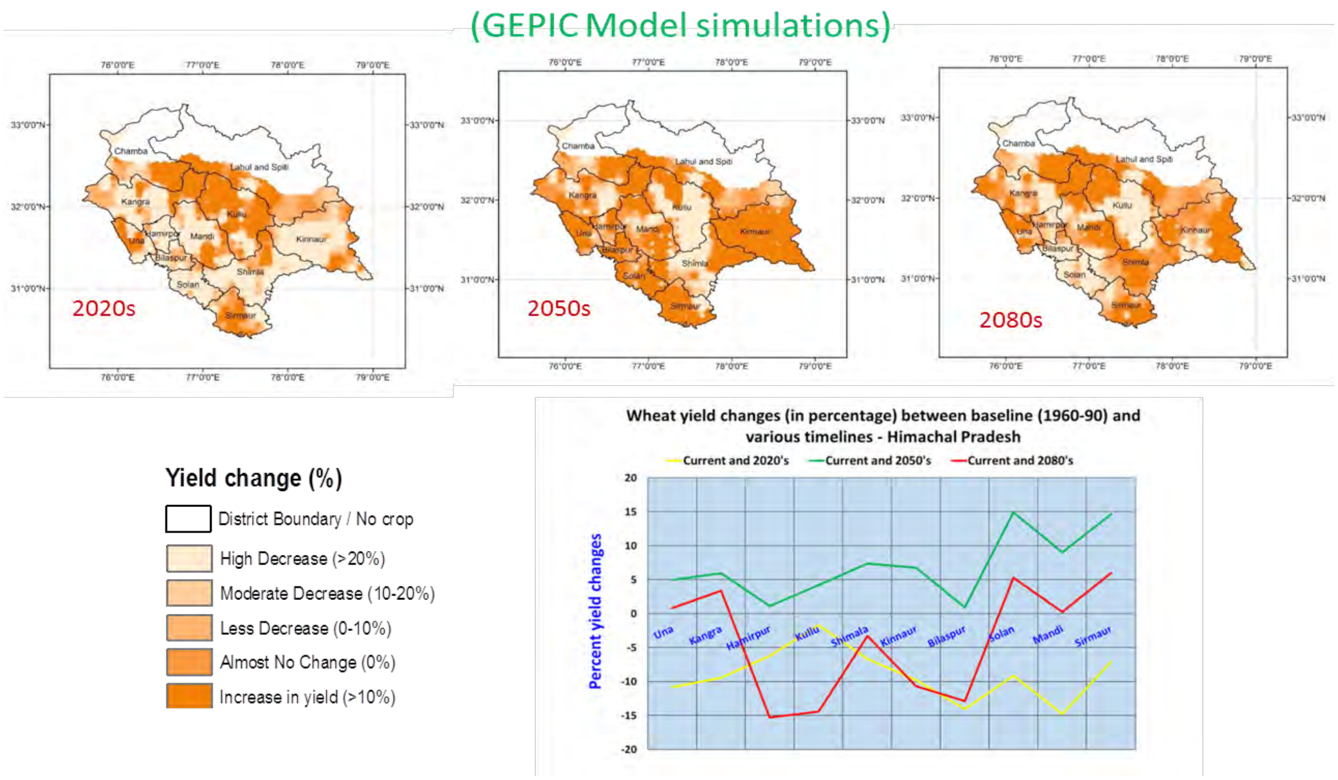

Fig.4 Simulated impact of climate change on productivity of wheat in HP

Climate change impact on crop's land suitability in Himachal Pradesh

Multi-criteria analysis done for identifying suitability of land for maize and wheat crop in baseline (1960-90) and future scenarios (2020s, 2050s and 2080s).Extensive literature exists on the combination of Analytical Hierarchal Process (AHP) and GIS in various disciplines (Malczewski 2006). Ying et al. (2007) combined AHP with GIS to provide an effective means for studies of regional eco-environmental evaluation. AHP (Saaty1977, 1990) is a multi-criteria decision-making method based on pairwise comparisons for elements in a hierarchy. It decomposes problems in a hierarchical structure and explicitly incorporates decision maker's expertise/experience in AHP evaluation. The approach included creation of a spatial database and its integration in GIS environment by developing a suitable rating and ranking scheme for the generation of spatially explicit information on land suitabllity for major crops in Himachal Pradesh, India (Fig.5).

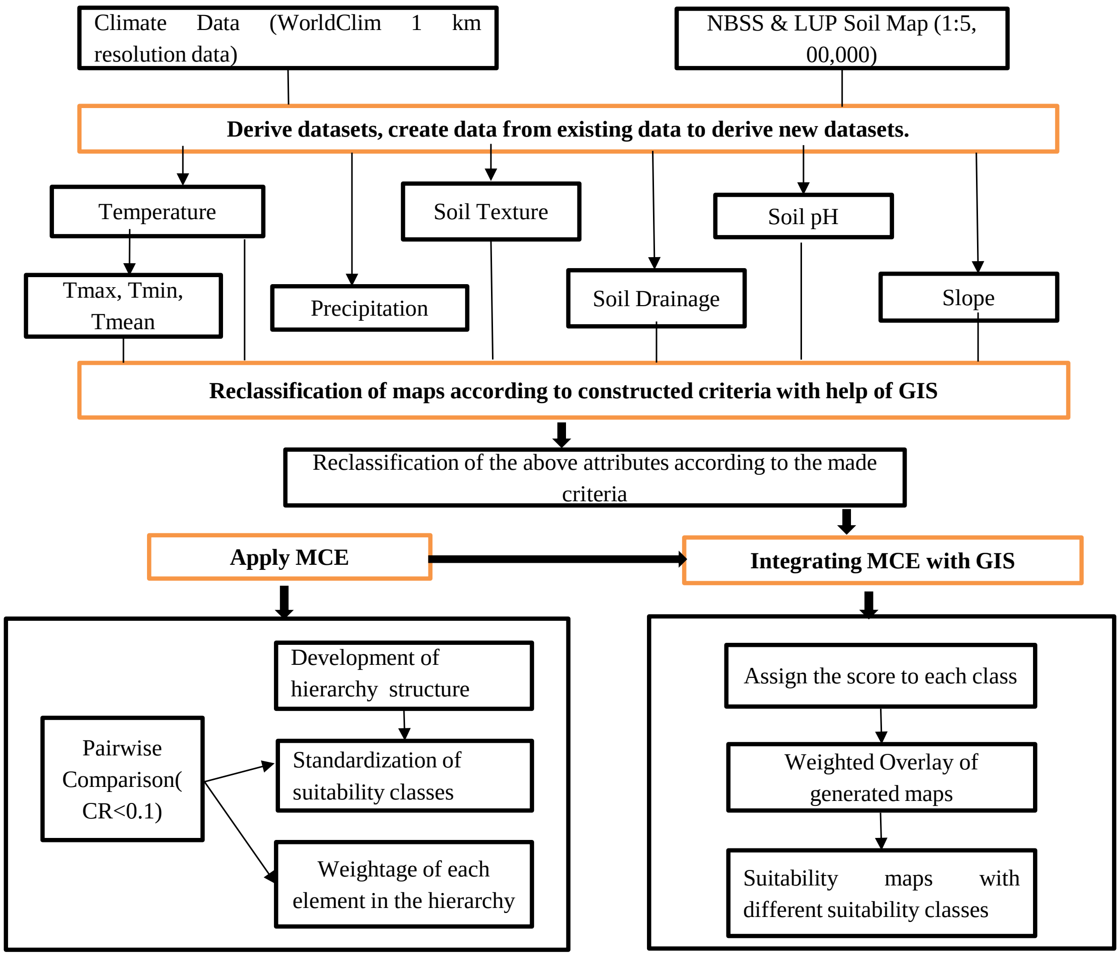

Fig.5. Methodology for agroclimatic suitability using multicriteria approach

The factors identified for land suitability analysis were climate (temperature and precipitation), soil (soil texture, soil depth, soil pH) and topography (slope). The spatial databases on climatic parameters (monthly precipitation and maximum/minimum temperatures) at 1 ×1 km grid resolution during baseline period (1960-90) and HadCM3-A2a future climate scenarios during 2020s (2010-2039), 2050s (2040-2069) and 2080s (2070-2099) were obtained from Worldclim global climate data archive *(Hijmans et al., 2005)*.The spatial information on classes of soil texture, depth, pH and slope were derived assigning attributes to digital soil map (1:250000 scale) obtained from National Bureau of Soil Survey and Land Use Planning (NBSS-LUP).

Impact of CC on agro-climatic suitability of maize

In the context of precipitation factor for Maize suitability, the highly suitable areas are situated in the lower parts of Himachal Pradesh in baseline period (1960-90), but in the future scenarios the highly suitable area are shifting toward upper parts of the state. Similarly, areas (Lahaul and Spiti districts) unsuitable due to inadequate rainfall in baseline period are becoming marginally to moderately suitable for Maize production because of increase in amount of precipitation. In 2020s, highly suitable areas ate becoming moderately suitable areas due to precipitation constraint. With respect to temperature rising in future scenarios, the highly suitable areas of maize are decreasing. because of increase in temperature in lower parts of Himachal Pradesh. Whereas, the upper areas of Himachal Pradesh which are being not suitable (cooler temperature limiting maize growing) for maize production will become suitable because of increase in temperature in future scenarios. The overall suitability based on precipitation, temperature and terrain (soil/topography) information reveals that suitable areas are increasing from baseline period to 2080s (Fig. 6). Hence we can say land suitable for cultivating maize will increase but their production potential will decrease in future.

Impact of CC on agro-climatic suitability of wheat

Criteria related to precipitation in Himachal Pradesh were considered as non-limiting criteria since wheat is irrigated crop unlike maize. However, suitable area is increasing from current climate to projected climate up to 2050s but later in 2080s it decreases drastically. In addition to this, it appeared that marginally suitable areas of wheat showed shift to a class of moderately suitable areas in 2080s.

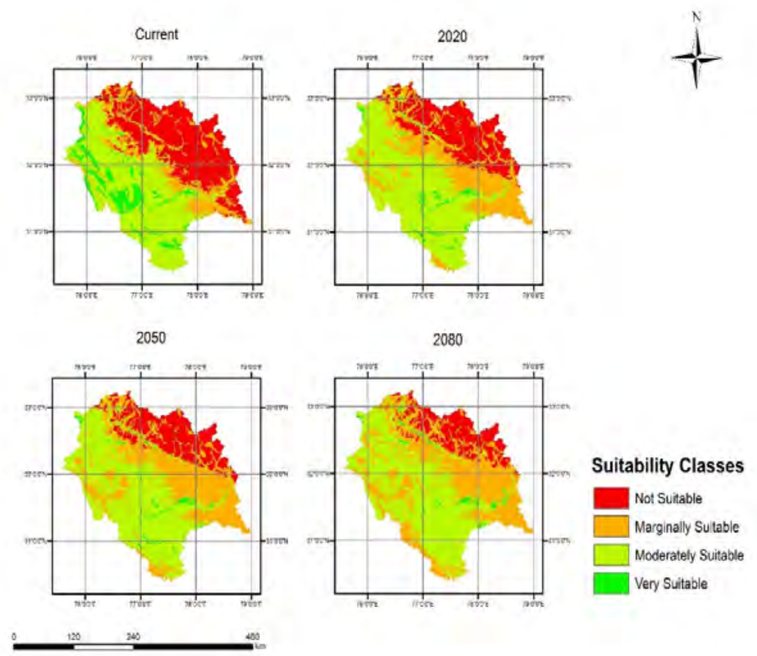

Fig. 6. Agro-climatic suitability of Maize in baseline and future CC scenarios

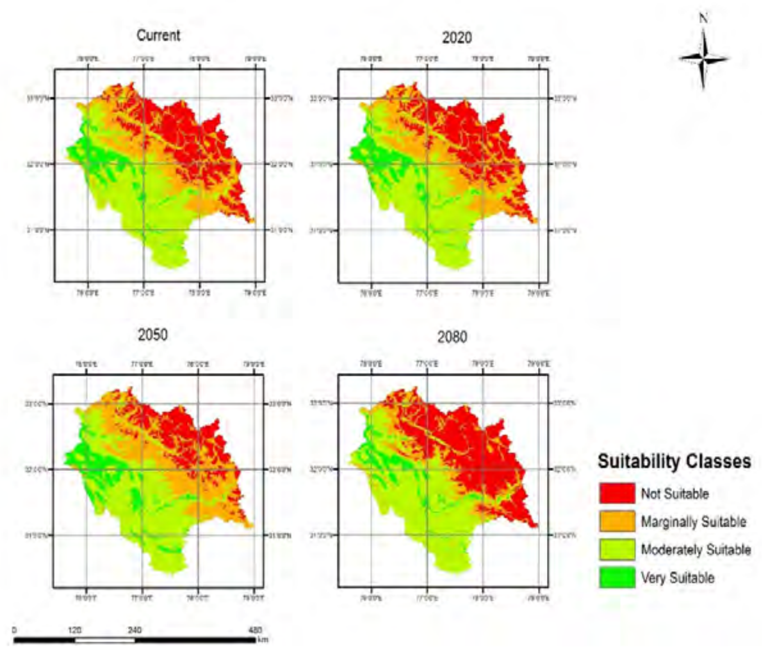

Fig. 7. Agro-climatic suitability of Maize in baseline and future CC scenarios

According to Worldclim data temperature is increasing gradually from current scenario to projected climate (2020, 2050 and 2080) but still not up to the extent that a large area can become suitable for cultivation of winter wheat. Agro-climatic suitability analysis showed that the highly suitable areas lies in north-west part of state are areas having high temperature, precipitation, soil and topographic suitability (Fig. 7). Northern and eastern parts of Himachal Pradesh are not suitable according to precipitation, temperature, soil and topography.

Climate change impact on apple growing areas in Himachal Pradesh

Adverse impact of climate change in Western Himalayas on Apple producing areas and productivity is being reported in recent decades (Vedwan et al., 2001; Caudhary et al., 2011; Rana et al., 2009). Kullu valley the apple belt of state has gone under sharp decline of apple productivity and apple orchards had been replaced by vegetables and fruit varieties (with lower chilling requirements) in several areas. Areas previously unsuitable because of very low temperatures are becoming suitable for apple cultivation like Lahaul & Spiti. Apple cultivation is collapsing in lower altitudes and expanding towards upper altitudes (Rana et al., 2009). Effort is made here to study apple cultivation areas and shift in apple zones under changing climate and time variability (36 years). Thus, various chilling zones, suitable classes for Apple cultivation and shift in Apple belt are spatially mapped for entire Himachal Pradesh.

GIS based Chill Unit Model

Point based chill unit models are widely to calculate effective chilling units (ECU) for the weather station or given point for assessing apple suitability. However to better address shift in apple suitability over a large area, a spatial calculation and analysis of ECU is required. A simple GIS based chill unit model was developed to calculate ECU (effective chill unit) on grid basis over Himachal Pradesh. This model consists of two broad steps: (1) Synthesis of hourly temperature from daily maximum and minimum temperature and (2) ECU calculation. Inputs for the model are daily maximum temperature and daily minimum temperature. The daily data on maximum and minimum temperature for a period of 1972-2013 were used as an input to the UTAH chill unit model (Richardson et al., 1974). According to the UTAH model most effective temperature range which contributes in dormancy release is between 1.5 and 12.4 ^{0}C. However, the effectiveness of chilling hour is different for each range of temperature and is weighted according to criteria of UTAH model. Effective chill unit for the whole season is calculated by adding by adding C_U for each hour from October to March of next year.

The suitability assessment for apple is done on the basis of the chilling requirements which clearly reflect the importance of winter temperatures. The threshold for the range of ECU indicating different suitability classes were derived from various literatures and expert advice of horticulture scientists from Himachal Pradesh. These suitability classes are assigned according to chilling zones, areas having ECU between 800-1000 is mapped as highly suitable. Parts of Kullu, Chamba, Kangra, Lahaul & Spiti and Kinnaur districts comes under very suitable zone in first decade but in fourth decade (2005-2013) kullu and kangra districts are no more in very suitable zone. Moderately suitable class contains two chilling zones, one with lower ECU (600-800) then very suitable zone and with higher ECU (1000-1500). Marginally suitable classes contains single chilling zone (300-600) which is below very suitable zone as well as moderately suitable zone. This area has shifted upwards causing lower areas to become unsuitable in the progressing decades (Fig. 8). Unsuitable zone with ECU<300 increased continuously from first to fourth decade, in first decade it consists of only lower portion of Kullu district but by coming up to fourth decade this region occupied more than half of the area of Kullu district.

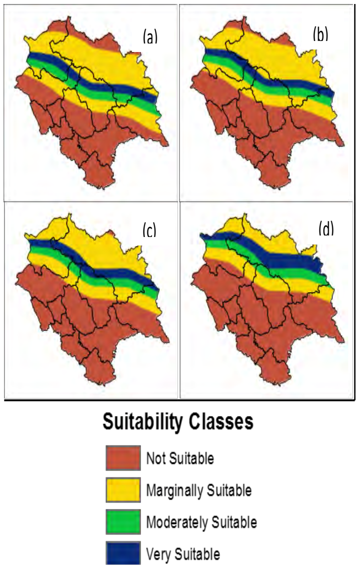

Fig. 8. Changes in apple suitability in Himachal Pradesh over climatic periods (a) 1978-86 (b) 1987-1995 (c) 1996-2004 and (d) 2005-2013

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COMPOSITE LIVELIHOODS RESILIENCE INDEX – A CONCEPTUAL FRAMEWORK

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Abstract

Sustainable Livelihoods are increasingly becoming central to the notion of sustainable development.Livelihood security transcends food security and encompasses - ecological security, economic efficiency, and social equity - the three basic conditions crucial for sustainable livelihoods and development. Ecological security is critical to conserve, and improve the resources bases of the economy and society including food, economic efficiency is important to indicate how resources – both human and natural – are used under current technological conditions to meet the present and development needs of the society, and equity is important to ensure a more broad-based distribution of economic and development benefits – both at present and in future – in the form of secured livelihoods especially for the marginalized groups.

Current trends in use of land, water, forest, air and energy resources in production of food, fodder, wood, fiber, energy consumption needs are reaching the thresholds to cross the – boundary limits - threatening transformation of hitherto pro-life conducive conditions to anti-life adverse conditions in a large measure. These are accentuated by the growing inequalities marked byunrest due to jobless growth, unprecedented wealth for a few, mass poverty and large scale unemploymentthreatening peaceful co-existence by increasing disputes and conflicts within communities and with the rest of others.

Following conceptualframework, indicators and method of computation of sustainable livelihood security index developed by Prof MS Swaminthan, Composite Livelihoods Resilience Index with appropriate modifications capturing the food, water and energy nexus will be shared.

PAPERS OF ORAL PRESENTATIONS

Theme 1
Green Energy and Water Sectors

T1 A090
THE ELECTRIC ENERGY-WATER NEXUS IN ENERGY SECTOR BY MANAGING THE SEASONAL LINKAGES : AN EMPIRICAL ANALYSIS

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Abstract
The fast growing demand for fresh water-coupled with the need to protect the environment has made many areas of India and the rest of the World vulnerable to water shortages for various uses of the economy. As they interact with Electricity Industry, water availability is critical to power generation. Without access to adequate amounts of water for steam generation and cooling, power plants that rely on heat energy to generate electricity cannot operate. Seasonal anomalies in water systems and electricity production are inextricably linked. A change in one of these systems induces a change in the other. Throughout much of developing world the fresh water supply comes in the form of seasonal rains. For example in India 90 percent of its annual rainfall during the rainy monsoon season lasts from June to September and for other eight months the country gets barely a drop. Such increasing incidents of seasonal fluctuations however are challenging the sustainability of water supplies needed for power generation. Therefore, there is an imperative need to better understand the interrelationship of Electric Energy- water for effective management of serious water related power generation issues. Taking cue of this, the study explores the common thread and identifies (i) Major water consuming power plants by calculating water foot prints or water to electric energy generated ratio in m3/MW by using water foot printing method. (ii) This paper also gauges the effects of the some of overlaps and gaps between seasonal anomalies in water availability and growth of power generation in rainy, summer, winter and post monsoon season for power plants of different energy types (Both non-renewable and renewable sources) in Coastal AP, Rayalaseema and Telangana regions of Andhra Pradesh using a detailed economic analysis, i.e. With the help of Seasonal Variation Index or Ratio to Moving- Average Method.

T1 A149
POSSIBILITIES OF RENEWABLE ENERGY TECHNOLOGIES TO ADDRESS THE POLLUTION HAZARD DUE TO BACKWATER TOURISM IN KUTTANAD AREA OF KERALA, INDIA

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Abstract
Kuttanad is one of the major wetland systems in India, which is included in the Ramsar sites and comprise of a unique ecology located below 2.2 m from mean sea level. The present study was focussed on the major ecological threats due to backwater tourism. The methodology included field surveys for data collection and analysis of secondary data. It was observed that the major problems were pollution from untreated sewage waste, seepage of oil from engine driven boats, discharge of non-biodegradable waste as well as wastage of energy. On assessment of available renewable energy technologies, it was evident that solar photovoltaics along with anaerobic digestion of organic wastes to treat the wastes from house boats with simultaneous biogas production as well as energy conversion of aquatic biomass the probable option.

Keywords: Backwater tourism, Energy, Environmental pollution, Renewable energy

Introduction
Kuttanad wetland system is a deltaic formation of five river systems viz. *Meenachil, Pampa, Manimala, Muvattupuzha* and *Achencovil,* located in the fertile low-lying areas of *Vembanad* lake of Kerala state and is famous for backwater tourism. Traditional boats which were used as goods carriages **(***kettuvallams***) in** olden days have been converted to house boats and at

present they are widely depicted as the icon of back water tourism of Kerala. As the population of house boats have increased significantly in the recent past, there is a serious concern over their impact on the wet land ecosystem (Narayanan and Karlaganis, 2014). Even though there are legal restrictions and rules imposed by the government to mitigate the environmental impacts of house boat tourism, there are many instances of negligence on the part of the operators. Hence this study was aimed at understanding the major pollution problems associated with back water tourism in Kuttanad area and to propose suitable renewable energy techniques for reducing pollution.

Methodology

The methodology adopted for the present study was a mix of primary data collection through surveys as well as analysis of secondary data collected from various stakeholders. The survey was conducted during the months of February to April 2016. The pollution hazard in the area becomes severe in this period of the year due to the closing of *Thaneermukkam* bund resulting in the stagnation of wastes in the backwaters. In order to collect information, interviews with key stakeholders, focus group discussions and interactions with a number of selected informants were done. The office bearers of All Kerala House Boat Owners Association (AKHBOA) were also interviewed. Data from the Kerala State Pollution Control Board and documents from the Department of Port, Government of Kerala were reviewed. The analysis was based on the surveys at two sites viz. Alappuzha (Alleppy) and Kainakary.

Results and Discussion

The general information collected from different classes of local inhabitants as well as tourists gave a picture of the environmental problems as well as their perceptions on the severity of problems. Out of the 130 people surveyed local inhabitants were the maximum and 66 % of them were sceptical about the house boat tourism. More than half of the tourists were also concerned about the environmental problems caused by house boats. Only 10 per cent of the house boat workers felt that there is any serious problem and more than half of them considered that the problems if any are not at all significant. It became evident that local inhabitants as well as tourists are at present worried about the environmental problems even though the house boat workers seemed to neglect them. It was also observed that the major problems were pollution from untreated sewage waste, seepage of oil from engine driven boats, discharge of non-biodegradable waste as well as wastage of energy.

The sewage treatment plant installed by the District Tourism Promotion Council (DTPC) in collaboration with AKHBOA with a capacity of 180000 litres per day was intended to prevent the discharge of sewage from house boats to the lakes. The process involves collection of raw sewage from house boats in an equalization tank. After aeration by recirculation by the feed pump the effluent from the equalization tank is fed to a reactor working on the principle of electrocoagulation. The treated sewage coming out from the reactor is passed through the clarifier tank and the clarified water is collected in the filter feed tank. From the filter feed tank, the water is fed to the pressure sand filter and activated carbon filter. The outflow of the carbon filter is passed through electro chemical oxidation unit for microbiological disinfection and the treated water is finally discharged to the soak pit.

From the survey, we understood that the treatment plant was not effectively used by the houseboat operators. The sewage wastes from the houseboats were most often not passed to the treatment plant but they were dumped in to the backwaters. More than 50% of stakeholders have endorsed that the management of wastes and sewage is not at all done in a proper way. Large percentage of the people had the opinion that water and soil characteristics have been badly also affected because of the backwater tourism. An estimate of the waste generation is given in table 1. On an average 1.2 ton of sewage wastes were dumped in to the backwater daily. From the current study we understood that majority of house boats were not obeying the rules and regulations. These results call for urgent measures for reducing the pollution and to protect the ecosystem of the wetland systems.

Table 1. Waste generation from house boats

Sr. No.	Particulars	Particulars
1	No. of house boats in Kuttanad region	838
2	Average number of house boats in daily service	465
3	Average number of persons per boat	10
4	Total amount of sewage waste	1.1625 tonnes
5	Total amount of plastic waste	0.697 tonnes

The examination of possible options for renewable energy use revealed that solar panels cannot be installed on houseboats due to technical and aesthetic difficulties. They may damage the traditional look of the boats and wind could create problems. The suggestion is to install small capacity decentralised solar power plants at suitable locations in Kuttanad. Floating systems also may be thought of. The electricity demand of the house boats can be met from solar power plants to some extent. Charging points may be provided or there can be provision for hiring charged batteries. A preliminary investigation of the wind potential was not very promising for the conventional aero generators. The possibility of low speed wind turbines also need detailed investigation.

Another option is anaerobic digestion of organic wastes and aquatic weeds. Supply of bottled biogas at safe pressures can reduce financial and economic costs expended on fuel for cooking. The produced bio-slurry is a very good organic fertilizer and may reduce the use of chemical fertilizer in Kuttanad agriculture. The aquatic weeds like *salvinia* and *eichornea* are posing threat to navigation in the lakes. Proper technology is already available for converting them to bioenergy. However, no effort in this direction is seen materialised. If the harvesting and energy conversion techniques for aquatic biomass is adopted a significant amount of green energy can be made available to the system.

Conclusion

Even though the backwater tourism around Kuttanad area have a positive impact on the economy, there are negative effects due to pollution. Major problems due to the backwater tourism arise from discharge of solid and liquid wastes and seepage of oil from diesel engines of house boats. The renewable energy technologies, especially solar and bioenergy alternatives are capable of reducing the pollution hazard. A proper monitoring from the local self-government authorities are required for conservation of *Vembanad* wetland system and to achieve the long term sustainability of eco-friendly backwater tourism.

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T1 A298
OHMIC HEATING - THE GREEN FUTURE TECHNOLOGY APPLIED OVER SOYMILK

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Abstract

Ohmic heating was applied to soymilk of different concentrations (100, 90, 80, 70, and 60%). By 100% concentration means soymilk of 3˚ Brix was used. Five different voltage gradients (14, 12, 10, 8 and 6V/cm) were applied. Graphs were plotted between temperature and electrical conductivity and time and temperature for five concentrations and voltage gradients.

Key words: Ohmic heating, soymilk, electrical conductivity, heating rate

Introduction

Ohmic heating is a novel technique used in food processing industry. It is defined as a process where (primarily alternating) electric currents passed through an electric conductive food directly connected to the electrodes to which sufficient power is supplied. At the same time, heat is produced in the form of internal energy generation within the food. Hence, ohmic heating is sometimes also referred to as Joule heating.

Ohmic heating can be used to cook, pasteurization and sterilize anything from the juice and dairy products to soups and stews. For any material to be ohmically heated, it must be capable of conducting electricity. When food product conduct electricity by electrolytic conduction, the moving ions within it collide with other molecules and these collisions lead to momentum transfer to these molecules, which in turn increases the kinetic energy, thereby heating the product. The main critical factor in ohmic heating is the electrical conductivity. The impact of this technique is that it increases the shelf life of food substance without destroying its nutritional value and also heating is uniform during this process. The objectives of the present work is to study the effects of voltage gradient on heating rate and electrical conductivity of soymilk having different concentrations.

Material and methods

Sample preparation – 300 g of soybeans were taken, and they were soaked overnight for approximately 10 hours in 500 ml of RO (reverse osmosis) water. After this the soaked beans were boiled for 15 minutes and were washed with tap water. The washed beans were grinded for approximately 60 seconds and 900 ml of distilled water was added to the grinded mixture. The mixture so obtained was filtered and the extract we got was soymilk.

The soymilk so prepared was assumed to be of 100% concentration. Different concentrations (100, 90, 80, 70 and 60) of milk were prepared by dilution with distilled water. Five different voltage gradients (14, 12, 10, 8, 6) V/cm were applied on each concentration. Experiment was repeated three times for each voltage gradient and for each concentration.

Electrical conductivity and heating rate measurement - Measurement of electrical conductivity and heating rate was done with the help of voltage, current and temperature data. Soymilk of known concentration was poured in the ohmic heating tube and the required connections were made. A constant voltage was set with the help of variac whose value was noted from the voltmeter. With no loss of time stop watch was started and current readings were noted with the help of ammeter at regular intervals of time, temperature readings were also noted at these intervals of time with the help of K-type thermocouples. From this recorded data the electrical conductivity values were calculated with the help of the equation which is mentioned below-

$\sigma = IL/VA$

Where I, V, L, A are current, voltage, length of ohmic heater and area of cross section respectively.

Result and discussions

The observed ohmic heating rate for 100% concentration was 0.020, 0.044, 0.085, 0.149, 0.196˚C/sec at 6, 8, 10, 12, 14V/cm voltage gradients respectively. It was observed that the heating rate followed a linear trend. A plot between time and temperature at 14V/cm voltage gradient for different concentrations of soymilk is shown in Fig.1. The heating rate increases with the increase in concentration. Similar trend was also observed for other concentrations having different heating rate. Same trend was observed by Darvishi *et al* 2011, Icier and Ilicali 2005, in case of ohmic heating of lemon juice and fruit purees respectively. Therefore, it is clear from the study that the heating rates are voltage dependent. At high voltage gradients, the current passing through the sample was higher and this increased the heat generation rate. As the voltage gradient increased the heating time of the soymilk required to reach the prescribed temperature decreased (Darvishi *et al* 2011).

The plot of change in electrical conductivity versus temperature for different concentrations is shown in Fig.2. It was observed from the plots that the variation of electrical conductivity with temperature followed a linear trend. Basically the variation of electrical conductivity with temperature was noted at one voltage gradient and at five different concentrations. The electrical conductivity depends on voltage gradients and concentrations. Similar trend was observed for other concentrations. Lamsal (1994), Assiry *et al* (2010) and Zareifard *et al* (2003) were reported similar results. The electrical conductivity for 100% concentration sample at 14V/cm was higher than the electrical conductivity at 90% concentration and so on i.e. the higher concentrated sample had higher electrical conductivity. This similar trend was observed by Assiry *et al* (2010). In his study the sample which was containing more TDS value i.e. which was more concentrated possessed more value of conductivity.

Conclusion

The electrical conductivity increased linearly with increase of temperature. The electrical conductivity is strongly dependent on temperature. Ohmic heating rate is dependent on voltage gradient and concentration. This study can be used for designing and controlling ohmic heating rate.

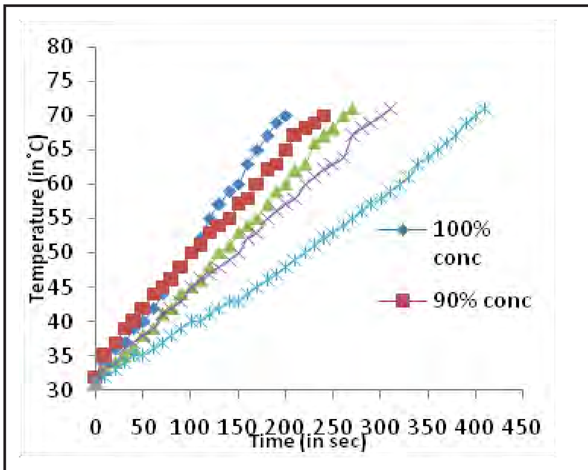

Fig.1. Change in temperature versus time at 14V/cm.

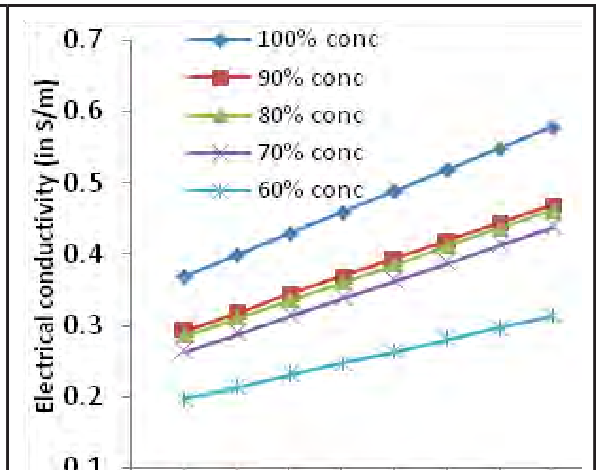

Fig.2. Change in electrical conductivity versus temperature at 14V/cm

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T1A301
GLOBAL SCENARIO ON SCOPE OF BIOGAS FOR MITIGATION OF CLIMATE CHANGE

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Abstract

Biogas is a clean and renewable source of energy. The optimal use of this resource can minimize environmental impacts, produce organic manure in form of digested slurry and are sustainable based on current and future economic and social societal needs. Sunlight absorbed in environment transformed as biomass, a main source for biogas production. Biogas production from biomass is considered carbon dioxide neutral and does not emit additional greenhouse gases emission to the atmosphere. Thus provides an excellent opportunity for mitigation of greenhouse gas emission and reducing global warming through substituting conventional energy sources. According to a study global warming mitigation potential (GMP) of a family size biogas plant was 9.7 t CO_2 equivalent per year and with the current price of US $ 10 t^{-1} CO_2 equivalent, carbon credit of US $ 97 $year^{-1}$ could be earned from such reduction in greenhouse gases emission under the clean development mechanism (CDM).
Keywords: Biogas, Greenhouse gases, Climate change, Global warming

Introduction

Energy is a very important input for development. The energy requirement is increasing with increase in the population of the world. There is a direct correlation between the development and amount of energy used. The demand of energy is increasing but supply is limited. This situation is called energy crisis. Recent high in oil and coal prices, as well as an intensified debate about climate change, have led many analysts to suggest that renewable energy development could mitigate the negative impacts of unstable fossil fuel prices on the one hand and the continued reliance on inefficient and unhealthy traditional biomass energy options on the other, as well as contribute to reducing greenhouse gas emissions.

Although the impact of small land holders on global anthropogenic greenhouse gas emissions is minimal, the impact of climate-change-related effects (in terms of heat stress, dwindling water and land resources, spread of diseases and loss of biodiversity) on small-scale farmers and livestock keepers is enormous (Thornton et al., 2009).

Within this scenario, waste manure and other organic materials from livestock farms could be an important source of energy production. A host of tested and successful technical options are available to mitigate the environmental impacts of agricultural activities while improving soil fertility and income levels. These can be used in resource management, in crop and livestock production and in the reduction of post-harvest losses (FAO, 2009).

Rural poor people tend to rely on human and animal power for mechanical tasks such as agricultural activities and transport and on the direct combustion of biomass for activities that require cooking, space heating, heating water for bathing and for some industrial needs Rural poor people account for only 1 per cent of consumers that can afford diesel fuel and electricity (UNDP, 2008).

Traditional cooking fuels like dung cakes, firewood are not only inefficient but also pollute the local and the surrounding environment by adding Green House Gases (GHG), which in turn contributes to global warming and climate change (Sharma, 2014). The globally averaged combined land ocean surface temperature data show a warming of 0.85 [0.65 to 1.06] °C over the period 1880 to 2012 (Intergovernmental Panel on Climate Change [IPCC], 2013). Whilst climate change has the potential to significantly impact on the supply and demand of energy, properly managed renewable technologies have potential to contribute to both climate change mitigation and support households and communities to increase their resilience to climate change by developing adaptive capacities (Alternative Energy Promotion Center [AEPC], 2012).

Biogas technology provides an excellent opportunity for mitigation of GHG and reducing global warming through (i) replacing firewood for cooking, (ii) replacing kerosene for lighting and cooking, (iii) replacing chemical fertilizers and (iv) saving trees from deforestation. It is one such alternative energy source, which is a viable and feasible technology, especially in rural setting. According to Mendis and Van Nes (1999) and SNV (2012), biogas plants provide multiple benefits at the individual, household and local (community and village), regional, national and global levels. Special Report of the Intergovernmental Panel on Climate Change: Methodological and Technological issues in Technology Transfer (IPCC, 2001) recognizes four general categories of Forest-sector carbon mitigation technologies and appreciates contribution to the use of domestic biogas in carbon offsets.

Biogas is increasingly gaining attention as a sustainable energy resource that may help to cope with:

1. Increasing demand for energy by increasing the global energy supply.
2. Rising fuel prices by providing import substitutions for expensive fossil fuels.
3. Concerns about climate change by reducing global greenhouse gas emissions.
4. Energy security by promoting domestic supply of renewable energy.
5. Desire to expand agricultural commodity markets with organic produce in the face of world trade forecasts.
6. Empower local people especially women farmers and contribute to food security and sustainable management of forests.

Biogas from livestock waste and crop residues

Biogas provides a renewable and environmentally friendly process that supports sustainable agriculture. It is one of the simplest sources of renewable energy and can be derived from sewage; liquid manure from hens, cattle and pigs; and organic waste from agriculture or food processing. Additionally, the by-products of the 'digesters' provide organic waste of superior quality (Arthur and Baidoo, 2011).

Biogas is an important renewable energy resource for rural areas. An estimate indicates that India has a potential of generating 6.38 X 10^{10} cubic meter of biogas from 980 million tons of cattle dung produced annually. It has approximately 55-65 % methane, 35-45 % carbon dioxide and other gases. The heat value of this gas amounts to 1.3 X 10^{12} MJ. In addition, 350 million tons of manure would also produce along with biogas (Mittal, 1996).

India has potential of about 12 million family size biogas plants. Over 3.5 million family size biogas plants and about 4000 large size (community / institutional) biogas plants have already been set up in the country (MNES, 2002). In addition to this, it is estimated that around 5000 *gaushalas (*common cattle sheds) / big dairies exist in India, where large size (120 m^3 /day or larger) biogas plants can be installed (Kapdi, 2014).

As shown in Figure 1, the significant health, sanitation and environmental benefits that could be obtained by feeding dung into a biogas plant and converting the waste into safe fertilizer. By using bio-energy resources and non-polluting technology, biogas generation serves a triple function: waste removal, environmental management and energy production. Biogas is now widely integrated with animal husbandry and can become a major means of manure treatment in the agricultural sector and environmental protection.

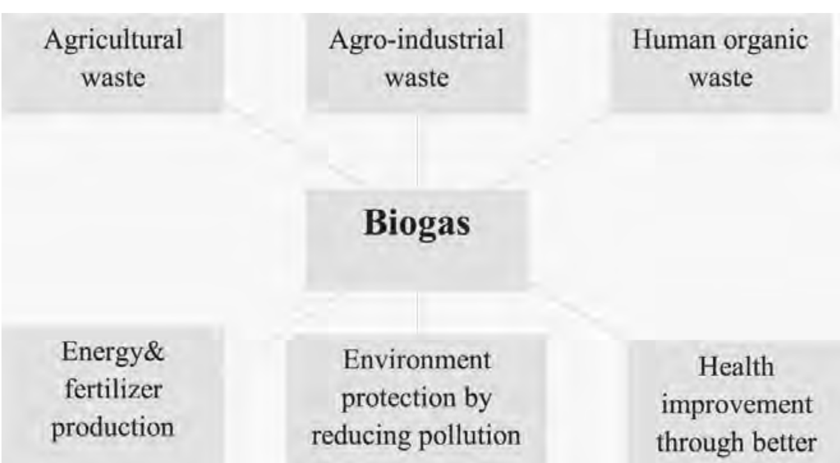

Figure 1. Multiple benefits from integrating waste flows for energy production

Harnessing the potential of biogas from waste

The conversion of animal waste and biomass into biogas encourages on- site energy production and brings the production of bioenergy at the farm level. Generating methane from manure produced by livestock under controlled conditions could supplement energy needs and consequently, reduce the direct contribution of methane to climate change; essentially reducing the use of firewood by relying on a more sustainable energy source. The reduction in firewood consumption results in reduction of greenhouse gas emission at the tune of 8.02 tons per biogas plant per year of carbon dioxide equivalent. The number of trees save per biogas plant per year is found to be 10.15 trees that help to mitigate the climate change through carbon sequestration (Chand et al, 2012).

The multiple benefits of biogas technology are making it an increasingly attractive manure management technology other than being adopted at the household level. The system can efficiently be used in medium and large livestock farms. The large scale energy production could provide electrification to entire rural communities for local use or for sale to small-scale industries via mini-grids.

The livestock manure management can be express in two ways as shown in Figure 2. By route 1, it results in the manure being applied as a solid on fields. This results in the generation and release of methane into the atmosphere, contributing to greenhouse gas emissions. The greenhouse gas emission from open storage of dung (route 1) escape to the earth's atmosphere create a type of insulation and trap the escape route of sun's energy after striking to the ground. This leads to higher temperature on the earth than would otherwise occur thus creates global warming. The systemic approach to reduce the greenhouse gas emission and combat the effects of global warming is done through a new concept of "carbon trade" through carbon credits and carbon footprints. It is dealt under the system described in Kyoto Protocol, in which some listed countries of the protocol are supported by non-listed countries by generating carbon credits and exchanging them in the form of carbon currency.

At the same time, if the livestock manure collection method is modified such that a high proportion of the manure is collected and fed to an anaerobic digester (route 2), methane can be generated under controlled conditions and use for generation of heat/ electricity and high quality organic fertilizer, which in turn increase crop production when applied to the fields. Thus direct methane emissions can be controlled by route 2.

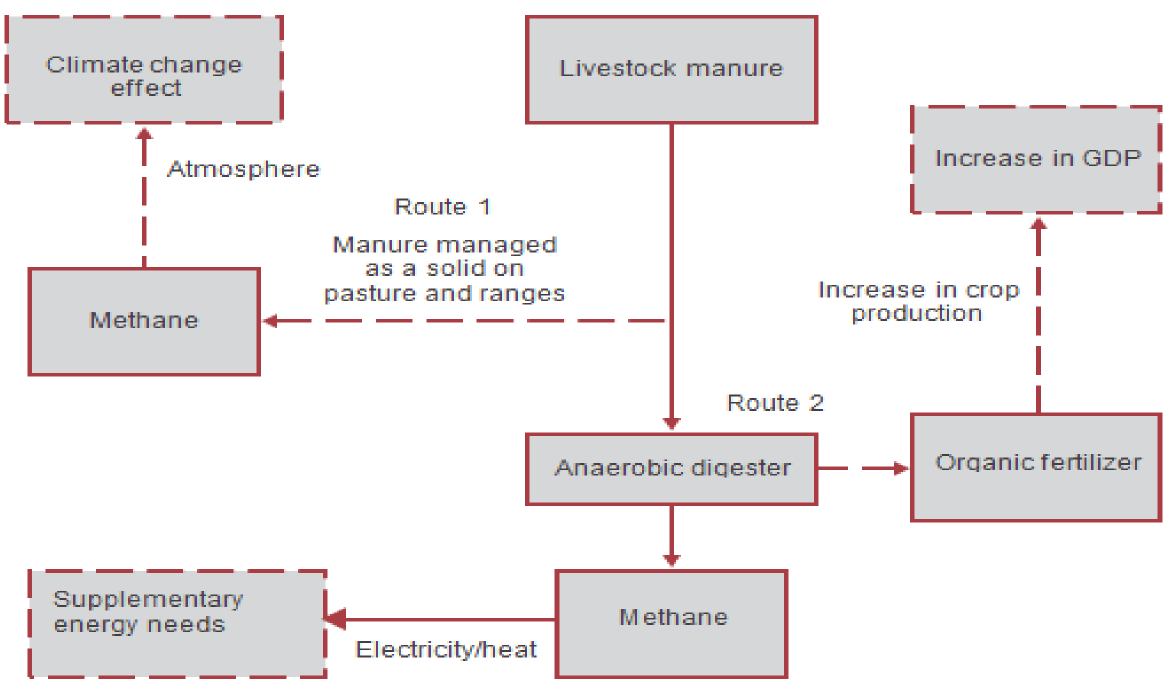

Figure 2. Mechanism for controlling direct methane emissions

The collection, transportation and processing of biomass waste poses significant challenges to their use in energy production. For these and other reasons, the technology is best suited to integrated systems at the household level, where families own up to four cattle and/or poultry animals. The potential of gas production from various types of waste use as feedstock for biogas generation is shown in Table 1 (Khandelwal and Mahdi, 1986).

Table 1. Potential of gas production from different wastes

Type of waste	Gas yield/kg (m^3)	Normal manure availability per animal per day (kg)	Gas yield per day (m^3)
Cattle dung	0.036	10.00	0.360
Buffalo dung	0.036	15.00	0.540
Pig manure (approxi 50 kg wt.)	0.078	2.25	0.180
Chicken manure (approxi. 2 kg wt.)	0.062	0.18	0.011
Human excreta (Adult)	0.070	0.40	0.028

Advantages of biogas technology

A biogas plant is an asset to a farming family. It provides clean fuel, improves sanitation generates power and produces good quality and quantity of manure.

a. Domestic fuel:

Presently, agricultural residues and dung cakes are used as cooking fuel in rural areas. It is wasteful practise as hardly 9-12 % of their fuel value is harnessed. Moreover, smoky kitchens are harmful to the health of women and children. Also collection and storage of these materials is problematic, in particular during the rainy season. A biogas unit helps to eliminate the age-old practise of burning cattle dung for fuel purposes as it is clean and efficient fuel for cooking purposes. It saves the consumption of kerosene, charcoal and wood. It avoids the need to collect fire-wood and twigs and thus saves the labour of women and children in rural areas who normally spend considerable time and energy to cover long distances daily to collect fuel. It would eliminate the practise of indiscriminate falling of trees and consequent soil erosion.it also alleviates the drudgery of rural women's lives and provides spare time after cooking for developmental activities that can make a contribution to the family income. Children can read under biogas illumination using biogas lamps during erratic supply of electricity or shortage of kerosene.

b. Sanitation and health:

Biogas units are effective means of sanitary disposal of human excreta. In rural areas with dry latrines, the practice of carrying headloads of night soils of night-soil can be eliminated by attaching latrine with a biogas unit. During decomposition of night-soil in a biogas plant, most of the diseases causing organisms are killed. This can serve as effective control of parasitic diseases, hookworm, roundworm etc. The digested slurry remains free from foul smell and most of pathogens. Mosquitoes and flies do not breed in digested slurry. Thus, biogas plants improve sanitation. The incidence of eye diseases among women and children is also reduced as burning of biogas does not cause any smoke in the kitchen.

Biogas, being clean fuel, does not cause air pollution. It is considered a better fuel than LPG because it does not contain sulphur, which is harmful. The danger of explosion of biogas is less as it contains carbon dioxide which acts as a fire extinguisher.

c. Motive power:

Biogas is new source of fuel for mechanization of agriculture and village industries. It can be used for running diesel and petrol engines for operating chaff cutters, flour mill, dairy equipment etc. even electricity can be generated from it. Biogas engines are available in market.

The average quantities of biogas consumed in these applications are shown in Table 2 (Khandelwal and Mahdi, 1986).

Table 2. Quantities of biogas consumed for various applications

Use	Specifications	Quantities of gas consumed
Cooking	Per person per day	0.24 m^3/day
Lighting of lamp	100 candle power lamp	0.13 m^3/h
Duel fuel engine	75-80% replacement of diesel oil/bhp	0.50 m^3/h
Electricity	1 kWh	0.21 m^3/h

d. Manure for agriculture

The manure produced through a biogas plant has a comparative advantage over ordinary manure produces through open pit composting in terms of quantity and quality. About 70-75 % of the original weight of cattle dung is conserved in a biogas plant while in open compost pit 50 % or more is lost. Similarly almost all the nitrogen content in cattle dung is conserve in a biogas unit, while substantial part of this is lost during composting. Biogas manure, known as "digested slurry" contains a higher percentage of other plant nutrients also. Besides this, this manure is free from pest and weed seeds as they were killed inside the digester. Thus, there is no need to buy and use harmful pesticides, weedicides etc. in farming. This promotes organic farming.

Biogas and climate change

The use of biogas as an energy source is climate-friendly. In sharp contrast to fossil fuels, biogas production and use emit little or no carbon dioxide. Instead, the carbon dioxide released when biogas burn will be reabsorbed in the atmosphere during biomass regrowth. Modern biogas technologies can serve similar ends by replacing traditional cooking fuels with clean, smokeless, efficient and easily controlled liquid and gas alternatives.

According to U.S. Environmental Protection Agency (2007) methane is over 20 times more effective at trapping heat in the atmosphere than carbon dioxide over a 100 year period. Methane reduction efforts have tremendous potential as part of a broader greenhouse gas reduction plan. Environmental and Energy Study Institute (2009) demonstrated biogas helps in reducing climate change impacts substantially as the methane in the gas is converted to carbon dioxide. Deforestation and forest degradation currently accounts for 18-25 percent of greenhouse gas emissions (Stern, 2006). Reforestation, afforestation and avoiding deforestation are the mechanisms of tackling climate change (Hunt, 2009). This study confirmed the substitution of fuel wood by biogas, as fuel contributes to forest conservation which further contributes to increased carbon capture and reduced GHG emission.

According to Shrestha et al., (2003) the biogas plants of sizes 4, 6 and 8 cubic meter mitigates about 3, 4 and 5 tons of carbon dioxide per plant per year in the hills. Similar study by Winrock and Eco Securities (2004) shows that the available carbon reduction per plant is 4.6 tons of CO_2 equivalent. Devkota (2007) calculated each biogas plant of 6 cu.m reduces 4.9 tons of carbon dioxide equivalent per year. Similarly AEPC (2008) capped the GHG reduction rate at 4.99 tons per year per plant. Biogas plays a crucial role in reducing the greenhouse gases especially carbon dioxide by reducing traditional unsustainable fuel wood consumption practices providing a clean energy. The global warming mitigation potential of a family size biogas plant was 9.7 tons CO2 equiv. per year and with the current price of US $ 10 per tons CO2 equiv. carbon credit of US $ 97 per year could be earned from such reduction in greenhouse gas emission under the clean development mechanism (Pathak *et al*., 2009). This technology has supported a smokeless kitchen environment and a healthier surrounding reducing the heavy drudgery of women and school-going children in collecting fuel wood. Biogas for the household cooking is a pathway to social change.

According to study a family size biogas plant substitutes 316 litre of kerosene, 5535 kg firewood and 4400 kg cattle dung cake per annum as fuels. Substitution of kerosene reduces emissions of NOx, SO2 and CO by 0.7, 1.3, and 0.6 kg per year. Substitutions of firewood and cattle dung cake results in the reduction of 3.5 to 12.2, 3.9 to 6.2, 436.9 to 549.6 and 30.8 to 38.7 kg per year NOx, SO2, CO and volatile organic compounds, respectively. Total reductions of NOx, SO2, CO and volatile organic compounds by a family size biogas plant are 16.4, 11.3, 987.0 and 69.7 kg per year (Pathak et al, 2009) .

Carbon revenue generated through biogas can play a significant role in financing biogas projects in rural communities. Manandhar and Bhatta (2013) documented the use of revenue from the sale of carbon credits to help communities in financing the installation of biogas energy in villages. The reduced installation cost would mean accelerated use of biogas which would ultimately contribute to climate change mitigation and strengthen the adaptation through multiple benefits from biogas application. Carbon Credits are a tradable permit scheme under UNFCCC (United Nations Framework Convention for Climate Change) which give the owner the right to emit one metric tonne of carbon-dioxide equivalent. They provide an efficient mechanism to reduce the greenhouse gas emissions by monetizing the reduction in emissions. Rural India has a tremendous potential to earn carbon credits by setting up household based energy substitution. A study for estimating the carbon credit potential of biogas plant at Goushala, Durgapura, Jaipur was carried out by Sharma and Agrawal, 2011. The Goushala had 250 cows, from which 750 kg (dry weight) of dung was obtained daily. Dung was converted into biogas through three floating digester biogas plants of 85 m^3, 60 m^3 and 25m^3 capacity. The cows produced over 273.75 tons of dung annually and if this dung was disposed of in lagoons or stored outdoors to decompose, such disposal methods emit methane and nitrous oxide, two important Green House Gases (GHG) with 21 and 310 times Global Warming Potential (GWP) of carbon dioxide, respectively. In total, greenhouse gas emissions from the Goushala amount to 594 t CO2 equivalents per year and with the current price of US $10 t^{-1} CO2 equivalent, carbon credit of US $5940 per year can obtained. About 1.1 metric tons firewood per household can be saved and 1.6 tons CO_2 emissions can be reduced per year by adopting biogas technology.

Conclusion

Mitigating climate change and adaptation to it is an increasingly pressing issue for the developed countries. Biogas technology is considered as the one of the best energy sources that provide energy in one hand and reduce the emission of the GHGs on the other hand. It is the effective and appropriate mitigation technology which conserves the forest area by reducing the fuel wood consumption, minimising kerosene use for cooking & lighting and reduction in chemical fertilizers use in farming. Besides this has many more positive socio-economic impacts that enhance the adaptive capacity of the people which help to minimize the vulnerability of the community, people to changing climate. The mechanism of earning carbon credit should use for promoting installation of biogas plants by making them financially viable.

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T1A305
CLIMATE CHANGE PROJECTIONS AND IMPACT ON EVAPO TRANSPIRATION

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Introduction

Evapotranspiration is an important process in the water cycle because it is responsible for 15% of the atmosphere's water vapor resulting in cloud formation and precipitation. Evapotranspiration is the combined name for the processes of evaporation and transpiration. The evaporation refers to loss of water from soil, wetlands, and standing water and also refers to direct evaporation of liquid water from the leaf surface of the plant. Transpiration happens when plants release water vapor from tiny holes, called stomata, in their leaves. This is caused in part by the chemical and biological changes that occur as the plant undergoes photosynthesis and converts carbon dioxide into oxygen. Plants perform transpiration to cool down their leaves.

There are many factors that affect evapotranspiration. The atmospheric parameters like temperature, wind speed and humidity are the main factors affecting the process of evapotranspiration. As temperature increases, the rate of evapotranspiration increases. Evaporation increases because there is a higher amount of energy available to convert the liquid water to water vapor. Transpiration increases because at warmer temperatures plants open up their stomata and release more water vapor.

If the air around the plant is too humid, the transpiration and evaporation rates drop. The rate of evaporation increases with increase in wind speed. The wind will also clear the air of any humidity produced by the plant's transpiration, so the plant will increase its rate of transpiration. Even the increase in CO_2 concentration may lead to reduction in stomata opening resulting in less evapotraspiration. The availability of water, and soil and plant types also affect the rate of evapotranspiration. Some plants, like cacti, naturally hold onto their water and don't transpire as much. Trees and crops on the other hand, can release copious amounts of water vapor in a day.

Climate change and projection

The key indicators of climate change are changes in carbon dioxide concentration, global air temperature, Arctic sea ice, land ice and sea level. Observations of the climate system are based on direct measurements and remote sensing from satellites and other platforms. Global-scale observations from the instrumental era began in the mid-19th century for temperature and other variables, with more comprehensive and diverse sets of observations available for the period 1950 onwards.

Carbon dioxide (CO_2) is an important heat-trapping (greenhouse) gas, which is released through human activities such as deforestation and burning fossil fuels, as well as natural processes such as respiration and volcanic eruptions. The Fig.1 shows that the atmospheric CO_2 levels has reached 404 ppm in August 2016. Fig.2 illustrates the change in global surface temperature relative to 1951-1980 average temperatures. The 10 warmest years in the 134-year record all have occurred since 2000, with the exception of 1998. The year 2015 ranks as the warmest on record. July 2016 has been recoded as the warmest month on record. Arctic sea ice reaches its minimum each September. September Arctic sea ice is now declining at a rate of 13.4 percent per decade, relative to the 1981 to 2010 average (Fig 3). Sea level rise is caused primarily by two factors related to global warming: the added water from melting land ice and the expansion of sea water as it warms. The Fig 4 shows the change in sea level since 1993 as observed by satellites. Presently sea level has risen by 86.2 mm.

As per IPCC report (2014), the cumulative emissions of carbon dioxide largely determine global mean surface warming by the late 21st century and beyond. Projections of greenhouse gas emissions vary over a wide range, depending on both socio-economic development and climate policy. Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise. Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development.

Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gases are stopped. The risks of abrupt or irreversible changes increase as the magnitude of the warming increases.

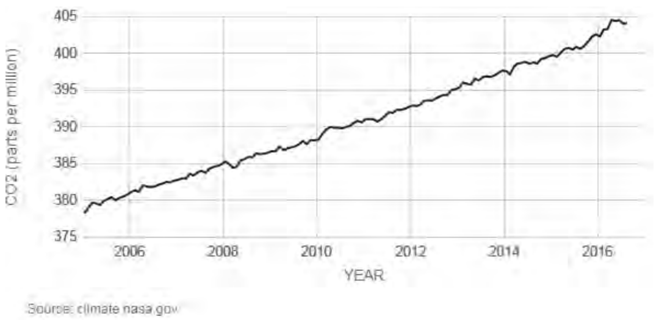


Fig.1 Atmospheric CO2 concentration in recent years

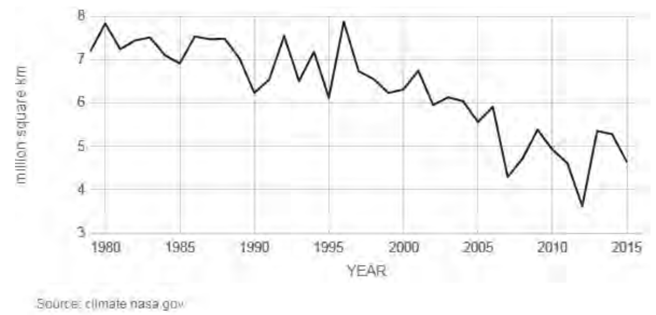


Fig.3. Arctic sea ice since 1980

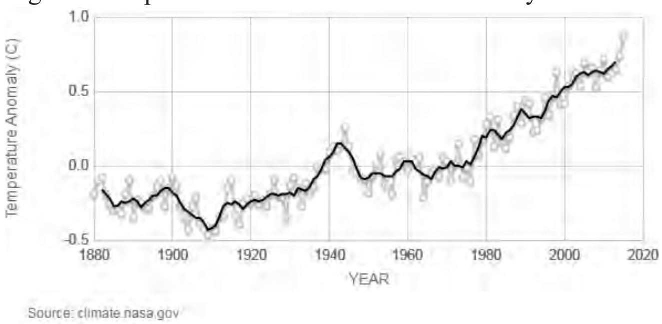


Fig.2. Global mean temperature since 1880

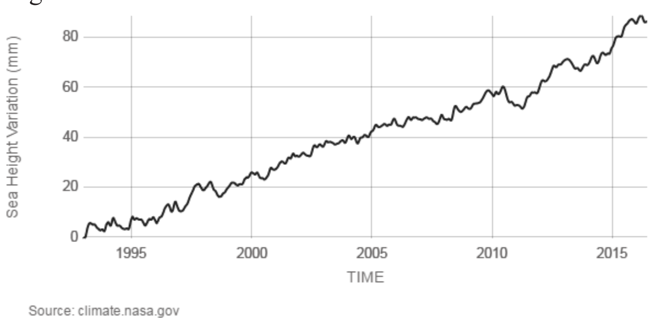


Fig.4. Increase in mean sea level

Impact on evapotraspiration

The climate change is now reality. CO_2 and temperature are increasing and rainfall patterns are changing, and these are projected to increase/decrease further over space and time. Thus, under projected climate change scenario, the evapotranspiration is bound to vary. The extent to which climate change will affect evapotranspiration and water deficits is still uncertain. Some of the viewpoints highlighted above are described here. The paper describes the change in evapotranspiration in past as well as projected for the future at different locations of the India. Moreover, spatial variability of evapotranspiration in Gujarat on daily, monthly, seasonal and annual scales are described at length. Although there are several methods for estimating reference evapotranspiration (ET_0), the most widely used method of Penman-Monteith (PM) equation (Allen et al 1998) has been used to estimate the evapotranspiration under varying climatic conditions.

The evapotranspiration (ET0) has been found to vary with locations as well as with seasons. During winter season it is lowest (4-6 mm/day) and summer season in highest (10-15 mm/day) in middle Gujarat (Fig. 5).

It is seen that with increase in maximum temperature by 1 ^{0}C, the evapotranspiration (ET0) rate would increase by 0.43 mm/day. However, the effect of minimum temperature on ET0 was found to be less (0.16 mm/day) in comparison to maximum temperature. The effect of relative humidity was found to be negative ie. ET_0 decreases with increase in RH.

$$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

where,

ETo = reference evapotranspiration [mm day-1]

Rn = net radiation at the crop surface [MJ m-2 day-1]

G = soil heat flux density [MJ m-2 day-1]

T = mean daily air temperature at 2 m height [°C]
u2 = wind speed at 2 m height [m s-1]
es = saturation vapour pressure [k Pa]
ea = actual vapour pressure [k Pa]
es - ea = saturation vapour pressure deficit [k Pa]
Δ = slope vapour pressure curve [k Pa °C-1]
γ = psychometric constant [k Pa °C⁾-]

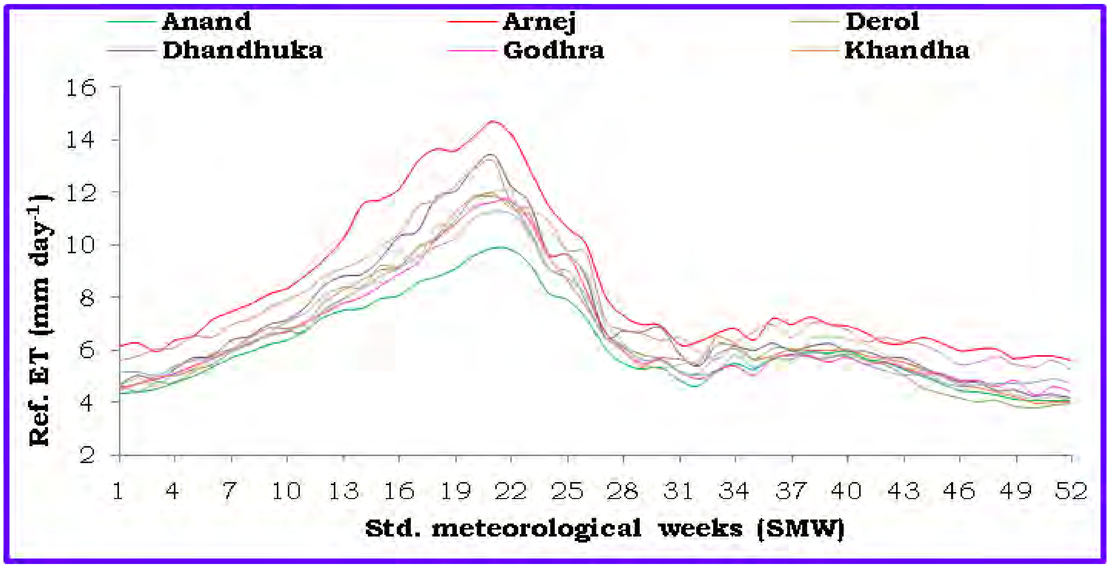
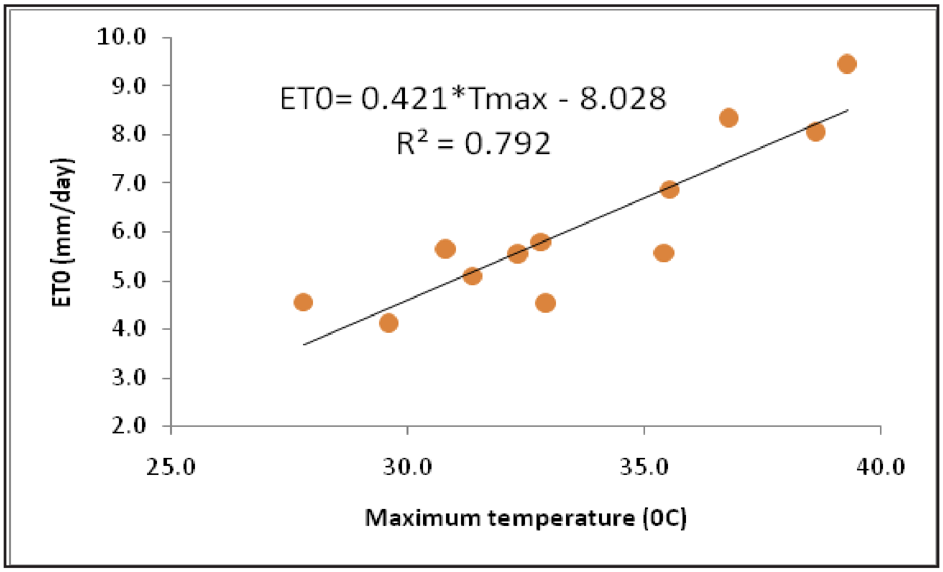


Fig.5: Weekly variation of ETo at selected stations of middle Gujarat



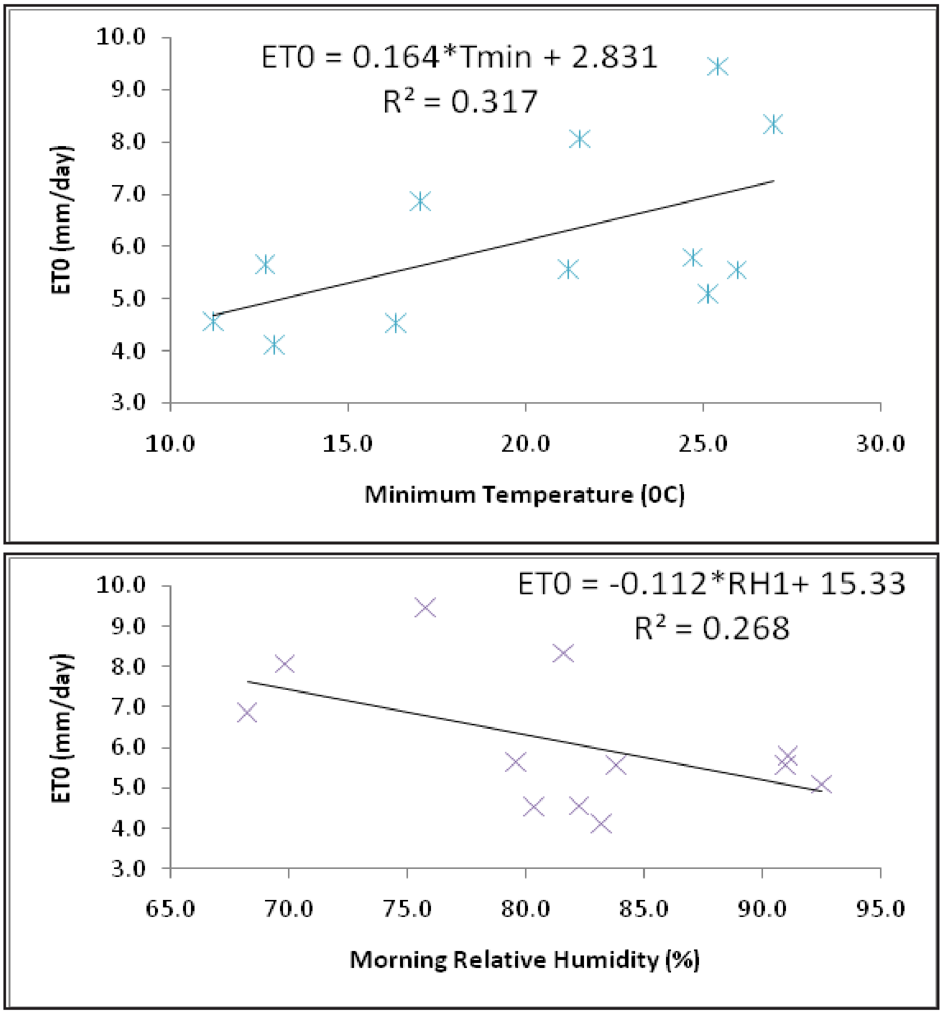


Fig. 6 Effect of temperature and humidity on evapotraspiration (ET0)

T1 A306
CLIMATE VARIABILITY AND FOOD SECURITY: THE ROLE OF TARGETED CLIMATE FORECASTS

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Food, water and energy security are significant challenges for a world in which population growth and increasing climate variability are predicted. While overall trends in climate indicate a warming world, this is likely to be accompanied by increased climatic variability including greater incidence and magnitude of extreme weather events (e.g. floods, drought, heat waves, storm events) and greater uncertainty in terms of precipitation. Agricultural food production systems, heavily reliant on climatic conditions (temperature, moisture availability), are likely to come under increasing pressure to both increase production and maintain productivity under conditions of increased risk and uncertainty. Regionally-targeted climate information, relevant to farmers' operational decision making, will become increasingly valuable, enabling access to timely information and facilitating adaptive climate risk management. This paper will detail cutting-edge improvements in climate forecasting for agricultural regions and discuss our experience in the application of such forecasts in the development of resilient climate risk management systems, best practices and insurance products designed to shield smallholder farmers and agri-businesses, across the agricultural value chain, from physical and financial risk associated with climate change.

Theme 2
Agriculture and Food

T2 A074
CLIMATE CHANGE IMPACT AND ITS ADAPTATION MEASURES OF GROUNDNUT OF SAURASHTRA REGION OF GUJARAT

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Abstract
The projected climatic data (2071 to 2100) as downscaled by PRECIS model for different stations (Bhavanagar, Bhuj, Rajkot and Kesod) of Saurashtra region of Gujarat were analysed for climate change impact studies on groundnut (cv. GG-20 and GG-2) during Kharif season. Results indicated that the annual rainfall during projected period would be 54, 93, 69 and 69 per cent higher than the base line rainfall (1961-90) at Bhavanagar, Bhuj, Rajkot and Kesod with 364,335,488 and 451 mm SD respectively. Quantum of rainfall was higher under projected period than Base line rainfall with high seasonal variation and extremes. Rainfall in the range of 500 to 750 mm during monsoon with good monthly distribution was more beneficial and sufficient for higher production of groundnut. Maximum temperature would increase by 4, 2.6, 3.7 and 3.8 0C, while minimum temperature would increase by 4.3, 3.7, 4.1 and 3.4 ^{0}C at same stations respectively. The impact of climate change on different cultivars of groundnut were studied using DSSAT models. High rainfall variability and greater impact of temperature showed negative impact on maturity days, LAI and biomass greatly affected on pod yield at all stations. The results indicated that climate change will negatively affect the mean pod yields of groundnut as 34, 20, 34 and 19 per cent at Bhavanagar, Bhuj, Rajkot and Kesod during projected period as compared to base line yield respectively. To narrow down the yield gap various adaptation criteria were simulated (use of only organic manures and shifting sowing earlier 15 days of onset of monsoon by applying one irrigation). Application of only organic manure in GG-20 gave 12 % and GG-2 sown earlier 15 days of onset of monsoon by applying one irrigation recorded 21 % higher yield over projected period. Thus by adopting appropriate adaptation measures impact of climate change on yield can be alleviated to some extent.

Key words: Climate change, trend analysis, base line, PRECIS, projected climate

Introduction
Groundnut (*Arachis hypogaea* L.) is one of the major oilseed crop of the subtropical and tropical regions of the world. It is grown in different rainfall and temperature regimes on a variety of soils. In recent past world's climate scientist showed that the frequency of extreme weather events, increased air temperature and vapor pressure deficit of air and spatial and temporal change in rainfall is a great challenge for agriculture sector. For the South Asia region, the IPCC has projected 0.5-1.2 ^{0}C rise in temperature by 2020, 0.88-3.16 ^{0}C by 2050 and 1.56-5.44 ^{0}C by 2080 depending upon the scenario of future development (Uttam Kumar *et.al.* 2012). Overall, the temperature increases are likely to be much higher in winter season than in rainy season. The pattern of precipitation is already changing and will become more erratic and intense with warming of the globe. In spite of beneficial effect of increased atmospheric CO_2 concentration, climate change will adversely impact the production and productivity of groundnut grown in subtropical and tropical regions of the world. Bapuji Rao *et. al*., (2011) studied that there was a decrease in productivity with increase in seasonal mean, maximum and minimum temperatures irrespective of the moisture regime. In view of this fact various adaptation measures were simulated to offset the production gap at a sustainable level at various location of the Gujarat state.

Materials and Methods
Climate change projection
The climatic data (rainfall, maximum and minimum temperature) of last 30 years considered as base line period (1961-90) of different stations (Bhavanagar, Kutch, Rajkot and Kesod) of Gujarat were used for climate change study. The climatic parameters were analysed for trend analysis in different seasons (winter: Dec. to Feb., summer: March to May, Monsoon: June to September and Post monsoon: Oct. to Nov.) in addition to annual basis. The climate change projection under A2 scenario was derived from PRECIS downscaled model output prepared by IITM Pune in a grid size of 0.4 degree. The climate projection under A2 scenario for period 2071-2100 were considered for climate change and adaptation study.

Climate change impact and adaptation on groundnut

The PRECIS generated projected daily data of A2 scenario for maximum temperature, minimum temperature, rainfall and solar radiation were used for preparation of weather file. Similarly soil and crop management files were prepared for validation of the model. The validated model (Patel *et al*., (2013) for DSSAT for groundnut was used for impact analysis and adaptation studies.

Results and Discussions

Long term trend analysis

Long term trend analysis (Table 1) of weather parameters showed that maximum temperature was found positive during winter, monsoon and post-monsoon season at Bhuj, while it had negative trend at Rajkot in summer season. Minimum temperature showed negative trend at Bhuj during summer and it was positive at Rajkot. There was positive trend of Tmin. at Kesod and Rajkot during monsoon and post-monsoon season respectively. Rajkot had negative trend of rainfall during winter season. There was no any trend over Bhavanagar for all the parameters. Annual trend for all station was also found non-significant.

Climate projections

The thirty years (2071-2100) mean projected climate are compared with the base line (1961-90) periods (Table 2). Results showed that highest change in projected rainfall (101 %) will be at Bhuj whereas the lowest change in projected rainfall (52 %) at Bhavanagar. The maximum temperature has been projected to increase between 2.8 to 4.1 ^{0}C at different locations, the maximum increase being at Bhavanagar while lowest increase being at Bhuj. Similarly, the minimum temperature has also been projected to increase between 3.8 to 4.4 ^{0}C at different locations. Rupa Kumar *et al*., (2006) have also reported that the extremes in rainfall, maximum and minimum temperatures are expected to increase in future in different parts of India.

Impact on crop yield

The impact of projected climate on groundnut was studied by using validated DSSAT model. The models were run for both the periods i.e., base line (1961-90) and projected (2071-2100). The mean of thirty years data were worked out and are compared. The differences in yield are presented in Table 3. The highest yield reduction under projected period at onset of monsoon sowing was recorded at Bhavanagar (32.95 %) under GG-2 cultivar, while it was lowest (16.41 %) at Rajkot for the same cultivar. In case of late sowing (fifteen days of onset of monsoon) there was nearly 5 % average reduction in pod yield of groundnut for all locations and for both the cultivars.

Adaptation strategies

It is clearly evident from the study that under projected climate change period there will be variable yield reduction in pod yield of groundnut at various locations. To bridge this yield gap various adaptation measures (use of only organic manures for GG-20 and shifting sowing earlier 15 days of onset of monsoon by applying one irrigation for GG-2) were simulated and results are presented in Table 4. Results showed that higher yield gain over projected yield were noted at Bhuj and Bhavanagar stations for GG-20. Similar trend was followed for GG-2 for same locations. Overall shifting sowing earlier 15 days of onset of monsoon by applying one irrigation was found best adaptation measures as compared to use of only organic manures.

Table 1: Trend analysis (slope) of selected stations of Saurashtra region of Gujarat (1961-90)

Weather parameters	Period/Season	Bhavnagar	Bhuj	Kesod	Rajkot
Maximum Temperature	Winter	-0.006	0.031*	-0.002	-0.012
	Summer	0.004	0.033	-0.012	-0.0001**
	Monsoon	0.001	0.044*	0.022	0.015
	Post-monsoon	-0.003	0.052*	0.001	0.012
	Annual	-0.001	0.039	0.021	0.005
Minimum Temperature	Winter	0.007	-0.032	0.009	0.082
	Summer	0.018	-0.020*	0.007	0.045*
	Monsoon	0.016	0.014	0.021*	0.037
	Post-monsoon	-0.012	-0.019	0.021	0.092*
	Annual	0.007	-0.016	-0.467	0.064
Rainfall	Winter	0.075	-0.032	0.098	-3.28*
	Summer	-0.180	-0.045	-0.019	-0.158
	Monsoon	-0.296	-1.508	-1.414	0.548
	Post-monsoon	2.344	-0.216	-0.237	0.443
	Annual	0.362	-0.449	0.002	-0.613

*: Significant at 5 % level, **: Significant at 1 % level

Table 2: Per cent variation of climate at various locations in relation to base line

Station	Rainfall (mm)			Maximum temperature (^{0}C)			Minimum temperature (^{0}C)		
	Base line (1960-90)	Projected (2071-2100)	Per cent change	Base line (1960-90)	Projected (2071-2100)	Diff-er-ence	Base line (1960-90)	Projected (2071-2100)	Diff-er-ence
Bhavanagar	627	953	52	33.9	38.0	4.1	21.3	25.1	3.8
Bhuj	389	782	101	34.7	37.5	2.8	19.4	23.3	3.9
Rajkot	660	1181	79	33.7	37.7	4.0	20.1	24.5	4.4
Kesod	836	1456	74	33.3	37.0	3.7	19.9	24.0	4.1

Table 3: Per cent yield reduction under projected period in relation to Base line yield at different locations.

Station	Groundnut cultivar	% yield reduction under projected period (2071-2100) from base line(1960-90)	
		Onset of monsoon sowing(D1)	Fifteen DAS of D1 sowing(D2)
Rajkot	GG-2	-16.41	-18.96
	GG-20	-20.54	-22.96
Kesod	GG-2	-20.52	-22.23
	GG-20	-17.23	-19.21
Bhuj	GG-2	-32.40	-38.73
	GG-20	-29.90	-36.41
Bhavanagar	GG-2	-32.95	-37.40
	GG-20	-30.57	-36.04

Table 4: Per cent yield gain over projected reduction by various adaptation measures

Station	Groundnut cultivar	% yield gain over projected reduction	
		Use of only organic manures	Shifting sowing earlier 15 days of onset of monsoon by applying one irrigation
Rajkot	GG-20	9	-
	GG-2	-	14
Kesod	GG-20	7	-
	GG-2		16
Bhuj	GG-20	15	-
	GG-2	-	17
Bhavanagar	GG-20	18	-
	GG-2	-	28

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T2 A115
CHALLENGE POSED BY CLIMATE CHANGE ON MANGO FLOWERING IN TROPICS AND SUBTROPICS IN INDIA

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Induction of reproductive or vegetative shoots is thought to be governed by the ratio of a temperature-regulated florigenic promoter and an age regulated vegetative promoter at the time of shoot initiation.In subtropics, low night temperature 50–100C produce synchronise flowering, however night temperature of 100-180 C produce asynchronous flowering. Climate change may cause abrupt changes in night temperature, which will result into asynchronous flowering in subtropics and flower bud exposure to cold temperature during night may change into vegetative one under the warm night condition. In tropics cool winters followed by rise in temperature may increase poor flowering. As evidenced in tropics, mango flower in response to age of the last vegetative flush. Stems must be in rest for sufficient time, generally 4 to 5 months, to be induced to flower in the absence of cool temperatures. The changing monsoon and rainfall pattern in tropics could influence the mango to initiate shoot initiation in sufficiently mature stem at any time of the year and to flower abruptly or give rise to vegetative shoot in response to abnormal rainfall. As a result of climate change, flowering trends of mango are considerably altered and directly influenced panicle growth. Frit set and availability of hermaphrodite flower for pollination may be defined as a function of time taking for panicle growth. Evidence of warmer winters and earlier panicle development, paired with the freezeevent pose several problems in mango production. Abrupt temperature rise during the flowering of mango will cause poor fruit set.

T2 A125
ASSESSMENT OF CLIMATE CHANGE AND ITS IMPACT ON MUSTARD PRODUCTIVITY IN *TARAI* REGION OF UTTARAKHAND

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Abstract
InfoCrop v 2.1 model was used to study the impacts of climate change on mustard variety RGN-73. As per the IPCC report, temperature and CO_2 projections were applied for the year 2020, 2030 and 2050 for three different dates of sowing where; mustard crop performed better under late sown conditions.

Key words: InfoCrop, mustard, dates of sowing, temperature, CO_2.

Introduction
Climate change has been recognized globally as the most critical issue affecting mankind survival in the 21st century. The last assessment report from the IPCC predicted an increment in mean temperature from 1.1 – 6.4 °C by 2100. The global atmospheric concentration of green house gases (GHG) *viz.* carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (NO_2) has increased tremendously as a result of human activities from the pre-industrial era. Increasing concentration of these green house gases is expected to have a great impact on global climate change thereby affecting agriculture. Climate change is a major global environmental problem and also an issue of great concern to all countries irrespective of their size or level of development. The mean annual temperature of India has shown significant warming trend and relatively accelerated warming of 0.22°C/10 yr, during 1970-2003. In developing countries, climate change would cause yield declines for the most important crops. The negative impact of climate change on crop production is alarming as the demand for food is expected to increase, in coming years, at a rate of about 2 percent a year (Banerjee *et al.,* 2014). Therefore, climate change will

be an additional challenge to produce enough food grains to feed an ever growing population.

Rapeseed- mustard being a cool season crop, the growth and yield of the crop in a particular agroclimatic condition is mainly influenced by temperature. It is highly sensitive to temperature and photoperiod, showing quite diverse patterns of growth and development under different sets of environmental conditions. The date of sowing of Indian mustard (*Brassica juncea*) varies from year to year depending on the harvesting of previous wet season crop in the northern and north-western part of India, which exposes the mustard crop to variable weather conditions. In recent times, the crop simulation models have been used extensively to study the impact of climate change on agricultural production and food security. The output provided by the simulation models can be used to make appropriate crop management decisions and to provide farmers and others with alternative options for their farming system. It is expected that in the coming decades with the increased use of computers, the use of simulation models by farmers and professionals as well as policy and decision makers will increase (Mall *et al.,* 2006).

Material and Methods

The field experiment was conducted at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar (Uttarakhand) during the *rabi* season of the year 2014-15. Mustard variety RGN-73 was sown at three different dates with the 10 days interval viz., 22nd October, 1st November and 11th November. Geographically this centre is situated at 29°N latitude and 79.3°E longitude with an elevation of 243.83 meter from mean sea level. The average rainfall of this area is about 1434.4 mm annually with maximum precipitation during South-West monsoon. May is the hottest month of the year and temperature generally rises up to 42.5±1.5°C. However, minimum temperature can be low as 1.5±1.0°C in the month of January. The daily meteorological data used for the study (i.e. minimum and maximum temperature, bright sunshine hours, relative humidity, rainfall and wind speed) were taken from Agrometeorological observatory at Norman E. Borlaug Crop Research Centre of the University.

Model used in the study was InfoCrop v 2.1, which is a generic crop model and simulates the effects of weather, soils, agronomic management (planting, nitrogen, residues and irrigation) and major pests on crop growth, yield, soil carbon, nitrogen and water, and greenhouse gas emissions. Its general structure is based on a large number of earlier models and the expertise of the scientists involved. In particular, it is based on MACROS, SUCROS, WTGROWS and ORYZA1 models. The crop models have been developed by the specialists for those crops which have been validated in major crop specific environments of India. The decision support system also includes databases of typical Indian soils, weather and varieties for applications. The calibrated and validated model was used for simulating the growth and yields of mustard during 2014-15 against the treatments conducted under field condition and also for the assessment of impacts of climate change on the crop production in near future. As per the IPCC recommendations, temperature projections of 1.5°C, 2.7°C and 4.7°C along with the CO_2 concentration of 414 ppm, 522 ppm and 682 ppm were applied for the year 2020, 2030 and 2050 respectively for climate change study over the production of Indian Mustard.

Crop Weather Simulation Models (CWSM) seeks to predict the phenology and yield of crops from the input of weather data, and would thus serve as an excellent tool to study the effect of climate change on crop production. Crop growth simulation models are very useful and effective tool for assessing the future crop production scenario (Aggarwal *et al*., 1994). The impact of projected climate change scenarios were assessed by running the validated model for 2020, 2050 and 2080 as per the climatic projections of IPCC, 2007. In this study the InfoCrop v 2.1 model was used to simulate crop growth in the present and changed climate scenarios.

The value of maximum leaf area index under 22 October decreased (1.64 to 0.31) as the temperature and CO_2 concentration increased from current year (2014-15) to the future projections. The model simulated an increase in the value of the maximum leaf area index for the climate projections of 2020 and 2050 but showed a decrease for the year 2080, when the crop sown on 1st and 11th of November. The highest value of LAI (1.90, 2.12, and 1.18) was reported under November 01 sown condition for all the three climatic projections, respectively. Therefore, on the basis of results obtained from the model simulations it can be concluded that, sowing of mustard on 1st of November would result into higher values of LAI for increase in the value of temperature and CO_2 concentration in near future.

The total above ground dry weight decreased as temperature and CO_2 concentration increased from the current temperature level for the first date of sowing (22 October) from 5502.2 kg/ha (2014) to 4767.70 kg/ha (2020), 4135.90 kg/ha (2050) and 1360.00 kg/ha (2080). The model simulated a steep reduction in dry weight from 2050 to 2080. It showed that a temperature rise of 4.7 **°C** was not favorable for the plant growth as compared to 1.5 **°C** and 2.7 **°C** rise in temperature. The model reported the least value of the total above ground dry weight for 11 November as compared to that of October 22 and November 01 for all the years.

Seed yield of Indian mustard increased in the year 2020 for all the three dates of sowing and decreased thereafter as the temperature and CO_2 concentration increased from present level which is reported in Table 1.The crop sown on 22nd October resulted into the lowest value of seed yield 425.10 kg/ha for the year 2080 with 4.7 **°C** + 682 ppm projection and reported its maximum for the year 2020. For the year 2050 the crop sown on 1st of November produced the best yields of 1819.90 kg/ha while for the year 2080 with the highest concentration of CO_2 (682 ppm) and maximum temperature rise (4.7 **°C**) crop sown on the 11th of November showed best results. For the year 2020 and 2050 the crops sown on all the three dates resulted in a positive change in seed yield while this change was on a negative side representing a yield reduction for the year 2080. Magnitude of this yield reduction was maximum for the crop sown on 22nd October. Similar results were reported by Haris *et al.*, (2010).

Table 1: Seed yield (kg/ha) as influenced by different climatic scenarios

Date of sowing	**Simulated seed yield (kg/ha)**			
	At present	**Projected increase in temperature (°C) and CO_2 concentration (ppm)**		
		2020	2050	2080
		1.5 **°C** + 414 ppm	2.7 **°C** + 522 ppm	4.7 **°C** + 682 ppm
22 October	1413.00	1780.70	1458.00	425.10
01 November	1371.80	1872.50	1819.90	726.20
11 November	1279.20	1403.90	1636.80	1186.00

Conclusion

Climate change studies with increase in temperature and CO_2 concentration for the year 2020, 2050 and 2080 showed a greater influence on the value of the maximum leaf area index, which was more than the normal for the year 2020 and lower than the normal for 2080 as per the model simulations. Model showed a continuous decrease in the production of total above ground dry weight from 2020 to 2080 with increase in temperature and CO_2 concentration for the crop sown on 22nd October from 4767.7 kg/ha to 1360.0 kg/ha. Climate change analysis of the model for the variety RGN-73 showed a drastic reduction in seed yield with increase in temperature and CO_2 concentration above the normal conditions. Crop sown on 1st and 11th of November showed an increase in seed yield for the year 2020 and 2050 reduced thereafter. Finally, it could be concluded that, under the changing climate scenario the mustard crop would perform better under late sown conditions, which is evident from the results obtained for seed yield and the total above ground dry weight as per the model simulations.

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T2 A162

HOW SENSITIVE IS GUJARAT'S AGRICULTURE TO CLIMATE CHANGE: A PANEL DATA ANALYSIS OF MAJOR CROPS

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Abstract
The study has assessed the impact of temperature and rainfall on the yield of major crops in Gujarat, during 1980-2011, using panel data fixed effects model. Rainfall had a positive effect on most crops, while temperature had a negative impact. Pearl Millet should be looked upon as a crop of future.

Key words: Climate change, Crop yield, Gujarat, Marginal Effects

Introduction
Several studies have been conducted to analyze the impact of climate change on the yield of crops. Most of these studies either adopted Crop Modelling Approach or Recardian Approach to achieve the objectives. The fixed effects approach, which off late has been adopted by economists, and we use here has advantages over both approaches in the sense that it takes care of farmer's adaptation that may have happened over time (and which Crop Modelling fails to incorporate) and also the time invariant variables such as soil characteristics (which the Recardian approach fails to incorporate). In this study, we study the changes in weather variables viz temperature and rainfall, and analyze the implications of marginal effect of these variables on the yield of major crops grown in Gujarat.

Data and Methodology
Our panel consisted of district level data on crop yields, rainfall, irrigated area under crops, and minimum and maximum temperature from 1980 to 2011 for 18 districts in Gujarat at their 1980 boundaries. The major crops selected from the State were Rice, Maize, Cotton, Groundnut, Wheat, and Pearl Millet (summer crop), grown in their major regions. The data on area and production of the selected crops was obtained from the district crop seasonal abstracts of Government of Gujarat. The data on rainfall and temperature for the districts were extracted from 1×1 degree high resolution daily gridded data obtained from the Indian Meteorological Department, Government of India. The daily temperature, minimum and maximum, was transformed into the average crop-growing period temperature, and the daily rainfall was summed-up to represent the cumulative rainfall during the crop-growing period. The fixed effect panel model as used by Birthal *et al* 2014, for climate impacts was used for the study and is specified as:

$$\text{h } y_{it} = D_i + T_t + \beta X_{it} + \gamma Z_{it} + \varepsilon_{it}$$

The subscripts i and t in above equation denote district and time, respectively. The dependent variable y is crop yield, and D and T are District and Time fixed effects. The District fixed effects absorb all unobserved district specific time-invariant factors; for example, soil and water quality. T represents time fixed effects that absorb the changes in technology, infrastructure, human capital, etc; X and Z are vectors of weather and non weather variables. The weather variables considered in this study were rainfall, minimum and maximum temperature. To account for non linear relationship between weather variables (Schlenker and Roberts, 2006; Guiteras, 2007), squared term of rainfall was also considered in the above equation. To account for non weather variables, we included irrigated area in the equation. To quantify the impact of a single climatic variable on yield, the marginal effects were evaluated at their means. The expected marginal impact of a single climatic variable was estimated as:

$$E\left[\frac{\partial y}{\partial x}\right] = \alpha_{1,i} + 2\alpha_{2,i} * E[x_i]$$

Results and Discussion
Trend in climatic variables
Table 1 presents the trend analysis of climate variables for selected crops. During the study period the minimum and maximum temperatures in Cotton growing season (in Saursahtra) showed a significant rise, the trend in minimum temperature was

quite stronger. The minimum temperature rose by 0.74^{0}C while maximum temperature rose by 0.47^{0}C. The Rainfall in this region showed a significant increasing trend; it increased by 333 mm during 1980-2011. In case of wheat (Middle Gujarat), maximum temperature registered significant rise by 0.89^{0}C, while the minimum temperature rose significantly by 5.41^{0}C (indicating warm winters). The rainfall during the wheat growing season (rabi) in Middle Gujarat showed a declining trend; rainfall declining by 47.92 mm and was more erratic (142%). In case of rice and maize (both kharif crops, studied in Middle Gujarat), only rainfall showed a significant rising trend; rainfall increased by 228 mm during the study period. For, Groundnut in Saurashtra and Kutch region, minimum temperature showed rising trend. Rainfall, too increased significantly. For Pearl Millet grown in summer season, both minimum nad maximum temperature showed significant rising trend; trend being stronger for maximum temperature.

Impact of Climate Change on Crop Yield

Table 2 presents the estimated equations for selected crops of Gujarat. It is to be noted that the district and time fixed effects which were included in the model as control, were significant for all crops, indicating the importance of these characteristics which might have correlation with the climatic variables.

The irrigation coefficient has been found positively significant in Wheat, Cotton, and summer Pearl Millet indicating the importance of irrigation in these crops in their respective seasons. For other crops, the irrigation coefficients were not significant.

We found that a rise in maximum temperature was harmful for all the crops (negative and significant coefficient), except Pearl Millet. Pearl millet is resistant to higher temperatures, so the impact of increase in maximum temperature on yield of pearl millet was not detrimental. On the other hand, a rise in minimum temperature was found having positive effect on the yield; significant for cotton and rice, insignificant for others.

The effect of rainfall was found positive and significant on all kharif crops. The quadratic term of rainfall was found negative and significant for cotton, groundnut, and maize, indicating that excess rainfall leads to damage and reduction in yield, presumably due to an increased probability of flooding. For rice too, it was negative and significant, which means that higher rainfall leads to increase in yield but at a decreasing rate (Gupta *et al*, 2012). Rainfall was found to have negative and insignificant impact on wheat, which is a rabi crop and is grown with irrigation. It was found to have positive and significant impact on Pearl Millet. Regression models give combined effect of variables on dependent variables; however, the individual effect of each of the independent variables is hard to interprete. To resolve this, the marginal effect of each of the individual climatic variables on yield, was evaluated at their mean values.

Marginal Effect

Table 3 presents the marginal effect of climate change, i.e. the effect on yield due to rise in 1^{0}C in temperature and 1mm rainfall. A 1 °C rise in the maximum temperature in *rabi* season reduces the yield of wheat crop significantly by around 10 per cent, while a similar rise in minimum temperature leads to a significant increase in the yield by 6 per cent. Patel and Shekh (2006) also stated on the basis of sensitivity analysis of CERES-Wheat that elevated maximum temperature decreased wheat yield significantly. GoG (2011), in a study found the same. Wheat is not significantly influenced by rainfall as the quantum of rainfall is less and is erratic in rabi season; the crop is grown in irrigated conditions.

A 1^{0}C rise in the maximum temperature leads decline in the yield of cotton by 7 per cent (insignificant), however a similar rise leads to a significant increase by 43 per cent. Elevated CO2 levels in the atmosphere of up to 650 ppm and temperature of 40º C was found to be optimum for cotton plant growth (CICR, 2009). By and large, though, research in India indicates that the impact of climate change on cotton production and productivity will be favourable (Kranthi, 2009), given we find a solution to combat pests and diseases. Marginal effect of rainfall on cotton was negligible, however, excessive rainfall is detrimental to cotton yield. Thakre *et al* (2014) concluded that erratic monsoon or delayed monsoon hampers crop physiology and yield

A 1^{0}C rise in maximum temperature causes rice yield to significantly decline by 13 per cent, while a similar rise in minimum temperature causes a decline in yield , but in this case not a significant one. Welch *et al* (2010) found higher minimum temperatures reduced grain yield in rice, while higher maximum temperature raised yields; because the maximum temperature seldom reached the critical optimum temperature for rice. However, under the scenario of future temperatures increases, they found maximum temperatures could decrease yields if they are near the upper threshold limit. The negative impact of increasing maximum temperature on yield of rice has been supported by other studies (Saseendran *et al*., 2000; Hundal and Kaur, 2004 Easterling and Apps, 2005; Chauhan *et al*, 2009; Birthal *et al*, 2014, and Raj A. *et al*, 2016) .

Climate limits the production area of maize and lack of rainfall (drought) or too much of it (flood) can result in 100 per cent loss of maize output (Chi-chung and Mccarl, 2004,). The marginal effect of rainfall on yield was negligible and insignificant. It was found that 1^{0}C rise in maximum temperature leads to a decline in yield by 9 per cent, while a similar rise in minimum temperature leads to a decline in yield by 8 per cent for the crop varieties grown in Middle Gujarat. The results are supported by Patel *et al* (2008) who found for Dahod region in Middle Gujarat that the gradual increase of minimum temperature showed gradual yield reduction for cv. Ganga Safed-2, while cv. GM-3 did not show any specific trend. They also found that incremental units of maximum temperature (1 to 3 ^{0}C) showed gradual decrease in yield ranging from 3717 to 3518 kg ha-1 (1.1,-0.5 and -4.3 % of base yield) for cv. Ganga Safed-2.

Groundnut is grown mainly as rainfed crop; the Marginal effect of rainfall on yield was positive and significant for groundnut. Low rainfall and prolonged dry spells during the crop growth period were reported to be main reasons for low average yields in India (Reddy *et al*., 2003; Challinor *et al*., 2003; and CRIDA, 2010), China (Zeyong ,1992) and several parts of Africa (Camberlin and Diop, 1999). A 1^{0}C rise in maximum temperature results in decline in yield by 9 percent, while a similar rise in minimum temperature shows a decline in yield by 8 per cent. Rao *et al*, (2011) found that the increase in seasonal minimum temperature beyond 22°C resulted in decline in average productivity by 26.2 per cent. According to their study, the yields of groundnut have shown a decreasing tendency with increase in maximum temperature, minimum temperature and as well as with mean daily temperature, irrespective of rainfall regimes during the growing season in arid and semi arid regions of Andhra Pradesh

In case of Pearl Millet, the marginal effect of rainfall on yield was positive and significant, but negligible during the study period. In summer, Pearl Millet is grown with irrigation and the yields are higher than the kharif grown crop. Pearl Millet is extremely resistant to drought and thrives well in high temperature. The same was reflected in marginal effect analysis of Pearl Millet; a 1^{0}C rise in maximum and minimum temperature leads to a significant increase in yield by almost similar quantum (5 per cent). Looks like pearl millet remains the only crop that has promise of food security for the growing world population under the changing climate. NRC (1996), Hussein et al, (2008) supported the same argument.

Conclusion

Gujarat is not resistant to climate change like rest of India. The impact of temperature and rainfall is significant on the production sub system of crops. The study shows that the marginal effects of increase in maximum temperature are significantly negative for most of the crops and may pose a threat to food security in the long run. Several researches have projected shortage of food between 2050-2100, wherein the yields of crop may decline highly and significantly, in response to climate change, under no mitigation strategies. Changes in planting dates, crop varieties, intercropping etc or adopting innovative technologies like precision farming, micro-irrigation, nanotechnology, may help. Aggarwal (2009) reported if farmers plant earlier than usual, climate induced damages to wheat can be reduced by 60-75 percent. Biotechnology has an important role here. Drought tolerant varieties can reduce production risk by 30-50 percent (Birthal *et al*, 2012). Patel *et al* (2012) showed that by applying supplementary irrigation at tasseling and silking stage to kharif maize, nearly 27-32 percent increase in yield can be achieved over no irrigation. Further, the authors suggested shifting crop to rabi season under climate change scenario as high yields could be achieved than kharif season. The crop of the future is Pearl Millet which shows resistant to high temperatures and the yield responds positively to marginal increase in both minimum and maximum temperature (Mustafa and Arshad, 2014). Cotton may be looked upon as a promising crop, however, the pest and disease incidence increases at high temperatures. More thrust should be given to the agricultural research and adoption of innovative technologies for sustainable agriculture in future scenario of climate change.

Table 1: Trend analysis of climatic variables in different regions of Gujarat (1980-2011)

			Cotton	Wheat	Rice	Maize	Groundnut	Pearl Millet
Min Temp	Mean		20.84 (0.0464)	16.26 (0.0690)	24.15 (0.0457)	24.15 (0.0457)	25.06 (0.0396)	18.8012 (0.0655)
	SD		0.6953	0.9573	0.6336	0.6336	0.5929	0.9083
	Change		0.74	5.41	-0.01	-0.01	0.33	0.78
	Trend		0.0232*** (0.0031)	0.1691*** (0.0048)	-0.0005 (0.0035)	-0.0005 (0.0035)	0.0104*** (0.0030)	0.0244*** (0.0052)
Max Temp	Mean		32.11 (0.0403)	32.17 (0.0613)	33.72 (0.0542)	33.72 (0.0542)	33.49 (0.0418)	35.21 (0.0769)
	SD		0.6039	0.8495	0.7515	0.7515	0.3918	1.0657
	Change		0.47	0.88	-0.21	-0.21	0.02	1.54
	Trend		0.0147*** (0.0035)	0.0277*** (0.0045)	-0.0066 (0.0056)	-0.0066 (0.0056)	0.0008 (0.0043)	0.0484*** (0.0062)

Rainfall	Mean		629.38 (22.2348)	28.7685 (2.9437)	832.05 (21.6577)	832.05 (21.6577)	617.2645 (22.2523)	1.2833 (0.2120)
	SD		332.78	40.7903	300.09	300.09	333.0431	2.9378
	Change		378.81	-47.92	227.97	227.97	401.77	0.60
	Trend		11.8379*** (2.1393)	-1.4977*** (0.3038)	7.1242*** (2.2291)	7.1242*** (2.2291)	12.5555 *** (2.1217)	0.0188 (0.0230)

Note: Total Change in Temp in ^{0}C, Trend: ^{0}C/year, Total Change in Rainfall in mm, Trend: mm/year, Figures within the parentheses are standard errors.

Table 2: Regression results with fixed effect panel data analysis of Major crops of Gujarat (1980-2011)

Variables	**Crops**					
	Cotton	**Wheat**	**Rice**	**Maize**	**Ground nut**	**Pearl Millet**
Minimum temperature	1.1862*** (.1605)	0.0327 (0.0299)	0.1862** (0.0907)	0.07219 (0.09619)	0.1651 (0.2221)	0.0487 (0.0357)
Maximum temperature	-.9175*** (.1527)	-0.0560* (0.0321)	-0.1338* (0.0787)	-0.2261*** (0.0832)	-0.5740*** (0.1799)	0.0359 (0.0273)
Rainfall	.0008** (.0003)	-0.0002 (0.0011)	0.0030*** (0.0005)	0.0037*** (0.0006)	0.0021*** (0.0003)	0.0436** (0.0180)
Rainfall square	-3.61e-07** (1.74e-07)	-5.67e-06 (5.74e-06)	-1.22e-06*** (2.97e-07)	-2.10e-06*** (3.09e-07)	-4.81e-07*** (1.28e-07)	-0.0020 (0.0013)
Irrigation	.0004** (.0002)	0.0004** (0.0001)	0.0002 (0.0003)	0.0024 (0.0017)	0.0013 (0.0010)	0.0002*** (0.0003)
Constant	10.4082*** (3.1532)	5.1499*** (0.9263)	5.4442*** (1.9948)	11.4603*** (2.1323)	20.3240*** (3.9455)	5.3430*** (0.6591)

Note: ***, ** and * denote significance at 1 per cent, 5 per cent and 10 per cent levels, respectively
Figures within the parentheses are standard errors.

Table 3: Marginal effect of climate change on Major crops of Gujarat 1980-2011

Variables	**Crops**					
	Cotton	**Wheat**	**Rice**	**Maize**	**Ground nut**	**Pearl Millet**
Minimum temperature	0.4331*** (0.1135)	0.0675** (.0265)	-0.0451 (0.0799)	-0.0838 (0.0745)	-.0523** (0.0555)	0.0545** (0.0231)
Maximum temperature	-.0738 (0.1100)	-0.1011*** (0.0290)	-.1330*** (0.0493)	-.0978*** (.0461)	-.0957*** (.0763)	0.0542*** (0.0190)
Rainfall	0.0011*** (.0003)	-0.0010 (0.0007)	0.0011*** (0.00009)	0.0002 (0.0001)	0.0020*** (0.0001)	0.0270** (0.0145)

Note: *** and ** denote significance at 1 per cent and 5 per cent levels, respectively
Figures within the parentheses are standard errors.

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T2 A246
UTILIZING THE IMPACT OF CLIMATE CHANGE FOR FLORAL INDUCTION IN MANGO

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Abstract
Climate related changes have greater influence on flowering and fruiting patterns of mango. This is adversely affecting fruit production in some areas. But it is also making some areas more suitable for mango production. Thus, climate change has both positive as well as negative impact on floral morphogenesis with specific region and genotype of the mango.
Key words: *Mango, climate change and floral induction.*

Introduction
Low yield of mango (*Mangifera indica* L.) in the tropics is most often attributed to the failure of floral induction while in subtropical areas flowering is usually reliable but fruit set is often poor is mainly due to interaction of crop genotype and environmental effect. Strong genotypic x environmental responses within mango cultivars are correlated with relative performance on flower induction. Low temperature and water deficit plays a major role in floral induction in mango. Day/ night temperatures below 20/15°C will result in floral induction but cold temperature during anthesis is a primary cause of the failure of fruit set in subtropical regions. Cool temperatures rather than a short photoperiod cause floral induction, whereas warm temperatures rather than a long photoperiod inhibits flowering. Similarly water stress advances floral bud break by nearly 2 weeks in nearly 40% of buds. In warm temperatures (mean minimum temperatures about 20°C), water stress delayed shoot extension, but did not induce floral morphogenesis. In cool temperatures (mean minimum temperatures about 15°C), floral buds were initiated regardless of water stress. Climate and weather play critical roles in the economic success or failure of tropical fruit tree species including commercial mango production. Air temperature and rainfall influence vegetative and phenological phases in mango and are two of the most important factors determining suitability of an area's climate for mango production. For instance, an increase in the temperature during coldest month has made mango cultivation possible in the valley areas of Himachal Pradesh and Uttarakhand. In several parts of the globe increasing temperature will offer opportunities for mango production in new areas.

Content
The floral induction of mango tree is mainly driven by cool temperatures. Consequently, increasing temperatures would have a negative effect on floral induction. But in regions with particularly cool temperature during flowering, increasing temperatures would have a positive effect on pollen viability and fruit set. Temperature also has a negative effect on inflorescence size (Dambreville *et al*., 2013) and on the number of flowers per inflorescence (Sukhvibul *et al*., 1999). Floral induction also requires the exposure of mature leaves to light, and higher levels of light intensity could have a positive effect on mango flowering. Drought and higher VPD would have a negative effect on fruit set and retention. Drought could also have an indirect positive effect on floral induction by promoting early growth cessation and vegetative rest required for floral induction. Off-season production and extended period of mango availability is likely to be a feature under the projected climate changes. This may be due to an increase in mango cultivation in non traditional areas where the changing climate is responsible for replacement of stone and pome fruits that require sufficient chilling hours by mango. The Philippines and Thailand are commercially producing off-season mangoes on a larger area using specific varieties and chemical manipulation. Temperature is one of the most important factors influencing the growth and off-season flowering phenology.
Sarker *et al*. 2014 studied the climate change adaptation and economic profitability: crop land shifting to mango orchard in Rajshahi region. Revealed that about 75% farmers are transforming crop land into mango orchard because of drought, extreme temperature, erratic rainfall and drawdown of groundwater, which restricts economic use of natural resources (particularly, land and water) for field crop production and also high profitability, easy cultivation process, land suitability and favourable environment for mango cultivation. Mango farmers obtained on average 231 kg/ha yield in 1st quarter (year 1-3) and then production increased sharply and reached 2,190 kg/ha in 5th quarter (year 13-15). The highest gross return of mango was found in the 5th quarter. The estimated net present worth (NPW) of the project was Tk 99,588 per hectare, which indicates that mango cultivation was profitable in Rajshahi area.

Harmonious phenological data: a basic need for understanding the impact of climate change on mango (Rajan *et al*., 2012). Critical phonological events of mango: 510-dormant flower bud, 513-flower bud burst, 610- opening of first flower, 615-full blooming and 619-fruit set.

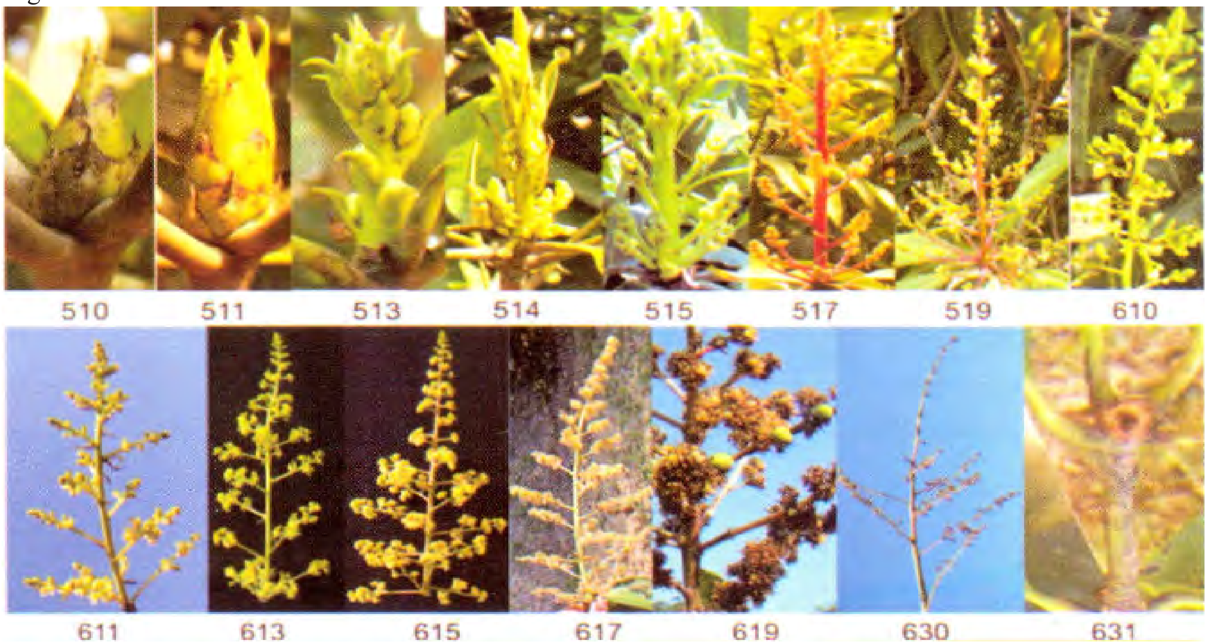

Figure 1: Critical phonological events of mango

Table 1: The timing of different phenophases at different ecological locations

Phenophases	CISH, Lucknow	IIHR, Bangalore	DBSKKV, Ratnagiri	APHU, Medak	FRS, Kanykumari
510	2nd week of Jan	1st week of Jan	3rd week of Oct	1st week of Jan	2nd fortnight of Dec
513	4th week of Jan	3rd week of Jan	1st week of Dec	3rd week of Jan	2nd fortnight of Dec
610	2nd week of Mar	2nd week of Feb	2nd week of Dec	4th week of Feb	4th week of Jan
615	3rd week of Mar	3rd week of Feb	1st week of Jan	1st week of Mar	1st fortnight of Feb
619	4th week of Mar	1st week of Mar	3rd week of Jan	3rd week of Mar	2nd fortnight of Feb

Conclusion:

Changes in climatic suitability suggest that there is no single "loser" or "winner" from climate change. Impacts are highly dependent on both the crop analysed and the environmental conditions in a particular place. However, accepting change and getting in tune with nature seems to be the key to survival and prosperity of the farmers.

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T2 A265
A STUDY ON THE EFFECT OF CLIMATE CHANGE ON AGRICULTURE IN INDIA

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Abstract
The study used Greenhouse Gas emission and Methane emissions as proxy for the climate change in India. Land under cultivation should be increased to increase the cereal production in short and long run. Greenhouse Gas emissions in the short run and Methane emissions in the long run should be controlled to not affect food security of India.
Key words: *Climate change, Greenhouse gas emission, Methane emission, Food security.*

Introduction
Climate Change is the major economic issue of 21st century. There are many issues raised, discussed and interpreted by the eminent scholars about climate change and its nexus with economy. It is expected that the change in climate also has its effect on Agriculture of a country. Agriculture production is a major source of food security for the country. Currently India is able to provide food security to the people under these varying conditions. However, climate change is an additional burden since ecological and socio-economic systems already face pressures from rapid population, industrialization and economic development. The adaptive capacity of farmers to the situation is limited because of subsistence agriculture and low level of formal education. The study aims to provide the insights of climate change on food security.

Objectives
The objective of the study is to analyze the trends in Agricultural Cereal Production and Indian Population and to identify whether Greenhouse Gas Emission impact India's Food Security.

Methodology
The study is based on published sources of data collected from The World Bank website. The study is focusing on the impact of Climate change on Indian agriculture for a period of 25 years from 1988 to 2012. The study employed the Augmented Dickey Fuller (ADF) Test for unit root, Autoregressive Distributed Lag (ARDL) Approach to Co-integration Model using E-Views.

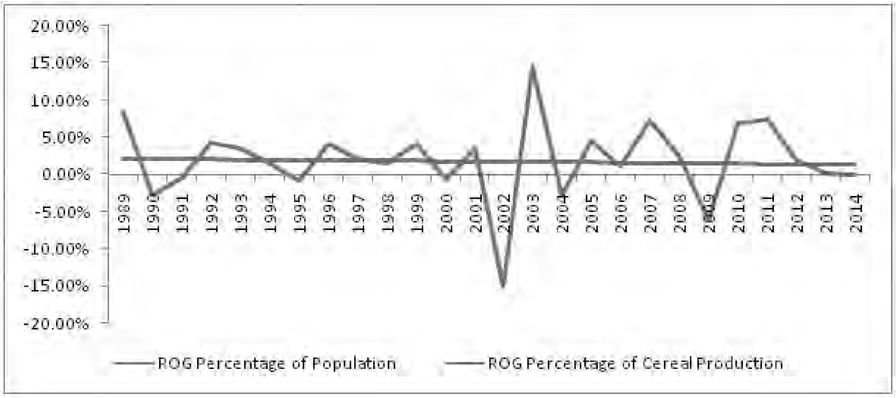
Model Specification
The model is specified as: CP = f (GHGE, ME, LCP) ..(1)

Where: CP – Cereal Production, GHGE – Greenhouse Gas Emission, ME – Methane Emission, LCP – Land under Cereal Production All variables are in their log form.

Findings and Discussion
Food Security and Population
It is known from the Classical economist, Thomas Malthus, that the Population is a force that increases in many fold and would require much more many fold of agriculture production. India has to meet up with Cereal production for the growing population. In absence of it, it not alone leads to unfavourable situation for the weaker section for their survival, but increases the overall food inflation to all strata of people. The balance of the growth of Cereal production to the growth in population avoids chaos in the nation.

It is observed that there is continuous decrease in the population growth rate of India from 1988 to 2014, but it is marginal. Government initiatives and modern lifestyle have brought down the population growth. Inflation and increase in expenditure for raising the children also have played an important role in the reduction of population growth. Though the growth rate is decreasing compared to previous years, Indian population is still increasing at a growth rate of 1.23 percent. The Food security is not smooth as like the population growth rate. It is highly volatile. It was during 2002, the nation experienced the highest fall in Cereal production during the period of study. It was due to the drought which hit one third of the country. The monsoon is vital to country's economy as agriculture is heavily dependent on rains. After a fall, it has the capacity to rise. However, it is lacking the sustainability. Inability to produce to feed the nation can raise the problems within country on various aspects.

Chart 1: Chart presenting the ROG percentage of Population and Cereal Production.



Source: Author computation on World Bank Data

Climate Change and Agriculture

Stationarity Test

Under the ADF test, the null hypothesis of non-stationarity (unit root) is rejected if the test statistic is more negative than the critical values. If a variable is found to be stationary in its raw form without any transformation, it is said to be integrated of order zero i.e. I(0), but if a variable only become stationary after taking its first difference, it is said to be integrated of order one i.e. I(1). From our result above, it can be seen that CP (Cereal Production) and LCP (Land under Cereal production) were found to be stationary in its level form and GHGE (Green House Gas Emission) and ME (Methane Emission) variables were found to be stationary only after taking their first difference. We could thus say from the above that our variables are integrated of different order, i.e. it is a mixture of I(0) and I(1) variables. This serves as a basis for determining the next tool of analysis to employ.

ARDL Bound Testing Result

In a situation where our variables are integrated of different orders, the next step in econometric analysis is to check for the presence of long run relationship among the variables. To do this, Pesaran et al (2001) proposed the Bound testing to Cointegration Approach to test the presence of long run relationship among the variables.

For the ARDL bound testing result , the decision rule of rejecting the null hypothesis of no co-integration (no long run relationship) as given by Peseran et al (2011) is, the test statistic must be greater than the upper bound. Our test statistic (6.313) which is found to be greater than the upper bound critical values at 5% (4.35) and 1% (5.61), we could thus reject our null hypothesis and conclude that our variables are co-integrated i.e. they have long run relationship. Greenhouse Gas Emission, Methane Emission and Land under Cereal production together have long run relationship with Cereal Production.

Long Run Relationship Estimation

Having confirmed the presence of co-integration i.e. long run relationship among our variables, the next step in the analysis is to estimate the long run relationship among the variables. To do this, the Ordinary Least Square is applied and the result is presented in the Table 1.

Table 1: Table showing long run and short run estimates

	Long Run Relationship Estimation Result	
Variables	Coefficients	T- Statistic
GHGE	1.2833	4.773125**
ME	-2.6524	-2.775799*
LCP	1.6073	6.409913**
C	6.2558	0.677443
F – Stat (Prob)	6587.803	
	Short Run Estimates and Error Correction Model	
Variables	Coefficients	T – Statistic
D(GHGE)	0.256	1.053
D(GHGE(-1))	-1.046	-3.929**
D(ME)	-1.037	-1.128

D(LCP)	1.941	7.715**
CointEq(-1)	-1.208	-10.024**

Source: Author's own computation, **and* denotes rejecting H0 at 1% and 5% significance respectively.

From the above, we can thus extract our long run cointegrating equation as:

Cointeq = GDP - (1.2833 * GHGE – 2.6524 * ME + 1.6073 LCP + 6.2558) ..(2)

From the result presented, Land under Cereal Production was found to have a positive effect on Cereal production at 1 percent significant level. Since our variables are in their log form, a percentage change in Land under Cereal production leads to 1.60 percent change in Cereal Production. Methane emission was found to have a negative effect on Cereal Production at a 5 percent significant level. A percentage change in Methane Emission leads to negative 2.65 percent change in Cereal production. Greenhouse gas emission was also found to have a positive effect and a percentage change in Greenhouse gas emission leads to 1.28 percent change in Cereal Production.

Short Run Dynamic Estimation and Error Correction Model (ECM)

After estimating the long run relationship among the variables, the next step in the ARDL methodology is the estimation of short run relationship and error correction term. The model was estimated based on the maximum lag of 2 using the Schwarz Information Criteria (SIC), the optima lag lengths are given in the bracket.

Table 1 above shows the short run estimates of the model as well as the Error Correction Term (ECT). The ECT is also known as the speed of adjustment, it captures the speed at which the economy converges to long run equilibrium in a period of one year (depending on the type of series used for analysis) following a shock in the economy. As a criteria, the ECT is supposed to be negative, less than one and statistically significant. From the result above, the negative and significant coefficient of ECT further buttress the presence of co-integration among the variables. The ECT coefficient is found to be -1.208 which implies that about 120 percent convergence towards long run equilibrium is completed in a period of one year.

The short run relationship between Land under Cereal Production and Cereal Production was found to be significantly positive and a percentage change in Land under Cereal production leads to a 1.941 percent change in Cereal Production. Methane emission was found to have negative relationship with Cereal Production in the short run but it was statistically insignificant. Greenhouse gas emission with lag one was found to be significantly negative at 1 percent significance level. A percentage change in the Greenhouse gas emission with lag one leads to a 1.046 percent decrease in Cereal production in the short run.

The findings prove that Land under Cereal production dominate the Food security of India positively both in short run and long run. Methane Emission affects Cereal production very badly in the long run. Greenhouse gas emission was negatively impacting Cereal production in the short run and positively in the long run.

Residual Diagnostics and Stability Test:

The study adopted the Breusch LM Serial Correlation test to check the model is free from serial correlation. To identify whether the residuals are normally distributed, the Jarque Bera Normality test was applied, while to test if residuals are homoscedastic or not, the Breusch-Godfrey Hetroskedasticity test was applied. The results suggest that the residuals are normal, homoscedastic and free from serial correlation. Another robustness check of our estimated model is the Stability Test. The study applies the Ramsey Reset Test which is a test for specification error. Under the Ramsey Reset Test, the null hypothesis of no mis-specification error is rejected as the probability value (0.4420) is greater than 0.05, we thus accept the null hypothesis and conclude that model is not mis-specified.

Conclusion

Sustainable agriculture development is essential not only to meet the food requirements but also to alleviate poverty and provide employment opportunity for increasing population. It is found the above analysis that the population growth rate is very marginally decreasing and the food production during the same period is found highly volatile. In some years, it is found a larger production and in some years it is found very lesser production which is not desirable for a growing population country like India.

Land under Cereal production is positively significant both in the long run and short run. It indicates that land under cereal production getting converted for commercial purpose should be monitored severely to stabilize the food security of the nation. The recent trend of converting agricultural land for commercial purpose is a bad sign for the food security of India. The decrease in agriculture production has been affected by climate change, more particularly the methane emission in long run. Methane's lifetime in the atmosphere is much shorter than carbon dioxide (CO2), but CH4 is more efficient at trapping radiation than CO2. The comparative impact of CH4 on climate change is more than 25 times greater than CO2 over a 100-year period. Policy measures to curtail the methane emission are the need of the hour. Greenhouse Gas though negatively impacts in the short run, it is positively impacting the Cereal production of India in the long run. The inter linkages between Greenhouse gas emission and Agriculture is a crucial factor. Transportation, Power supply and other technological up gradation are not confined to cities. They also play vital role in determining agricultural growth. Though it is believed high greenhouse gas emission is not desirable, the developing countries are in an unpleasant situation in arriving at to draw a line for their sustainable development.

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TRENDS AND VARIABILITY IN EVAPOTRANSPIRATION AT JUNAGADH, GUJARAT

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Abstract

Evapotranspiration demands and trends were analyzed for Junagadh region in western Gujarat by assessing reference evapotranspiration (ET_o), energy balance and aerodynamic components for 32 years (1984-2015). The analysis indicated multiple trends in annual ET_o and annual aerodynamic component of ET_o. During the study period, a clear decreasing trend was observed with 2002 and 2004 years having low ET_o values.The highest ETo of 1522 mm was observed in the years 1987, which was drought year. Energy balance component has shown increasing trend with the increasing in temperature and sunshine hours. The trends in 32 years average ET_o values indicated to increase in *kharif* season while the ET_o reduction in *rabi* season.

Key words: Weather parameters, Climate change, Penman-Monteith, ET_o, Gujarat

Introduction

In agriculture crop water use is determined by crop evapotranspiration. Reference, potential, and actual evapotranspiration are distinguished. The potential evapotranspiration of a given crop is defined as soil evaporation and plant transpiration under unlimited soil water supply and actual meteorological conditions. The actual evapotranspiration is the amount of water transpired from plants and evaporated from soil surface under actual meteorological conditions and under non-optimal soil, biological, management, and environmental conditions. The evapotranspiration from a reference surface is called the reference evapotranspiration

Recently, considerable interest has been shown to climate variability and its effect on the hydrological cycle and water supply (Schwartz and Randall, 2003).Evapotranspiration (ET) is an essential component of both climate and hydrological cycles, and has thirty seven significant agricultural, ecological and hydrological implications. ET uses approximately three fifths of the available annual solar radiation globally received at the Earth’s surface (Wang and Dickinson, 2012). In addition to the energy balance, ET is also a major component of the water cycle, as it accounts for approximately two thirds of the precipitation falling on land (Baumgarter and Reichel, 1975). ET is important in several atmospheric processes, as it determines the supply of water to the atmosphere from the oceans and terrestrial areas. It affects the magnitude and spatial distribution of global temperature and pressure fields (Shukla and Mintz, 1982).

Earth temperature has increased by 0.74 ^{o}C during the last century (1906 to 2005) due to increase in greenhouse gases through anthropogenic emissions with temperature may rise from 1.8-4.0 ^{o}C by the turn of 21st century resulting in an anticipated instability in food, feed and fibre production (Aggarwal, 2008). Agricultural sector is one of the vulnerable sectors influenced by the rise in temperature, rainfall variability and climate change. Climate change is likely to alter crop durations, impact pest populations, hasten mineralization in soils, increase evapotranspiration (ET) and bring in more uncertainties in crop yields. Demand for irrigation water is more sensitive to agricultural production as climatic variability increased dryness thereby creating more demand of water to fulfill crop growing period (IPCC, 2001).

In addition, change in normal pattern of temperature, precipitation and amount of rainfall also influence soil water content (Mall *et al*. 2006). ET is a major component of hydrological cycle and maximum portion of total rainfall falling on land surface is returned to the atmosphere through ET. Increase in the rate of ET along with temperature causes depletion in soil moisture retention capacity and increase salinity in semi-arid situations (Sankaranarayanan *et al*., 2010).

Chattopadhyay and Hulme (1997) analyzed evaporation time series data for different stations in India, and for the country as a whole, for different seasons on both a short-term (15 years) and long-term (32 years) basis for pan evaporation and on a short-term basis alone for potential evapotranspiration. Their analysis shows that both pan evaporation and potential evapotranspiration have decreased during recent years in India. They concluded that future warming seems likely to lead in general to increased potential evapotranspiration over India, although this increase will be unequal between regions and seasons. Evaporation demand or potential evaporation almost increases everywhere in the world in the future climate scenarios (IPCC, 2008 (Reference crop evapotranspiration (ET_o) was determined at ICRISAT, Patancheru using FAO Penman Monteith equation using data for the period 1975-2009 and analysis showed that annual reference crop evapotranspiration (ET_o) has decreased during the period. The rate of reduction in ET_o was about 10% for *kharif* and 14% for *rabi* seasons. Contribution of energy balance to the total ET has shown negative trend while positive trend was seen for aerodynamic component (Rao and Wani, 2011). In the arid region of China, a study with a dataset of 1955-2008 from 23 meteorological stations indicated that ET has shown a decreasing trend with wind speed as a most sensitive meteorological variable followed by relative humidity, temperature and solar radiation (Huo*et al*, 2013).

Materials and Methods

Junagadh is situated at 21°30 N' and 70°31'Eand altitude of about 82 m above the mean sea level. This region tropical and subtropical climate and is predominant with black soil. The climatic data were collected from the Agro meteorological Cell, Department of Agronomy, and College of Agriculture. Junagadh Agricultural University, Junagadh. The daily data on maximum temperature, minimum temperature, morning and afternoon relative humidity, rainfall, wind speed, and sunshine hours were collected for the period of 32 years (1984-2015). Normal monthly climatic parameters at Junagadh are presented in Table 1. Average annual rainfall is about 903 mm with 45 rainy days. About 91% of the annual rainfall is received during southwest monsoon season (Jun-Sep). Average relative humidity in the morning and afternoon were observed to be highest in August and rainiest month is July as it with a rainfall of 330 mm. The maximum number of rainy days is 13 & 11 in the months of July and August. The bright sunshine varies from 1.8 to 9.8 hours per day over the year with February-May experience above 9 hours of bright sunshine. July and August experience lowest, about 1 to 2 hours of sunshine due to cloud cover in monsoon season.The FAO PM method was developed by defining the reference crop as a hypothetical crop with an assumed height of 0.12 m, a surface resistance of 70 s m–1 and an albedo of 0.23. This closely approximates the evaporation expected from an extensive surface of actively growing and adequately watered green grass of uniform height (Allen et al., 1998), and is defined by the equation:

$$ET_o = \frac{0.408\Delta\left(R_n - G\right) + \gamma \frac{900}{T+273} u_2 \left(e_s - e_a\right)}{\Delta + \gamma\left(1 + 0.34u_2\right)}$$

where,

ET	=	reference evapotranspiration [mm day^{-1}]
R_n	=	net radiation at the crop surface [MJ m^{-2} day^{-1}]
G	=	soil heat flux density [MJ m^{-1} day]
T	=	mean daily air temperature at 2 in height [°C]
u_2	=	wind speed at 2 in height [m s^{-1}]
e_s	=	saturation vapour pressure [k Pa]
e_a	=	actual vapour pressure [k Pa]
e_s -e_a	=	saturation vapour pressure deficit [k Pa]
Δ	=	slope vapour pressure curve [k Pa °C^{-1}]
γ	=	psychometric constant [k Pa °C^{-1}]

Results and Discussion

The highest ET observed in the year 1987 (Fig. I). The lowest value of 1233 mm observed in the year 2004. Thomas (2000) worked on spatial and temporal characteristics of PET trend over China and reported that the wind speed, relative humidity and maximum temperature are the primary factors to be associated with evapotranspiration changes in northwest, central and north-east China. A 10% increase in temperature and actual vapor pressure coupled with 10% decrease in net solar radiation could result in a marginal decrease of total ET by 0.30 (Goyal, 2004).

The energy balance component has shown positive trend with values ranging from 1303mm (2012) to 1046 mm (1995) (Fig. 2). Similar to the total ET, aerodynamic component shown curvilinear trend with a decreasing trend up to 1988 and then by an increasing trend up to 2003 (Fig. 3). After 1988, wind velocity and rainfall observed increasing trend up to 2003 and then decreasing up to 2015. At Junagadh, energy balance contributes about 74% while aerodynamic component by 26% to the total ET. Energy and aerodynamic components were observed to be contributing 70% and 30% respectively to ET_o at ICRISAT, Patancheru (Rao and Wani. 2011).This indicated that the energy balance component was the dominating factor than aerodynamic component to ET_o.

Mean monthly ET_o, energy balance component and aerodynamic component found maximum in the month of May having maximum temperature of 38.9 ^oC with ET of 271 mm, 164 mm and 107 mm respectively. The lowest mean monthly ET_o, energy balance component and aerodynamic component observed in the month of January with ET of 52 mm, 42 mm and 10 mm respectively. At Jabalpur, the mean monthly ET_o, energy balance component and aerodynamic component found maximum in the month of May while lowest in the month of December (Reena Chakravarty *et al*., 2015).

The normal values of ET_o and its components for summer (March-May), monsoon (June-Sept.), *post monsoon* (Octo.- Nov.) and *winter*(Dec – Feb.) seasons over the last 32 years are computed and presented in Table 3. When comparing different seasons, the normal ET and aerodynamic components observed minimum in *winter* season with 57.7 mm and 11.4 mm respectively while maximum in *summer* season with 194.8 mm and 67.2 mm respectively. Summer season ET_o values observed highest while lowest in winter season among all the seasons (Rao *et al*, 2013). In normal energy balance component, maximum ET of 127.6 mm observed in *summer* season while lowest ET in *winter* season with 46.4 mm. ET observed negative trend during *monsoon* season, while positive trend during *winter* season. In *monsoon* season, reduction of ET during the study period was 4.0% while it increased by 2.5% in *winter* season. In *zaid* season, the ET_o did not show any trend (Reena *et al*., 2015). Rao and Wani (2011) analyzed ET_o at a semi-arid location of western India and observed a decreasing trend in both *kharif* and *rabi* seasons, with 10% reduction in *kharif* and 14% in *rabi* seasons.

The mean annual ET observed 109.6 mm while 80.9 mm and 28.8mm for energy balance component and aerodynamic component respectively.

Conclusion

Analyses of 32 years of daily meteorological data of Junagadh indicated that seasonal analysis has shown that ET has an increasing trend during *kharif* season. Mean annual ET_o 1334 mm with 978 mm for energy balance component and 356 mm for aerodynamic component. Mean monthly ET_o, energy balance component and aerodynamic components observed maximum in the month of May while lowest in the month of January. Crop water requirement are more during April to June as ET is observed to be highest during this period. Trend analysis provides indication on patterns in historical data of evapotranspiration. At Junagadh, energy balance contributes about 74% while aerodynamic component by 26% to the total ET.

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Table 1: Normal monthly climatic parameters at Junagadh

Month	Tmax (°C)	Tmin (°C)	RH-I (%)	RH-II (%)	Wind speed (km day^{-1})	Rainfall (mm)	Bright sunshine (h day^{-1})	Rainy Days
Jan	29.6	11.7	66.5	29.2	5.4	1.0	8.9	0
Feb	32.1	14.5	66.4	26.1	5.7	1.9	9.4	1
Mar	36.4	18.9	65.4	22.3	6.2	1.7	9.5	0
Apr	39.2	22.6	72.5	24.0	7.2	1.2	9.8	0
May	38.9	25.7	82.6	39.0	9.7	3.9	9.3	2
Jun	36.0	26.6	85.5	58.8	10.7	165.5	4.9	6
Jul	31.7	25.4	93.8	78.4	9.2	330.5	1.8	13
Aug	30.6	24.6	94.8	78.3	6.8	197.2	2.1	11
Sep	32.6	23.9	91.6	65.1	4.7	159.8	6.0	6
Oct	35.8	21.3	78.3	37.7	3.8	33.3	8.6	4
Nov	34.2	17.0	70.6	31.4	3.7	6.8	8.8	2
Dec	31.1	12.8	71.0	33.1	4.6	0.0	8.4	0

Table 2: Normal ET_o and its components on monthly, seasonal and annual basis

Month/Season	ET_o (mm)	Energy balance component (mm)	Aerodynamic component (mm)
Jan	51.9	41.9	10.0
Feb	67.3	53.6	13.8
Mar	117.1	87.4	29.6
Apr	196.5	131.5	64.9
May	270.8	163.8	107.0
Jun	170.9	110.3	60.6
Jul	96.2	78.2	18.0
Aug	62.9	54.9	8.0

Sep	80.0	70.8	9.2
Oct	98.4	85.6	12.9
Nov	68.6	56.6	12.0
Dec	53.9	43.6	10.3

Table 3 : Normal seasonal climatic parameters ,ET_o and its components

Season	climatic parameters								ET_o and its components		
	Tmax	Tmin	RH-I	RH-II	WS	RF	BSS	RD	ET_o	Energy balance	Aerodynamic component
Summer	38.2	22.4	74	28	7.7	2.3	9.5	0.7	194.8	127.6	67.2
Monsoon	32.7	25.1	91	70	7.9	213.3	3.7	9.0	102.5	78.6	24.0
Post monsoon	35.0	19.2	75	35	3.8	20.1	8.7	3.0	83.5	71.1	12.5
Winter	30.9	13.0	68	30	5.2	1.0	8.9	0.3	57.7	46.4	11.4
Annual	34.2	19.9	77	41	6.2	59.2	7.7	3.0	109.6	80.9	28.8

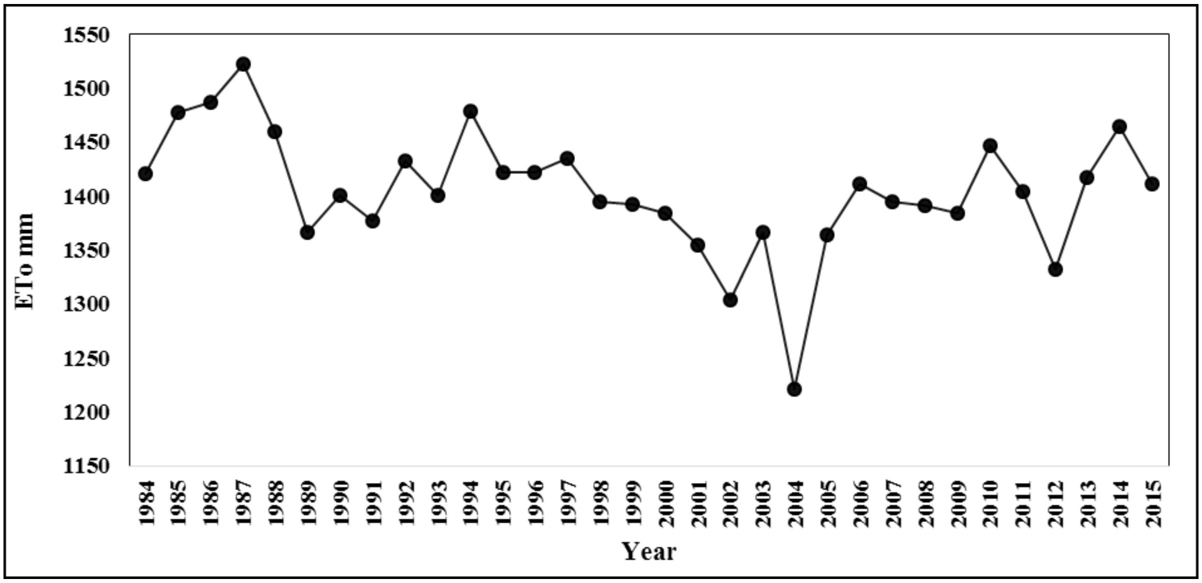

Fig.1 : Trend in reference crop evapotranspiration (ET_o) at Junagadh

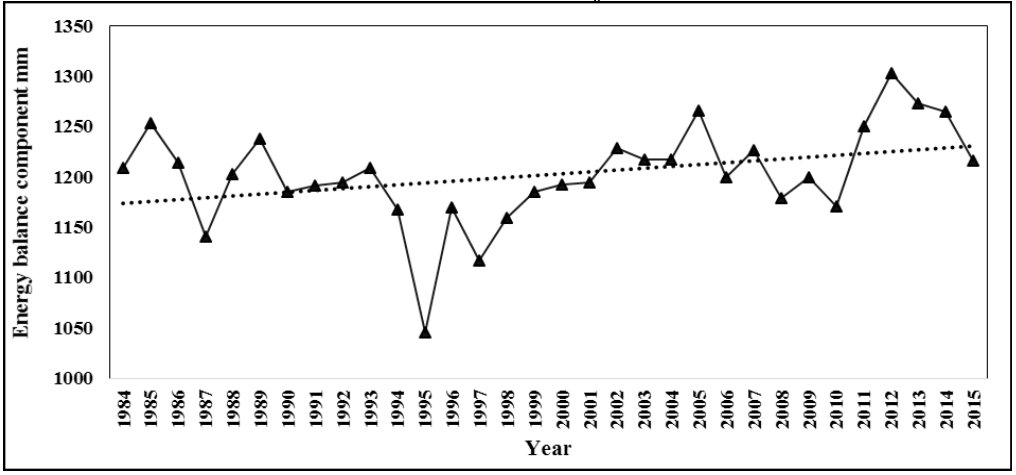

Fig. 2 : Trend in energy balance component of (ET_o) at Junagadh

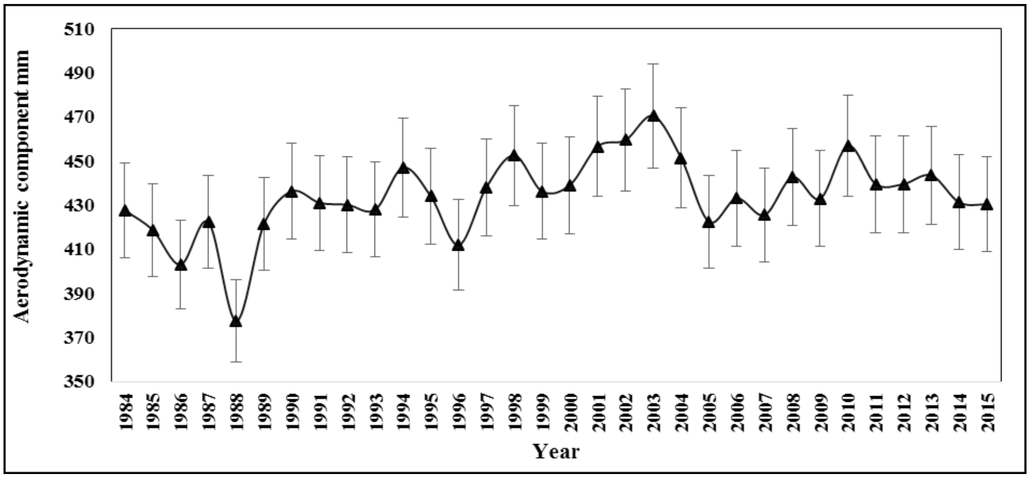

Fig. 3: Trend in aerodynamic component of (ET_o) at Junagadh

Theme 3
Resource Conservation Technology

T3 A017
CONSERVATION SYSTEM IN AGRICULTURE

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Abstract
Conservation Agriculture (CA) is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. CA is based on enhancing natural biological processes above and below the ground. Interventions such as mechanical soil tillage are reduced to an absolute minimum, and the use of external inputs such as agrochemicals and nutrients of mineral or organic origin are applied at an optimum level and in a way and quantity that does not interfere with or disrupt the biological processes. Agricultural productivity both in terms of sustainable yields and genetic resilience is being lost and the ecological services on which agriculture depends are being degraded. Regimes of protection for biodiversity throughout the agricultural landscape are needed to support the agriculture sector in general and farmers in particular. There are many opportunities to establish protective regimes that will contribute to the agriculture sector through "protect-and-connect" policies and practices. Changes in attitude and policy are needed to give practical effect to biodiversity conservation in agricultural landscapes through the practice of CA. CA is now practiced globally on about 117 M ha in all continents and all agricultural ecologies, including in the various temperate environments. Cropland under CA has been increasing 6 million hectares per annum.
Keywords: Conservation, Biodiversity, Agriculture, Productivity.

T3 A075

VISION AND CHALLENGES FOR CLASPING FACTUAL POTENTIAL OF "INTERNET OF THINGS" TOWARDS AGRICULTURAL WATER MANAGEMENT

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Abstract
The idea of 'Internet of Things' (IoT) is future panorama of Information Technology. The rationale behind its working is the blend of web, mobile and information communications technology. It indeed enables various devices in a system to communicate & interact with each other and perform their job in a harmonious way. IoT has great prospects & potential to facilitate water-saving agriculture, which ultimately deliver higher values of water use efficiencies. System engineering of water, soil, vegetation resources and their comprehensive management & utilization is solely depend upon accurate 'informatization' which indeed is a decisive link encompassing major contents like perception, processing and integrated applications. Emerging potentials, prospects, issues and inherent basic architecture of 'IoT' is traversed and discussed giving food for thought to make intensive application of this emerging concept in agricultural water management and other allied interventions. Relevant researchable issues are offered as vital food for thought to visualize a smart agriculture.
Keywords:Internet of Things, Wireless Sensor Networks, Agriculture, Water, Sensor Nodes

Introduction
The term "Internet of Things" (IoT) was first used in 1999 by British technology pioneer Kevin Ashton, to describe a system in which objects in physical world could be connected to Internet by sensors. However, in past decade, definition had been modified being more inclusive, covering wide range of applications (Figure 1). Also the meaning of 'Things' has changed with many technological evolutions. It is evident from recently emerged fact that number of interconnected devices on the planet has already overtook the actual number of people living on the planet. Certainly the next revolution will be the interconnection

between objects to create a smart operations and environment under agrarian or non-agrarian era. Only in 2012, there were about 9 billion interconnected devices and it is expected to reach 30 billion by 2020 (Statista Web Portal, 2016) offering huge revenue opportunities with spanning vertical segments such as health, automotive, utilities, consumer electronics, climate change, agriculture, natural resource management etc. The huge expansion of IT based gadgets and their concentrated built up in developing nations/regions (Figure 2) noticeably reflect the vast prospects of 'IoT' applications in agrarian catchments or even fields to accurately control and manage input resources in particular the water at various scales of time and space. Present paper is a sincere attempt to offer certain food for thought in this direction by providing a few basics of 'IoT' concept encompassing its basics, inherent architecture, logical constituents, potential of applications in water sector specifically the agricultural water domain, and some of the visionary thoughts and challenges on its true applications which in turn is expected to facilitate researchers, planners , field functionaries and policy makers for making it real on ground at finer scales.

Methodological architectural of iot

The IoT is a novel paradigm shift in IT arena, where the phrase "Internet of Things" is coined from the two words i.e. the first word is "Internet" and the second word is "Things". The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to serve billions of users worldwide. It is a network of networks that consists of millions of private, public, academic, business, and government networks, of local to global scope, that are linked by a broad array of electronic, wireless and optical networking technologies (Gubbi et al., 2013). Today most of the countries on the globe have access to internet and are linked into exchanges of data

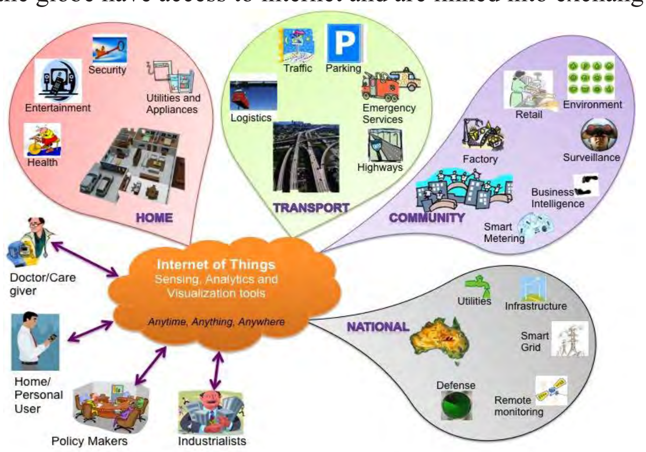

Figure 1 Schematic View for 'Internet of Things' Showing Data Based Prevailing End Users and Application Areas (Source : Gubbi et al., 2013)

news and opinions on enormous knowledge & information spheres (Vongsingthong and Smanchat,2015). According to Internet World statistics, as on 12th Aug, 2016, there was an estimated 3432809100 internet users worldwide, in contrast to mere 1.06 billion users in 2014, with initiation of 1st web site somewhere around 1991. Moreover there is a large gap among developed and developing nations. A comparison of key ICT parameters (no of telephones, mobile, active broad band, household computer, individual internet, fixed broad band subscriptions and other things related to internet per 100 person) is illustrated in Figure 2, encompassing different regions of world. It is quite evident that Asian region, in particular India & China are progressing very fast to have high rates & volumes of development in this regard.

Basics : The Internet of Things (IoT) refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems. Though there exists several definition of 'IoT', but the simpler version depicts that it is "an open & comprehensive network of intelligent objects that have the capacity to auto-organize, share information, data & resources, reacting & acting in face of situations and changes in the environment".

Architecture : One of the main problems with the IoT is that it is so vast and such a broad concept that there is no anticipated, uniform architecture. Broadly any 'IoT' based application must consist of an assortment of sensor, network, communications and computing technologies, amongst others. It incorporates certain effective communication models too, which could be (1) devise to devise communication model, (2) device to cloud communication model, (3) device to gateway model, or even (4) The back-end data sharing model.

'IoT' for agriculture

Under present age of information technology (IT), India is marching ahead making it out as a global level IT hub, owing to its quality IT tools (HR, Hardware, Software) on measurement, management, and communication capabilities) to effectively deal with all domains of science and engineering by applying concept of IoT in natural resource management in agricultural sector, and in particular the 'water' which happens to be a prime entity, offering greatest prospects 'IoT' based applications at multiple levels starting from grass roots. IoT has a large application space and is driven by a wide variety of use cases. A modular, scalable architecture that supports adding or removing capabilities depending on functional requirements will, therefore, be useful. Multilayer applications of IoT concept in agriculture may truly revolutionize the things converting agriculture into agri business.

Prevailing Scenario : Gartner, Inc. (NYSE: IT) is world's leading information technology research & advisory company, to deliver technology-related insight necessary for its clients to make right decisions, every day, and it recently forecasts that 4.9 billion connected things were in use in 2015, up 30 % from 2014, and will reach 25 billion by 2020. The IoT has become a powerful force for business transformation, and its disruptive impact will be felt across all industries/areas of society. The digital shift instigated by such Nexus of IT Forces (cloud, mobile, social and information), and boosted by IoT, threatens many existing businesses. They have no choice but to pursue IoT, like they have done with the consumerization of IT. Under this scenario, the consumer applications will drive the number of connected things, while enterprise will account for most of the revenue. Gartner estimates that 2.9 billion connected things were in use in consumer sector in 2015, reaching over 13 billion in 2020.

Potential & Prospects Towards Agricultural Water Management : A shifting and erratic climate will have far-reaching consequences on our limited water resources, in particular the lives & livelihoods of many people in developing world, more specifically tropical locations like India. Deliberations on adaptation to climate change and its variability usually focus on how people use water resources. This write up is focused towards seeking prospects of 'IoT' towards accuracy of estimations/ measurements of water problem's real shape/dimensions, which varied vastly even at shorter scales of time & space. Smart application of 'IoT' based estimations on back ground indicator like "water stress", can bridge the gap of uncertainties towards quantitative & qualitative dimensions which are presently derived either empirically or with available scattered numerical estimations published by researchers/experts from their confined domain. This is truer in case of agricultural water management, where the complexities of its use (Hade and Sengupta, 2014) illustrates plethora of short comings in this regards

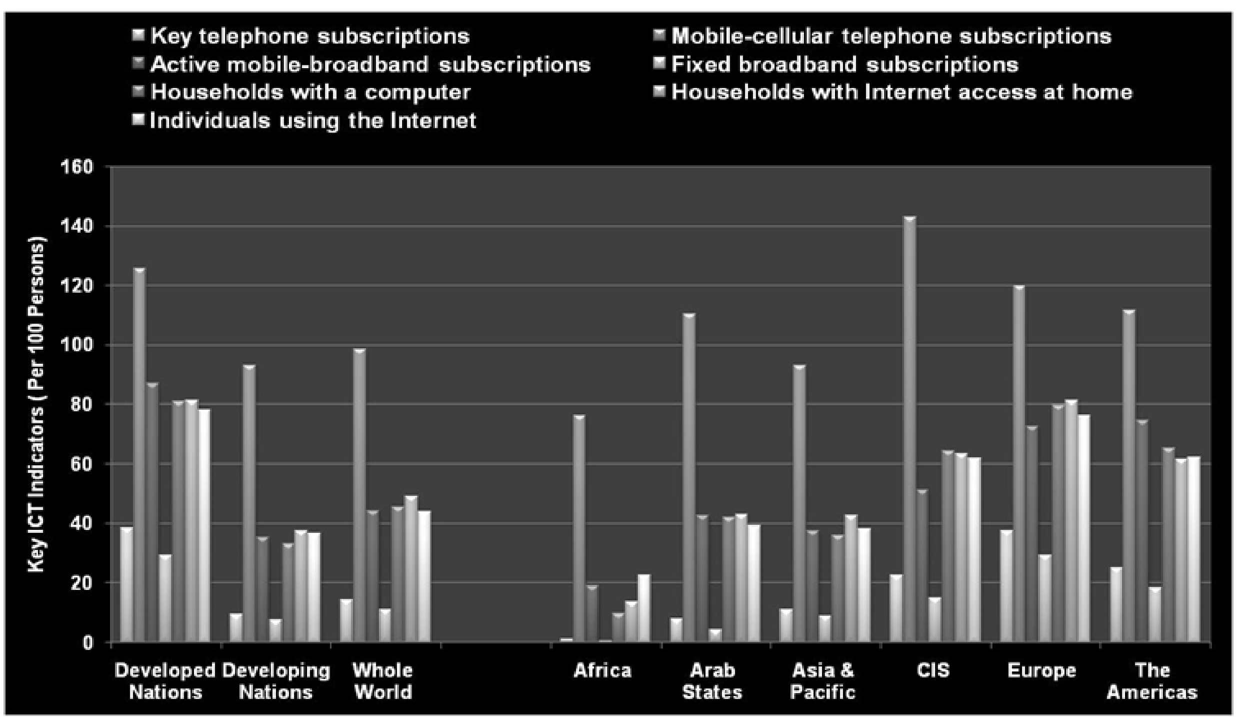

Figure 2 Variability in Existence of 7 Key ICT Indicators per 100 Person in Different Regions of World As in 2015 (Source : Statista Web Portal, 2016)

A Few Working Modules : IoT applications have recently been recognized and associated with some of the agricultural domains like smart irrigation, smart volumetric estimations of water on agrarian catchments. To achieve these enormous kind of modules too are being adopted like,

(1) Remote Monitoring using GSM, where subscriber or user sends activation command to the system via SMS, and the system use to check moisture level and if it is less than prescribed level, system will start the motor and monitoring the soil moisture and water level constantly deciding the closing of motor. IoT system sets time period depending on temperature &humidity of soil.

(2) Monitoring using fuzzy controller which consists 2 units, Wireless Sensor Network (WSN) and a monitoring center. Nodes in monitoring area collect information of soil moisture & growth information of different crops in different periods even using solar power.

(3) Monitoring using humidity sensors with low cost soil moisture sensor (Shock et al, 1999) to control water supply in water deficient areas.

(4) Monitoring in drip or sprinkler irrigation, where sensors are scattered throughout field region to sense water level in the well or water storage tank. If measured value is less than the prescribed value, then alert is given to the user. If the level of water in tank is low, then it directs the command to the nearby well. The pump is activated thereby the valve is opened and the water is pumped out to the well. Sensors in the field sensed the value of temperature and moisture in the field and based on the input value, the system decides either to open the valve or not.

(5) Water catchment and eco-system monitoring by adopting a network of sensors to monitor water flows in catchments or the areas where access is difficult or expensive. It could be utilized to provide an early warning system for flood prone regions during high floods & natural disasters.

Discussion

Futuristic Projections & Visionary Targets : It would be fair to say that we cannot predict how lives will change. We did not predict the Internet, the Web, social networking, Facebook, Twitter, millions of apps for smart phones, etc., and these have all qualitatively changed societies' lifestyle. New research problems arise due to the large scale of devices, the connection of the physical and cyber worlds, the openness of the systems of systems, and continuing problems of privacy and security. It is hoped that there is more cooperation between the research communities in order to solve the myriad of problems sooner as well as to avoid re-inventing the wheel when a particular community solves a problem. The high level IoT vision of building an ubiquitous society of people and Things, apart from the set of enabling technologies, requires an elastic, scalable architecture. With the continued increase in the proliferation of Things, there exists a large population of physical entities that are currently observable, but do not easily connect in a meaningful way to people or to each other at the envisioned scale. In this article, we attempted to disaggregate these core problems and offered a though provoking trajectory to go for a tailor made set of design paradigms and a possible architecture for a new IoT in agricultural field considering not only the water but many other input ingredients too (Lutful et al, 2013).

Salient Issues : Any new innovation brings many issues having its pros & cons, so is with 'IoT' too. Certain points are being presented below as a food for thought,

(1) Whose Data is it anyway ?. The intersection of devices, communication, data and humans within IoT are interesting incentive & business models. A key success of world wide web (www) is the ability for businesses to monetize users' data (e.g., Google Ads using user's web data pays for free search and email services). With IoT, devices are going to be even more closer to humans and blend into our environment. Transparency in data ownership, sharing, and usage is important. Further, there is scope for data brokering that encourages open data sharing by users with business in return for clear rewards, be they monetary, peer recognition, or for the greater good.

(2) When "good enough" is enough ?, as 'IoT' is naturally a diverse ecosystem with unreliability & uncertainties like, (i) cheap sensor's mean questionable data quality, (ii) humans tackling model, (iii) complexity of physical systems, (iv) distributed things & intermittent communication, and (v) data privacy which puts bounds on its availability. As a result, analytic and decision making have to be probabilistic; and the system and application has to be conscious of what is good enough.

(3) IoT has a large application space and is driven by a wide variety of use cases. A modular, scalable architecture that supports adding or removing capabilities depending on functional requirements will, therefore, be useful. Accordingly, the multilayer applications of IoT concept in agriculture may truly revolutionize the things converting agriculture into agri business.

(4) A wise and thought full integration of physical and virtual space is an important matter of concerns, as at lowest layer of any IoT , there use to be collection of sensing elements/data generators and consumers that provide context

information. This information is sensed not only from the physical space of hardware level sensors, but also from soft sensors that exist in the virtual space. Physical modules/platforms contain the interface to the physical world, but at the same time there is always a need ,rather broad scope for creating a sizeable 'virtual sensing space' too which could consist sensing entities that are released from local living beings (e.g., crowd sourced data from human/animal/birds/fishes, collaborative projects, blogs, content communities, social networking sites, virtual agrarian games, virtual rural social worlds, electronic calendars, weather forecasts, movements and crises of farmers for inputs etc) and their digital applications.

(5) Localized business canvas needs to be sketched for 'IoT' in agricultural domain in particular irrigation (Liai et al 2013) to yield successful agricultural business models.

Projected vision, potential & researchable issues

The truer applications of 'IoT' based concept has great potential in developing countries, as more and more people are coming under the umbrella of comfort & smartness. Concept of making smart people with smart things and smart systems has became the need of hour. To achieve this gigantic target, there can never be a better tool other than locally synthesized 'IoT' ensuring smart villages, smart farmer, smart agriculture and smarter use of available natural resources for values life system. Some of the key deliberations on topic of this sub section are briefly enumerated below,

(1) IoT, so far has been applied in urban domain, and amazingly, there too it is still in initiation phase, where most people often hold the view that cities and the world itself will be overlaid with sensing and actuation, many embedded in "things" creating what is referred to as a smart world. Degree of density of sensing & actuation coverage is a big issue, which in coming time going to give a significant qualitative change in how we work &live. We indeed have systems-of-systems that synergistically interact to form totally new and unpredictable services in coming time.

(2) The basic research on 'IoT' is in its initiation phase, and often relies on underlying technologies such as real-time computing, machine learning, security, privacy, signal processing, big data, and others. Much smarter vision with practical applications could be achieved by involving agricultural science, technology and engineering for wider integrations & interactions & integrations to facilitate deeper understanding of demands & supplies, specifically agricultural water sector (both on-farm/off-farm as well as catchment scale.

(3) The salient problems & future research needs to be intensified in broad areas like, (i) Effective Massive Scaling to accommodate trillions of things on the Internet, giving them a logical naming, authenticate access/maintenance/protection/utility/support at such a large scale, (ii) Architecture & Dependencies ensuring tailor made regional architectures, offering easy connectivity/control/communications/utilities/applications, and tracing their interactions by developing inclusive approach for specifying/detecting/resolving reliance across applications.

(4) Creating Knowledge and Big Data and developing techniques that convert this raw data into usable knowledge. Another main challenge is making good (control) decisions using this created knowledge ensuring number of false negatives and false positives and guarantee safety.

(5) Robustness even under noisy/faulty/non-deterministic physical realities is an emerging issue.

(6) Openness for better illustration of complexities involving effective feedback control theory and ensuring stability, overshoot, settling time and accuracy requirements at micro scale applications.

(7) Dealing security attacks is another fundamental issue seeking smart detection/diagnosis/repairs.

(8) Privacy is going to be another critical issue as inconsistencies arisen between interactions of one system with other, needing on-line consistency checking, notification and resolution schemes.

(9) As IoT applications Human in-the-loop systems offer exciting opportunities to a broad range of applications including energy management, hence it could be another researchable issue.

(10) There are overarching premises that should determine the research agenda of 'IoT' in the context of water management and security. These include: an emphasis on devices and technologies for water systems management (considering issues such as platforms, sensor networks, security, efficiency, speed, survivability and reliability of such applications and systems); a focus on wireless networks; and the use of data for decision making. Within these considerations, specific research focus areas could include: the use of open source technology; online monitoring; topic specific evaluations of enabling infrastructure; research into water resource governance systems; research into the application of traditional knowledge for water security; and using technologies for fairer water distribution in communities and between regions or even countries.

(11) If we consider the specific domain of agricultural water management the identified key issues areas for Indian context can be broadly categorized in five groups, namely (i) Improving local management of water resources, (ii) Strengthening capacity of vulnerable communities to deal with climate change-induced water stress, (iii) Creating more

effective governance mechanisms to manage scarce water resources in agrarian domain, (iv) Building partnerships, networks and stakeholder collaboration through the use of IT & ICTs, and (v) Supporting knowledge sharing, improved communications and dissemination for awareness raising and decision making among water clients. For each of these categories there could be enormous research questions, viz. What are the potential socioeconomic barriers to be addressed to implement a successful community-based monitoring water management system?" or "What targeted communications strategies are needed to improve adaptability to climate change ? "How can 'IoT' concept be used to develop & support implementation of such strategies?" What is prevailing quantification of hydrological effects of climate change & other constraints on urban & rural water demands v/s supply ? How effectively we can use 'IoT' including tools for "water prospecting, gauging, water withdrawal control, water source mapping, water service provision and water pollution tracking and control.

Conclusion

Key enabling technologies & application domains to drive IoT research in near future are discussed, with their probable applications based upon inherent potential & prospects. It is concluded that time has arrived when effective execution of IT, ICT and IoT based interventions must find their designated place in Indian agriculture which in turn, not only ensure effective demand-supply management of inputs, but also facilitates the agricultural researchers and their end clients to understand and cope up with emerging sensitive issues like that of climate change. While the concept of combining computers, sensors, and networks to monitor and control devices has been around for decades, the recent confluence of key technologies and market trends is ushering in a new reality for the "Internet of Things'', with a promise to users in a revolutionary way offering fully interconnected "smart" world with relationships between objects & their environment, objects & people and becoming more tightly intertwined. There exists vast prospects for effective application of 'IoT' on managing agricultural water both as farm as well as catchment scale. A big in depth portrait is presented by reflecting critically required researchable issues on the theme of paper and generating a food for thought to adopt & harness benefits of this amazing tool for agricultural prosperity achieving higher water use efficiencies and mitigation of adverse influences from climate change scenarios.

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T3 A084

CLIMATE CHANGE AND WATER CYCLE – AGRICULTURE, FOOD, WATER AND ENERGY: KNOW THE NEXUS

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Abstract

Our consumption of food, water and energy — directly or indirectly — impacts ecosystems and natural resources that society depends on for its survival. Recent events like droughts, oil spills and increasing food prices tell us that we can no longer view our food, water and energy systems in isolation. Instead, we all must understand how and where these three systems intersect — the nexus.

Consider:

*Energy is required to treat wastewater and transport drinking water;

*Water is required to make electricity and produce transportation fuels;

*Energy and water are required to grow food;

An increasing portion of certain crops is being used for fuel instead of food; and Water quality can be adversely impacted by food and energy production.

The use and management of one of these resources can impact the others, so it is necessary to take a nexus approach to all three. This means gaining a better understanding of how these three systems interconnect, then acting to ensure food, water and energy security and sustainability for the future. With the world facing dynamic shifts stemming from an ever-growing population, climate change and globalization, moving forward with a nexus approach is no simple task. As this research paper demonstrates, doing so will require the combined efforts of individuals, businesses and governments.

The nexus concept may seem academic at first, but the real-world implications can be dramatic. Take, for example, the record-breaking heat and drought conditions across the United States during the summer of 2012. A significant portion of corn crops withered from lack of rainfall, affecting food and livestock feed supplies and prices as well as corn ethanol production. Numerous power plants had to scale back operations or even shut down, because the water temperatures of many rivers, lakes and estuaries had increased to the point where their waters could not be used for cooling. In the Midwest, household, municipal and farm wells had to be extended deeper into rapidly depleting aquifers to make up for the lack of rainfall, draining groundwater supplies and demanding more electricity to run the pumps. When the nexus becomes unbalanced, there are clear consequences for public health, our economy and the environment. These imbalances are often expressed through habitat loss, poorer water quality and limited food, water and energy resources for humans.

Intended for advocates, community leaders and decision-makers in the United States, this research paper defines the nexus and its components. The research paper also illustrates how Americans are beginning to address its many challenges — in both positive and negative ways — and provides suggestions for filling in gaps in both our understanding and our management of the three systems. I hope that you will see the food, water and energy nexus not as an impossible riddle, but rather as a new way of thinking about the systems we depend on and how we can best manage and plan for a more sustainable future. We hope to stimulate a much broader conversation to help knock down the silo approach of isolated resource management because what we do every day affects the nexus and the nexus, in turn, affects our everyday life.

T3 A210
IMPACT OF CLIMATE CHANGE ON CROP WATER REQUIREMENT OF BANANA IN THRISSUR DISTRICT, KERALA

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Abstract
Banana crop occupies a major position in the agricultural production in Kerala State. Under the present climate change scenarios the climatic parameters are subject to variations and that in turn will affect the water requirement of the crop. A great stress on the irrigation reservoirs and projects for additional water to be released will be effected. It was attempted to generate the climate data for 2030, 2050, 2080 under IPCC emission scenarios RCP.45.The crop water requirement for Banana was calculated under the predicted climate for Thrissur district using CROPWAT model.
The minimum temperature in the district were found to increase during the future years. The maximum temperature also showed an increasing trend through the future years. The summer months January – March were found to remain as the hot months during the predicted years. The solar radiation was also found to increase. The average annual rain fall for Thrissur district was found to vary as 3139.1, 3089.8 and 3307.6 mm for the future years of 2030, 2050, 2080. The onset of south west monsoon may become early. The summer rains will continue to give a good amount of rain fall through the future years. There will be a reduction in the post monsoon rain fall and a poor distribution of rain fall over the district.
The crop evapotranspiration was found to be increasing from 104.72 mm during 2015 to 111.08 mm during 2080. When compared to the year 2050 the irrigation water demand was found to decrease during the year 2080. The crop water use efficiency was found to decrease during future years. It needs high attention in finding proper sources of irrigation in future years.
Key words: Crop water requirement, Climate change

Introduction
Climate change is real and it is regarded as the greatest challenge to future agriculture. The variation in the temperature and rainfall pattern affects the productivity of crops in Kerala. Banana occupies a major position in the agricultural production in Kerala. Banana grows well in tropical humid lowlands and is grown from the sea level to 1000 m above Mean Sea Level (MSL). It has been observed that production is reduced at altitudes beyond 1200 m from MSL. Optimum temperature for the growth of banana is 27ºC. Under the present climate change scenarios the climatic parameters are subject to variations and this in turn will affect the water requirement of the crop. It will cause a great stress on the irrigation reservoirs and projects for additional water resource allocation will be needed. The main cropping seasons of Banana in Kerala are rain fed cropping (April- May) and irrigated cropping (August- September). The variation in water availability and temperature changes in these seasons will affect the productivity of banana. A prediction of the future water needs in terms of crop water requirement of banana is needed under the projected climate change for the future years. This will help in managing the water resources in a sustainable manner and will aid in planning the schedule of operation of irrigation projects and other water distribution systems. A re-structuring of the operation system of major projects may be necessary in the event of major climate changes.

Materials and methods
This experiment was conducted in Thrissur district, Kerala (10.69 N, 75.96 E (EN); 10.19 N, 76.15 E (ES); 10.27 N, 76.87 E (WS); 10.74 N, 76.46 E (WN)). Monthly average climatic data of twenty five years (1985-2010) for the research site were used for the research. Model CROPWAT, developed by FAO was used for the analysis of the data. Using this model calculations are done for reference evapotranspiration, crop water requirements and irrigation requirements for the development of irrigation schedules under various management conditions and scheme water supply. Climate change data projected by GCM’s on daily basis is used for the present study.

Results and Discussion
Banana is indigenous to humid areas of tropical humid lowlands. It is grown under wide range of soil and water conditions. The critical factors such as soil air, soil water and temperature define the optimum condition to obtain maximum yield. The water requirement for the Banana crop generally varies from 900 mm to 1200 mm depending on the season and crop growth

conditions. It is reported that the present climate is likely to vary in future years. The likely change in the weather parameters and associated climate change will affect the crop water requirement of Banana. This study has been taken up with objective of generating the climate for 2030, 2050 and 2080. Under emission scenario, RCP 4.5 and to work at the crop water requirement of Banana under the predicted climate.

The climate of Thrissur district during the present day was analysed and the mean monthly maximum temperature of the district is 31.9°C and March is the hottest month (35.3°C). The mean monthly minimum temperature is 23.3°C and December (22.5°C) is the coldest month. Mean maximum monthly temperature of 35.3°C was observed during the month of March. The normal annual rainfall of Thrissur is 2637.1mm. The highest monthly rainfall was recorded in the month of July (577.3 mm) and the lowest was observed during the month of January (0.7 mm). During the third crop season (summer) January to April the average amount of 148.5mm rainfall will be occurring. Non availability of rainfall during the critical stages of Banana crop necessities the application of irrigation water. The average annual solar radiation was to the tune of 17.8 MJ/m2/day. Maximum available solar radiation was recorded during the month of February and the lowest was observed during the month of July. The weather parameters of temperature and radiation being higher during the third crop season, the situation demands assured irrigation to meet the evapotranspiration requirements.

The minimum temperatures are likely to increase during the future years of 2030, 2050 and 2080. Months of March, April, May and June may remain as the hot period with May as the hottest month. The minimum temperatures observed at present for the periods June to November is almost uniform but the trend is likely to vary during the predicted years of 2030, 2050 and 2080. The minimum temperatures during the summer season are found to be showing an increasing trend during the predicted years of 2030, 2050 and 2080.

The maximum temperature will show an increasing trend from present (2015) to 2080 and the month of May will become the hottest month of the year during the periods 2030, 2050 and 2080. Unlike the minimum temperature, the increase in maximum temperature is moderate. The maximum temperatures observed at present during the months of June to November remained uniform but the predicted maximum temperature during the periods is found to be varying with higher values than the present. Highest maximum temperatures during the future years was predicted as the month of May. The summer months January to March will also remain as the hot months during the predicted years. The monthly solar radiation will increase during summer months i.e., from February to May and during August, September, November and December. In general, the solar radiation showed an increasing trend. But during the rainy season there will be considerable reduction in the amount of insolation particularly during the month of June-July. It may be mainly because of increased cloudiness associated with increase in rainfall activities during that period.

The predicted average rainfall for the future years of 2030, 2050 and 2080 will increase from the present value of 2637.1mm to 3139.1, 3089.8 and 3307.6mm respectively. It is likely that the onset of south west monsoon may become early or the summer rains may continue to give a good amount of rainfall during April and May. The period November to March will continue to remain dry during the future years also. This may affect crops and possible shifts in the cropping season may also occur. The rainfall is found to increase in future years based on the predictions attempted in the study. Months of June and July will continue to receive highest amount of rainfall. The rainfall activity during the south west monsoon period will increase. It is worth to notice that the amount of rainfall after south west monsoon period will drastically reduce under climate change projections and the summers will be drier compared to present day conditions. The future climate change projections showed poor rainfall distribution and predisposes the district to frequent floods and droughts.

As per the RCP 4.5 scenario, 2080s will have the highest average annual reference crop evapotranspiration (3.37 mm a day) where as in the present day conditions it was 3.17 mm. It is clear from the table that the total annual reference crop evapotranspiration is showing an increasing trend.

The impact of climate change on crop evapotranspiration in Banana was analysed. The results showed that the crop evapotranspiration in all the three Banana growing seasons will increase as per the projected climate change scenario based on RCP 4.5. The total crop evapotranspiration was found to be increasing from 104.72 mm during 2015 to 111.08 mm during 2080.

The impact of climate change on irrigation water requirement was found to be very evident and will decrease slightly till 2050 and decreased tremendously during the predicted year 2080.

Crop water use efficiency is the yield of the crop (y) per unit of water lost through evapotranspiration of the crop (ETc) was worked out in the present study. It was seen that crop water use efficiency in the purview of climate change will decrease drastically up to 2080.

In this research work, the ability of CROPWAT model is exploited for decision making in irrigation water use in response to climate change. The model has many realistic features that can be used as a decision tool for applied research of water management. The optimal water use policies were derived for the system, with an objective function, using CROPWAT model, and simulated the optimal rules of water use for climate change scenarios. Optimal long term water allocation decisions for irrigation projects are affected by several agronomic, hydrologic, climatic and economic factors. This study provides a framework for long term water allocation decisions considering the climate change scenarios

Conclusion

Climate change has significant impact on agriculture. It was found that total crop evapotranspiration was increasing from 104.72 mm to 111.08 mm in the period 2015 to 2080 and the results shows that crop water use efficiency was going to decrease in the future years. It can be clearly observed from the study that the demand for irrigation water will increase tremendously in Thrissur District as per the climate change projections (RCP 4.5). An additional amount of about 890 billion litres of water will be required for meeting increased demand in future during the cropping season. Considering the above conditions, it can be concluded that Banana production in Thrissur district will be affected due to increased irrigation water demand.

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T3 A213

ASSESSMENT OF GROUND WATER QUALITY AND SEAWATER INTRUSION ALONG THE COASTAL AQUIFERS OF KACHCHH THROUGH IONIC RATIOS AND ISOTOPIC STUDIES

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Abstract

Salinization is one of the most worldwide environmental problems in arid and semi-arid coastal regions that deteriorate the water quality and are highly vulnerable to groundwater resources. Seawater intrusion is generally the outcome of indiscriminate and unintended groundwater withdrawal, for fulfilling the growing freshwater requirements of coastal regions because more than two third of the world’s population lives in these areas. Over-pumping of groundwater for irrigation purposes, significant industrial development, rapid urbanization and induced sea level rise as a result of global warming are posing great pressure on ground water resources. Groundwater salinization may be caused by several processes, including seawater intrusion, upcoming of brines from the deeper parts of the aquifer, flow of saline water from the adjacent aquifer, return flow from irrigation water, and leakage of wastewater. These sources can be characterized by a distinguishable ionic chemistry and isotopic ratios. The ionic ratio such as Mg2+/Ca2+, Na+/Cl–, SO42–/Cl–, K+/Cl–) and isotopiccomposition (δ 18O and δ D) in ground water help to determine the major cause of salinization whether it is from seawater intrusion or from any other activity. While, the stable isotopes 2H (D) and 18O are well known promising indicator of the water origin. With the help of isotopic data, we should find out the major causes of salinization in the area in order to sustain the coastal aquifers.

Keyword: Sea water intrusion, Salinization, Groundwater, Isotopes

T3 A223

MICRO-LEVEL LAND AND WATER MANAGEMENT PLANNING USING REMOTE SENSING AND GIS

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Abstract

The methodology adopted for this study was to map the suitability classes based on the crop edaphic suitability and crop climatic suitability using the FAO frame work Land Suitability Analysis using remote sensing and GIS. The areal statistics of the suitability classes shows that highly suitable area for cotton crop is about 83.42 percent. According to this, it can be shown that cotton is the best suitable crop for the major portion of the Amreli Taluka.

Key words: land and water management planning, land use classification, land cover, seasonal aridity index, land suitability potential index, cotton crop

Introduction

Water resources are useful or potentially useful. Uses of water include agricultural, industrial, household, recreational and environmental activities. The demand for water has increased over the years and this has led to water scarcity in many parts of the world. Therefore, there is an urgent need of land and water resources planning for agricultural development. Planning is now a widely accepted way to handle complex problems of resources allocation and decision-making. The emergence of Remote Sensing (RS) and Geographic Information System (GIS) as a powerful tool for spatial analysis and storage has in effect alleviated the problem by computerization of the spatial data. This new technology can reduce the time and cost to the planners in organizing the data in arriving at precise conclusion and decisions. For effective and efficient decision-making the prime requirement is the data on various facts. In the subsequent stages of the process, the original data are interpreted and analysed to produce information useful to those involved in the planning process. One of the main reasons underlying the growing interest in multi-criteria analysis for land use management for the planning at micro-level is the need for an integrated approach to such complex problems. The GIS based spatial data infrastructure is very important in the development of planning support systems.

Materials and Methods

The study has been under taken at Amreli Taluka of District Amreli, (Gujarat) for micro-level planning based on seasonal aridity index (SAI) for cotton growing period and integrated land suitability potential index (LSPI) using multi-criteria decision rule. The remote sensing and GIS techniques were used for integrating temporal and spatial variations and complete the work in a short duration. Satellite images of IRS P6 of sensor LISS III (DOP Jan. 31, 2009), CARTOSAT (DOP Feb. 17, 2006,) and LISS IV (DOP May 12, 2008, Feb. 24, 2009, Jan. 31, 2009 and March 30, 2009) were procured from Bhaskaracharya Institute for Space Applications and Geo-informatics, Gandhinagar and for GIS application ArcGIS V9.2 and PCI Geomatica V10.1 software was used. The IRS-P6 LISS III sensor image of 31st January, 2009 covering Amreli Taluka was classified by using maximum likelihood supervised classification technique for generating land use/Land cover map of study area. Various thematic layers like land use/land cover, waste land, irrigated land, soil salinity status, drainage, soil texture etc. were generated for land suitability analysis.

Results and Discussion

The IRS-P6 LISS III sensor image of DOP 31st Jan., 2009 was used for supervised classification. The training signatures for different land use classes were generated using False Color Composite (FCC) image. The polygons of various classes like dense agriculture, medium agriculture, poor agriculture as well as eroded and fallow lands and water body were identified on the FCC for training signature generation. . In *kharif* season a major area comes under the dense agriculture (dense cotton) is about 23493 ha, which occupies about 28.27 per cent of the study area and almost 60 per cent of the cultivated area of *kharif* season. The medium agriculture in *kharif* season is about 18484 ha, which occupies about 22.24 per cent of total area and almost 30 per cent of the cultivated area and 11825 ha area of Amreli Taluka comes under poor agriculture, which occupies about 14.23 per cent of the study area, it is almost 10 per cent of cultivated area, i.e. area comes under poor agriculture is very less. The area under fallow land is about 13974 ha, which occupies about 16.81 per cent of study area and the area under habitation/settlement is about 9980 ha, which occupies about 12.01 per cent area of Amreli Taluka. The area under waste land/eroded land is about 3931 ha. The waste land is very less which is about 4.73 per cent of study area. About 1.71 per cent of command area is under water bodies, i.e. 1425 ha area of Amreli Taluka comes under the water bodies, which belongs to the ponds or submerged area. The Error (confusion) matrix of land use/land cover classification of LISS III data covering Amreli Taluka. The Overall accuracy and overall Kappa statistics ($\hat{\kappa}$) for LU/LC classification were 83.08 per cent and 0.754 respectively indicating that LU/LC classification is very good to excellent and can be accepted for further use and analysis. The reult on soil ferti;ity status indicates that the villages the available nitrogen is medium (except village Mangvapal), the available phosphorous is low (except village Bhandariya Mota) and the available potash is high. The The rainfall data of 10 years of Amreli Taluka indicates that the monthly rainfall ranges from 100 mm to 600 mm, which is much less as compare to that of the Gujarat state. In Amreli Taluka the seasonal aridity index varies from 0.848 to 3.191. As per the classification given by De Martonne , the seasonal aridity index values < 5 comes under the arid climate class, hence, Amreli Taluka comes under arid zone. In the present study, a land suitability analysis in the Amreli Taluka has been carried out using the indicators of land suitability. The parameters considered are land use/ land cover, soil texture, soil fertility and soil salinity. Various thematic layers which have direct or indirect impact on agricultural product have been generated using remotely sensed data of IRS P6 LISS III. These thematic layers have been categorized based on their merits with respect to agriculture potential. These thematic layers have been integrated on GIS platform by giving appropriate ranking and weightages. The thematic layers like land use/land cover, waste land, irrigated area, soil salinity, soil type, slope map and soil depth were generated in GIS environment to generate land suitability units of the study area. The basic theory of FAO framework for land evaluation (1976) was adopted here to define the suitability of cotton in Amreli Taluka. For cotton crop, land unit was created from overlay process of the defined thematic layers or land qualities on which the suitability is based. The study area was divided into three land suitability classes according to the Criteria of Agro-Ecological Zones (AEZ) for Cotton Cultivation. The Various parameters/categories with their weightages were integrated to derive an overall assessment of the different alternatives for deriving crop suitability. Once the weights of all the sub-units of considered parameters were decided, the Spatial Module of ArcGIS was utilized for calculating the total rating of all the themes by multiplying the theme weightage with the unit weightage, and then adding all the final ratings pertaining to various themes. Finally, all the weighted maps were aggregated in a linear combination in ArcGIS raster calculator module to develop the cumulative maps, which were further categorized into three classes of suitability. Calculated Weights of different Classes in selection of four parameters is given in table below.

Table 1: Calculated Weights of different Classes in selection of four parameters.

Parameter	Category	Ranking	Weights
A) Soil Texture	i) Fine (Medium Black)	10	0.575
	ii) Loamy	8	0.425
B) Soil Fertility	i) Medium N	7	0.510
	ii) Low P	4	0.300
	iii) High K	3	0.190
C) Soil Alkalinity	i) Neutral	8	0.610
	ii) Slightly alkaline	6	0.235
	iii) Moderately alkaline	5	0.155
D) Land use	i) Agricultural Land	10	0.700
	ii) Waste Land/ Eroded Land	3	0.300

The overall weightages were used to generate a composite layer, which contains overall scores for all the alternatives. Alternatives with high overall scores are more suitable. The entire range of values in the composite layer is divided into three classes using equal interval classification method. The crop suitability map generated with three different suitability classes were overlaid on the registered satellite data covering study area. The resultant image with suitability classes brings out the information about how the crop is spatially distributed across the various suitability classes within the study area. The land suitability classification done for cotton crop showed that majority of the area falls under "Highly Suitable Class", because of the terrain slope condition and the soil depth characteristics. The three classes were defined as highly suitable, fairly suitable and Unsuitable are also represented by the pie diagram shown in the Fig. 4.26. It is revealed from the figure that the major area of the Taluka (83%) falls under the highly suitable class, about 15% falls under "Fairly suitable class" and only 2% falls under "Unsuitable class". Therefore, it can be recommended that the study area is highly suitable for growing cotton crop.

For the farming community, existing cropping systems and input management are influenced by the awareness of the farmers and the demand for the market due to the proximity of a city. Sudden crop diversification or a change in cropping patterns is inflexible and risky due to the socio-economic conditions of the farming community. Therefore, the present study presents the technique of micro level planning with the rigidity of the existing land use pattern and integrating the available resource information in a spatial domain to categorize land suitability in the study area. The developed integrated index for assessing agriculture land suitability in any area based on intensive field information and logical reasoning and integrating the information derived from various sources, including land use/land cover information from remote sensing data, soil characteristics and slope of the terrain will be helpful in providing a logical tool to the agricultural planners and decision makers. The methodology developed can be extended to any spatial multi-criteria decision-making and micro level planning process involving resource management.

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Theme 4
Biotechnology and Biodiversity

T4 A004
PLANKTON VARIATION IN THE COASTAL WATERS OF DHAMRA, BAY OF BENGAL (ODISHA)

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Abstract
The present study was carried out from July 2014 to November 2015 in the coastal waters of Dhamra, Bay of Bengal.Water samples were collected from 0 km to 10 km in the sea using Niskin water sampler and from various depths. Plankton samples were collected using Plankton net Water quality parameters like SST, pH, dissolved oxygen, salinity, sulphate, silicate, phosphate (orthophosphate and total phosphate), nitrite and nitrate were analysed during the study period. In addition to hydrography analysis, plankton diversity was also recorded. The Sea surface temperature value was maximum during the month of September at around 30.39°C and minimum during January 22.61°C. Whereas, pH value was maximum during January and minimum during September 9.29 and 7.82 respectively. Dissolved oxygen was maximum in September and minimum in January (7.25mg/l and 3.88mg/l). The study revealed that SST was directly proportional to Dissolved Oxygen and inversely proportional to pH. Similarily Salinity was maximum in the month of March (42.28ppt) indicating maximum evaporationand minimum during September (15.62ppt). Nutrient concentration and plankton diversity was found to be minimum during the month of March. The total phosphate concentration varied from 0.07-0.15mg/l and orthophosphate from 0.04-0.15mg/l. Nitrate and nitrite variedbetween 17.54-77.79µM/l and 1.46-5.58µM/l respectively.Phytoplanktons are producers of the water body and their community is mediated by nutrient concentration which in turn regulate Zooplankton distribution.Ceratium trichoceros were observed in large numbers with other planktons likeThalassionema nitzschioides, Coscinodiscus sp.,Ralfsia verrucosa ,Microsetella norvegica ,Ceratium fusus,Globigerana sp..

Key words : Bay of Bengal, Dhamra, Diversity, Nutrient, Physicochemical, Plankton

T4 A300
ABIOTIC STRESS MANAGEMENT THROUGH GENETIC IMPROVEMENT UNDER CHANGING CLIMATE

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Abstract
World population is expected to reach 9.2 billion people by 2050. Feeding them will require a boost in crop productivity using innovative approaches. Current agricultural production depends on many kinds of inputs in large amounts including water which are major limiting factors. In addition, the loss of genetic diversity and the threat of climate change alter paradigm in plant breeding and necessary agricultural practices. Average yields of all major crops are only a small fraction of record yields and drought and soil salinity are the main factors responsible for yield reduction. Therefore, there is a need to enhance crop productivity by improving crop adaptation. The success in the development of crops adapted to drought and high salt depends on the efficient use of available plant genetic resources. Drought, salinity and phosphorus deficiency illustrate the range of abiotic stresses that are faced by farmers in developing countries. Most crop species show considerable genetic variation in tolerance to the major climatic and chemical stresses. Genes responsible for tolerance of salinity, aluminium toxicity and phosphorus deficiency are now elucidated. Breeding for tolerance to the abiotic stresses of low nitrogen, drought, salinity and aluminium toxicity is of immense interest today. Drought will increase with climate change, the area of irrigated land that is salinized continues to increase, and the cost of inorganic N is set to rise. There is a good potential for directly breeding for adaptation to low N while retaining an ability to respond to high N conditions. Breeding for drought and salinity

tolerance has proven to be difficult due to complex mechanisms of tolerance. Marker-assisted selection for component traits of drought in rice and pearl millet and salinity tolerance in wheat has produced some positive results and the pyramiding of stable quantitative trait loci controlling component traits may provide a solution. New genomic technologies like MAS, QTL mapping, functional and structural genomics, genome editing techniques and genetic engineering by making more use of crop wild relatives (CWR), promise to make progress for breeding tolerance to these two stresses of drought and salinity through a more fundamental understanding of underlying processes and identification of the genes responsible. There is a great potential of breeding for genetic resistance against salinity and aluminium tolerance using genetic resources of wild relatives.

Introduction

Current world population is about 7.2 billion people and is projected to grow by almost 30% over the next 35 years, to reach 9.2 billion individuals by 2050 **(FAOSTAT, 2015).** FAO estimates indicate that it will be necessary to increase agricultural production by at least 60% over 2005–2007 levels to meet the expected demand for food (Alexandratos and Bruinsma, 2012). Looking back at the recent past, this goal does not seem so difficult to be achieved. Indeed, in the last 50 years, specifically between 1960 and 2009, world population became more than doubled while it was still possible to increase the amount of food per capita from 2200 Kcal/person/day to an average of more than 2800 Kcal/person/day. As sessile organisms, plants are inevitably exposed to one or a combination of stress factors every now and then throughout their growth and development. Stress responses vary considerably even in the same plant species; stress-susceptible genotypes are at one extreme and stress-tolerant ones are at the other. Elucidation of the stress responses of crop plants is of extreme relevance, considering the central role of crops in food and biofuel production in the era of extreme climatic variation predicted in this century. Crop improvement has been a traditional issue to increase yields and enhance stress tolerance; however, crop improvement against abiotic stresses has been particularly compelling, given the complex nature of these stresses. As traditional strategies for crop improvement approach their limits, the era of genomics research has shown promise with new perspectives in breeding improved varieties against abiotic stresses. Here, we review the present scenario and propose the development of crops tolerant to abiotic stresses especially drought and salt stress for addressing the challenge of dramatically increasing food production in the near future under the adverse effects of climate change.

Unraveling the molecular details of plant response and defense against abiotic stress factors such as drought, salt, and temperature extremes is a crucial and challenging issue in plant research. Functional genomics and computational biology have enhanced the pace of molecular dissection of abiotic stress response mechanisms. In the past two decades, significant progress has been made in identification of genes involved in abiotic stress responses in model plants *Arabidopsis* and rice through forward and reverse genetic analyses. Besides, QTL analysis is a powerful complementary technology with functional genomics to discover and isolate the genes of agronomic importance. The availability of complete genome sequences of important model plants, namely, *Arabidopsis* and rice, QTL databases, and mapping tools facilitates genomics-based strategies for gene discovery, coupled with high-throughput techniques for abiotic stress tolerance. Fine mapping of these QTL will help the identification of major genes and development of tightly linked molecular markers that can be employed to genetically improve crops through genetic engineering and marker-assisted selection (MAS) breeding. Identification and isolation of novel genes by genomic approaches will advance the understanding of mechanisms of high salt tolerance. Plant stress tolerance can be improved by manipulating stress-associated genes and proteins and/or over expression of stress-associated metabolites.

To meet the challenges of climate change, exploring natural diversity in the existing plant genetic resource pool as well as creation of new mutants through chemical mutagenesis and molecular biology is needed for developing climate-resilient elite genotypes. With the advancement in modern techniques such as next-generation sequencing technologies, it is now possible to generate on a whole-genome scale, genomic resources for crop species at a much faster pace with considerably less efforts and money. The genomic resources thus generated will be useful for various plant breeding applications such as marker-assisted breeding for gene introgression, mapping QTLs or identifying new or rare alleles associated with a particular trait. Various aspects of abiotic stresses under climate change, their impact on crop productivity and production, generation of genomic resources and their utilization for developing abiotic stress-tolerant crops to ensure sustainable agricultural production and food security in the backdrop of rapid climate change are discussed below.

Abiotic stresses in crops

Crop plants encounter environmental stresses in the form of both abiotic and biotic stresses. Abiotic stress has main impact on the crop productivity worldwide, reducing average yields for major crop plants. Therefore, in order to understand the stress response mechanism in plants, it is very important to identify these stresses, their consequences and plant responses to these abiotic stresses **(Table 1)**.

Table 1. Consequences of abiotic stress and plant responses

Stress	Consequences	Plant Responses
Heat stress	High temperature leads to high evaporation and water deficit. The consequent increased turnover of enzymes leads to plant death.	Efficient protein repair systems and general protein stability support survival, temperature can lead to acclimation.
Chilling and cold stress	Slow rate of biochemical reactions, slow photosynthesis; carbon dioxide fixation lags, leading to oxygen radical damage. Freezing leads to ice crystal formation that can distrupt cells membranes.	Cessation of growth in adaptable species may be overcome by changes in metabolism. Ice crystal formation can be prevented by osmolyte accumulation and synthesis of hydrophilic proteins
Drought	Inability to transport water to leaves leading to photosynthesis declining.	Leaf rolling and other morphological adaptations. Stoma closure reduces evaporative transpiration induced by ABA. Accumulation of metabolities, consequently lower internal water potential and water attracting.
Flooding and submergence	Generates anoxic or microaerobic conditions interfering with mitochondrial respiration.	Development of cavities mostly in the roots that facilitate the exchange of oxygen and ethylene between shoot and root (aerenchyma).
Heavy metal	In excess, detoxification	Excess of metal ions may be countered
High light stress	Excess light can lead to increased production of highly reactive intermediates and by-products that can potentially cause photo-oxidative damage and inhibit photosynthesis.	Exposure of a plant to light exceeding what is utilized in photochemistry leads to inactivation of photosynthetic functions and the production of reactive oxygen species (ROS). The effects of these ROS can be oxidation of lipids, proteins and enzymes necessary for the proper functioning of the chloroplast and the cell as a whole.

Plant Genes for Abiotic Stress

1. Abiotic stress-inducible genes

The complex plant response to abiotic stress involves many genes and biochemical-molecular mechanisms. The analysis of the functions of stress-inducible genes is an important tool not only to understand the molecular mechanisms of stress tolerance and the responses of higher plants, but also to improve the stress tolerance of crops by gene manipulation. Hundreds of genes are thought to be involved in abiotic stress responses (Seki, 2003., Avni Öktem *et al*., 2008).

2. Transcriptional factor genes involved in abiotic stress

Responses to abiotic stresses require the production of important metabolic proteins such as those involved in synthesis of osmoprotectants and regulatory proteins operating in signal transduction pathways, that are kinases or transcription factors (TFs). The regulation of these responses requires proteins operating in the signal transduction pathways, such as transcriptional factors, which regulate gene expression by binding to specific DNA sequences in the promoters of respective target genes.

3. Drought stress transcriptional factors

The genome controls the regulation of the response to water deficit as well as the effectiveness of the response. Microarrays, largely performed using *Arabidopsis thaliana* as model plant, have been used to catalogue many genes that are induced or repressed in response to conditions that may lead to cellular water-deficit stress (Seki *et al*., 2002). These genes can be placed in at least four different functional groups *viz.* signal transduction, transcriptional regulation, cellular metabolism and transport and protection of cellular structures. There are at least six different classes of TFs that participate in gene induction or repression in response to water deficit.

4. Gene regulation and transcriptional factors in water deficit

A recent review (Shinozaki & Yamaguchi-Shinozaki, 2007) on analysis of gene expression during drought stress response in plants showed and summarized the functions of some genes in both stress response and tolerance. Microarray analysis performed on wheat genome, showed that among 300 unique single expressed sequences tag (ESTs), the 30% of genes were significantly up-regulated and 18% were down-regulated under drought stress (Way *et al*., 2005).

5. Transcriptional factor involved in response to flooding stress

Flooding and submergence are two conditions that cannot be tolerated by most plants for periods of time longer than a few days. Reviews on gene expression analysis performed by microarray tools reported as the expression of several transcription factors, such as heat shock factors, ethylene response-binding proteins, MADS-box proteins, AP2 domain, leucine zipper, zinc finger and WRKY factors, increases in response to various regimes of oxygen deprivation in Arabidopsis and rice (Loreti *et al*., 2005., Lasanthi-Kudahettige *et al*., 2007).

6. Salinity stress

High salinity is a critical environmental factor that inimically affects large areas of cultivated land. Plant growth, physiological and metabolic processes are affected, resulting in significant reductions in global crop productivity (Magome *et al.,* 2008., Zhang *et al.,* 2009). Exposure to high levels of NaCl not only affects plant water relations but also creates ionic stress in the form of cellular accumulation of Cl^- and in particular Na^+ ions.

7. Chilling and cold stress: Gene regulation and transcriptional factor

Cold stress prevents the expression of full genetic potential of plants owing to its direct inhibition of metabolic reactions and indirectly, through cold-induced osmotic (chilling-induced inhibition of water uptake and freezing-induced cellular dehydration), oxidative and other stresses. Cold stress, which includes chilling (<20°C) and/or freezing (<0°C) temperatures, adversely affects the growth and development of plants. A large number of studies have used a transcriptional profiling approach to identify genes in Arabidopsis that respond to cold (4°C) and chilling (13°C) temperatures.

8. Heavy metal accumulation and metal stress

Uptake of excess metal ions is toxic to most plants. Phytotoxicity of heavy metals can be attributed to symplastic accumulation of heavy metals, particularly in the plasmatic compartments of the cells, such as the cytosol and chloroplast stroma (Brune *et al.,* 1995). Metal-induced changes in development are the result of either a direct and immediate impairment of metabolism (Van Assche & Clijsters, 1990) or signalling processes that initiate adaptive or toxicity responses that need to be considered as active processes of the organism (Jonak *et al.,* 2004).

9. High light stress

Light plays a critical role in regulating plant growth and development through the modulation of expression levels of light-responsive genes that regulate developmental and metabolic processes. The photoconversion of phytochromes results in their translocation from the cytoplasm into the nucleus, which is crucial for allowing them to interact with transducers in initiating downstream transcriptional cascades (Quail, 2002). The responses of plants to light with regards to seed germination, seedlings photomorphogenesis, chloroplast development and orientation, photodinesis, stem growth, pigment biosynthesis, flowering and senescence are complex (Kendrick & Kronenberg, 1994). Collectively these processes are known as photomorphogenesis.

Strategies for Abiotic Stress management through genetic improvement

Genetic gains translate to 'smart' crop varieties

Crop yields represent the net result of the intricate interactions between two main critical determinants of approximately equal contributory effects, namely, the inherent genetic constitution of the crops and agronomic management practices (Beddington *et al.,* 2011). Genetic gains, accruable from harnessing the potentials coded into the genetic blueprints of plant genetic resources for food and agriculture (PGRFA), could therefore make significant contributions to attaining this required 70% increases in food production. Instances of the dramatic effects of genetic gains on crop yields include the development and massive dissemination of high yielding and resilient cereal crop varieties around the world in the course of the aforementioned Green Revolution starting in the late 1960s.

Exploring the inherent potentials of PGRFA

Deliberate human interventions, including hybridizations and selection pressures, in the last 10,000 years have resulted in the domestication of wild ancestors into the hundreds of thousands of breeds of both plants and animals that now form the basis for food and agriculture (Waines and Ehdaie, 2007). An unintended consequence of this human intervention in the natural process of evolution and speciation has been the narrowing of the genetic base of the plants cultivated for food (Tester and Langridge, 2010). The extremely narrow genetic base of crops, as evidenced in the similarities and shared close ancestries of cultivars, imperil food security grievously as a majority of the cultivars of the world's most important food crops would be vulnerable to the same stresses.

Widening the sources of heritable variations

Scientists are aware of the shortcomings in the genetic diversity and hence, increased vulnerabilities of crops. Wild relatives of crops, land races and other non-adapted genetic materials, even if usually low yielding and harboring undesirable traits, should be used more routinely in genetic improvement as means to addressing this shortcoming (McCouch, 2004). The investments of efforts in the use of such non adapted materials in plant breeding have been quite rewarding. Instances include the use of genes located on a translocated chromosome arm of rye in the genetic improvement of wheat (Rabinovich, 1998). Gur and Zamir (2004) also demonstrated that the introduction of genes from the wild relative of tomato, the drought-tolerant green-fruited *Solanum pennelli*, increased yields by up to 50%. The legendary contribution of the reduced height gene from the Japanese wheat variety, Norin 10, to the Green Revolution is widely chronicled and certainly, other efforts have yielded significant results as well. In general, crop wild relatives (CWRs), underutilized crops, and neglected species, that are conserved *ex situ*, on-farm, and *in situ* are veritable repositories of the beneficial heritable traits lost in the course of domestication (Maxted, 2008), including those for adapting to climate change (Chavez, 2005)

Induced mutations

In situations where it is either impossible or impractical to source heritable variations from existing germplasm, the induction of allelic variations becomes an appealing option. Mutation, the heritable alteration to the genetic blueprint, has been the main driver for evolution and hence speciation and domestication of both crops and animals. Induced mutation is hence an established crop improvement strategy and is credited with the development of over 3,200 officially released elite crop varieties and ornamental plants being cultivated all over the world (http://mvgs.iaea.org/AboutMutantVarieties.aspx). The induction of mutation is a chance event, so scientists traditionally enhance their chances of success at inducing useful mutation events by generating massive numbers of putative mutants that are then subsequently screened. Biotechnology applications are now being used to enhance the efficiency levels for producing and evaluating large populations. For instance, the high throughput reverse genetics technique, TILLING (Targeted Induced Local Lesions IN Genomes) (Greene, 2003) permits the efficient screening of large populations of plants for specific mutation events (Caldwell, 2004).

MAS against abiotic (physical and chemical) stresses

Abiotic or physical and chemical stresses such as drought, salinity or submergence are major challenges for sustainable food production. Ongoing global climate change will further increase these challenges, making crops with abiotic stress tolerance a key for the future. MAS is seen as having potential to facilitate the development of crops tolerant to abiotic stresses. However, while the number of markers for abiotic stress tolerance genes has increased in recent years, so far only a few of them have been applied successfully in public breeding programmes. Nevertheless, recent releases of water submergence, drought and salt tolerant rice varieties confirm the potential of MAS. Furthermore, progresses in using MAS for breeding drought tolerance in maize, chickpea and sorghum, salt tolerance in durum wheat or aluminium tolerance in barley, illustrate that the number of success stories will grow in future.

Transgenic approaches for abiotic stress tolerance in plants

Abiotic stresses including drought are serious threats to the sustainability of crop yields accounting for more crop productivity losses than any other factor in rainfed agriculture. Success in breeding for better adapted varieties to abiotic stresses depend upon the concerted efforts by various research domains including plant and cell physiology, molecular biology, genetics and breeding. Use of modern molecular biology tools for elucidating the control mechanisms of abiotic stress tolerance and for engineering stress tolerant crops is based on the expression of specific stress-related genes. Hence, genetic engineering for developing stress tolerant plants, based on the introgression of genes that are known to be involved in stress response and putative tolerance, might prove to be a faster track towards improving crop varieties. Far beyond the initial attempts to insert "single-action" genes, engineering of the regulatory machinery involving transcription factors has emerged as a new tool now for controlling the expression of many stress-responsive genes. Nevertheless, the task of generating transgenic cultivars is not only limited to the success in the transformation process, but also proper incorporation of the stress tolerance.

Novel plant-breeding techniques

The incredible advances in biotechnology demonstrably hold great promise for crop improvement (Moose, 2008). For instance, molecular breeding, the integration of molecular biology techniques in plant breeding (Stam, 2003), through enhanced efficiencies, has great potentials for changing permanently the science and art of plant breeding. Molecular breeding encompasses both the use of distinguishing molecular profiles to select breeding materials and the applications of recombinant deoxyribonucleic acid (DNA) methods, that is genetic transformation, to add value to PGRFA. There are also a number of other emerging molecular biology-based techniques that hold promise for enhancing the efficiency levels of plant breeding activities. We provide some overview of the use of these technologies and techniques in developing novel crop varieties.

Advances in molecular biology, including the ever cheaper sequencing of whole genomes, have resulted in the availability of significant amounts of information on and hence tools for assaying, the totality of an individual's genetic make-up, that is the genome; this is known as genomics. The related proteomics (the study of proteins) and metabolomics (the study of metabolites), made possible by an ever growing volume of publicly accessible DNA, gene and protein sequence information, are also novel ways for investigating the heredity of traits. Equally significant, advances in bioinformatics and computational molecular biology which are facilitated greatly by the novel sophisticated and powerful information technology platforms for storing and analyzing the huge volumes of data generated through these molecular biology strategies, permit the making of valid inferences in the molecular characterization of germplasm, assessments of genetic diversity and for the selections of breeding materials.

Emerging biotechnology techniques of relevance to plant breeding for abiotic stresses

The integration of biotechnologies into crop improvement is a very dynamic field of endeavor that is changing continually. A snapshot of the status of emerging technologies is provided by Lusser *et al.* (2012) in response to a request by the European Commission 'to provide information on the state of adoption and possible economic impact of new plant breeding techniques'. Eight new such techniques have been identified and the new varieties ensuing from these techniques might be released within 3 years. These new techniques are Zinc finger nuclease (ZFN), Oligonucleotide directed mutagenesis (ODM), Cisgenesis and intragenesis, RNA-dependent DNA methylation (RdDM), Grafting (on GM rootstock), Reverse breeding, Agro-infiltration and Synthetic genomics. Lusser *et al.* (2012) concluded that ODM, cisgenesis/ intragenesis and agro-infiltration were the most commonly used techniques with the crops developed using them having reached the commercial development phase. On the other hand, the ZFN technology, RdDM, grafting on GM rootstocks and reverse breeding were the less used techniques in breeding.

High throughput phenotypic evaluations

The selections of few promising individuals out of large populations of segregating materials can be a very daunting task. Phenomics, the study of phenomes - the sum total of an individual's phenotype is the term that describes the novel high throughput measurements of the physical and chemical attributes of an organism. High throughput imaging of parts of a living plant, for example roots and leaves, using thermal infra-red, near infra-red, fluorescence, and even magnetic resonance imaging permit non-destructive physiological, morphological, and biochemical assays as means for dissecting complex traits such as drought and salinity tolerances into their component traits (http://www.plantphenomics.org.au/).

Conclusion

The abiotic stresses are natural processes arising from atmosphere, soil and water related phenomena resulting in loss of about 50% of world's agricultural productivity. Abiotic stresses such as drought, salinity, water logging, extreme temperatures and heavy metals pose serious constraint to plant growth and development leading to yield reduction by more than 50% for major crop plants (Bray *et al.,* 2000). In the context of global warming and climate change, further productivity loss due to escalating adverse effects of abiotic stresses could be any body's guess. In the world, only 9% of the area is conducive for crop production, while 91% is under stress. This includes 25% under drought, 22% has got shallow depth, 22% is under mineral stress, 14% is under freezing stress and 11% is water logged. Added pressure is that global population is likely to reach 7 billion by 2025 and 10 billion by 2050. The area under stress is likely to increase further due to land degradation and urbanization. Thus agricultural production has to be increased from these lands that are under stress. In India, 67% of the areas is rainfed and crops in these areas invariably experience droughts of different magnitudes. Although, 33% of the cropped area in the country is under irrigation, crop production is constrained by environmental stresses. Focusing the importance of abiotic stresses in crop plants and to update the recent research activities in this area, this paper is concluded with a consideration of more emphasize to be given on following points as follows.

- The 21st century plant breeding must be re-oriented to generate 'smart' crop. Scientific and technological tools ought to be the staple of all breeding programs.
- Plant breeding using conventional and new techniques to improve yields, increased water, nutrient and other input use efficiencies' must be adopted.
- Conventional Plant breeding approaches for abiotic stresses should be reoriented by making more use of Marker assisted breeding and *In vitro* approaches for development of abiotic stress tolerant varieties.
- The use of transgenes to improve the tolerance of crops to abiotic stresses remains an attractive option.
- Options targeting multiple gene regulation appear better than targeting single genes.
- An important issue to address is how the tolerance to specific abiotic stress is assessed, and whether the achieved tolerance compares to existing tolerance. The biological cost of production of different metabolites to cope with stress and their effect on yield should be properly evaluated.
- A well-focused approach combining the molecular, physiological and metabolic aspects of abiotic stress tolerance is required for bridging the knowledge gaps between short- and long-term effects of the genes and their products, and

between the molecular or cellular expression of the genes and the whole plant phenotype under stress.

- Thorough understanding of the underlying physiological processes in response to different abiotic stresses can efficiently/successfully drive the choice of a given promoter or transcription factor to be used for transformation

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T4 A013

WATER-LABOR-ENERGY SAVING, RESOURCE-EFFICIENT, MECHANIZED, CLIMATE SMART RICE

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Innovation of improved coping strategies, superior technologies, instrumentation, and climate smart ideotype in rice-based production system is the key to model the impacts of aggravating climate extremes/variability on national and international food security. The problem of water scarcity is increasing day by day. Water requirement for rice is two-three times that of other cereals such as wheat. Transplanted puddled system of rice cultivation is water and labor demanding and also a major methane emitter, contributing 10–20% of total global annual methane emissions. Puddling adversely affects the performance of succeeding non-rice crops in the world's major crop rotations (rice-wheat and rice-maize) grown on millions of hectares. With the predicted water and labor shortages in agriculture, the required increase in rice production to feed the increasing population must be achieved with less water, less labor, less land, with highly productive, highly profitable, sustainable climate smart, resource efficient, and long term reliable cultivation system. Farmers are struggling with conventional rice cultivation system in present scenario. So far no variety has been developed that possesses traits specifically needed to produce stable high yield and flexibility to be grown under variable situations ranging from dry and wet direct seeded to transplanted situations. Development of stable yield ecofriendly genotypes across environments will be increasingly desirable for rice farmers in the face of climate change-related variability. Modernization employing mechanistic understanding, new traits,

donors, genes and genomic techniques from research platform will contribute to future transformation of existing puddled transplanted system of rice (PTR) cultivation.

Aerobic rice and Alternate wetting and drying are one of technologies with 30-40% and 15-20% water saving, respectively. IRRI has developed a series of tropical-adapted aerobic rice lines with a yield potential ranging from 4.7 to 7.5 t ha^{-1} and AWD rice lines with a yield potential ranging from 5.6 to 8.3 t ha^{-1} with yield advantage of 0.8-1.2 t/ha and 1.0-1.5 t/ha over the presently cultivated rice varieties under aerobic and AWD conditions, respectively. These breeding lines have been shared with the national partners for further evaluation in different countries. During 2011-15, new varieties suitable for dry direct seeded situation have been released in India (CR dhan 200, CR dhan 201, CR dhan 202, CR dhan 203, CR dhan 205), Nepal (Tarahara 1, Hardinath 2) and Bangladesh (BRRI dhan 56, BRRI dhan 66) through the joint efforts of IRRI and national partners. A large scale seed multiplication program as well as demonstrations undertaken together with national systems and NGOs in an attempt to disseminate these water saving varieties and technologies with the associated mechanization and management practices to farmers to convince them to adopt new technologies through knowledge sharing, conducting farmer's field trials, effective media program, trainings, and extension manuals is in progress.

IRRI has been actively involved in conventional breeding program involving multiple donors (having DSR adaptability traits) to open the window of increase in productivity under direct seeded conditions. Grain yield advantage of lines from complex mapping populations over lines from bi-parental cross under DSR conditions has been observed. QTLs and donors for seedling stage establishment traits, grain yield under direct seeded conditions, root traits related to nutrient uptake, root phenotypic plasticity (adaptability of rice genotypes to variable growing conditions) has been identified at IRRI (Sandhu et al. 2013, Sandhu et al. 2015, Sandhu et al. 2016). Efforts are continued with the marker assisted breeding program involving traits leading better adaptation to dry direct seeded situation such as anaerobic germination, early uniform emergence, early vegetative vigor, number of nodal root, lateral roots and root hair density, lodging resistance to develop better rice varieties combining high yield potential and resistance to insects/diseases. Successful introgression of these traits can provide a unique opportunity to breeders/molecular biologist/physiologist to combine and study the interaction of these traits/QTLs/genes efficiently in research aimed at increasing the yield and adaptability of rainfed rice to direct-seeded conditions. Such trait complementarities may result in improved performance beyond the sum of that conferred by the individual traits. Development of full complete package of water-labor-energy saving, resource-efficient, mechanized, sustainable, new generation climate smart rice varieties is the urgent need of nearby future and could be a significant benefit to farmers in regions with unstable rainfall and struggling with water, labor and resources issues and contribute to reduce global warming.

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T4 A041

ECOFRIENDLY MANAGEMENT OF DRY ROT OF POTATO INCITED BY *FUSARIUM SOLANI*(MART.) SACC.

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Abstract

Among the phytoextracts and bioagents screened against potato dry rot pathogen, *Nerium indicum* and *Trichoderma asperellum* found significantly superior in inhibiting the mycelial growth of *F. solani* as well as most effective in managing dry rot disease..

Key words: *Fusarium solani, phytoextracts, antagonists, Nerium indicum, Trichoderma spp.*

Introduction:

Fusarium dry rot incited by (*Fusarium solani* (Mart.) Sacc.) is an important post harvest disease which affects tubers in storage as well as seed tuber pieces in the field (Choiseul *et al*., 2006). Bhardwaj (2012) reported 25 to 60 per cent yield loss in India due to dry rot.

Use of fungicides on post harvest tubers is not desirable from health point of view, also continuous and indiscriminate use has led to the development of fungicide resistant strains of the pathogens. It also reduces the export quality due to high residues. Attempts were made to explore the possibility of ecofriendly management strategies namely natural products and antagonists for the management of fusarium dry rot of potato.

Material and Methods:

Natural products

In vitro

Efficacy of phytoextracts having medicinal value were tested (10%) *in vitro* by Poisoned Food Technique against potato dry rot pathogen (Nene and Thapliyal, 1979).The per cent growth inhibition (PGI) of the pathogen in each treatment was calculated by the method suggested by Asalmol *et al.* (1990).

In vivo

The phytoextracts studied *in vitro* were tested (10%) pre and post-inoculation methods.

Antagonists

In vitro

Antagonistic effect of different bioagents *i.e. Trichoderma viride, T. harzianum, T. virens, T. asperellum, Pseudomonas fluorescens* and *Bacillus subtilis* were tested by dual culture technique for their antagonism against potato dry rot pathogen (Dennis and Webster, 1971).

In vivo

The antagonists were also screened to test their efficacy *in vivo*.

Results and Discussion

Natural Products

In vitro

All the phytoextracts screened, were found significantly superior in inhibiting the mycelial growth of *F. solani* over control (Table 1.). On 8th day after inoculation Red Kaner found significantly superior in inhibiting the mycelial growth showing 89.34 per cent mycelial growth inhibition followed by garlic (87.21%).

The results of present study are in agreement with the results obtained by Adedokun and Ataga (2007). They reported the extracts of *A. sativum* inhibited the mycelial growth of *F. solani* infecting the sweet potato tubers by 42.07 per cent as compared with control.

In vivo

Pre- inoculation

Significantly lowest Fusarium dry rot severity was noticed in tubers treated with Red Kaner (0.60%) and it was at par with garlic clove extract (1.13%) at 8th day after inoculation.

Post- inoculation

Trand similar to that observed in pre-inoculation was noted in post-inoculation.

Antagonists

In vitro

On 8th day after inoculation *T. asperellum* found significantly superior in inhibiting the mycelial growth (93.99%) followed by *P. fluorescens* (72.01%). The results of present study are in agreement with the results obtained by Abeysinghe (2007

In vivo

Pre-inoculation : *Trichoderma asperellum* was found significantly superior in reducing the Fusarium dry rot severity in pre-(13.40%) and in post-inoculation (5.60%) (Table 2).

Post- inoculation : Trand similar to that observed in pre-inoculation was noted in post-inoculation.

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Table 1: Bio-efficacy of natural products against *Fusarium solani in vitro* and *in vivo*

Sr. No.	Botanical name	Common name	8th day		8th day	
			Radial growth (mm)	Percent growth inhibition (PGI)*	Pre-Inoculation	Post-Inoculation
1.	*Nerium indicum* Mill.	Red Kaner	3.33	89.34	0.60	1.43
2.	*Allium sativum*L.	Garlic	4.00	87.21	1.13	2.06
3.	*Curcuma longa* L.	Turmeric	8.33	73.38	3.96	4.43
4.	*Nicotianatabacum*L.	Tobacco	10.33	67.13	4.20	5.70
5.	*Ocimum sanctum* L.	Tulsi	10.00	67.97	4.86	6.40
6.	*Adhatodavasica*Nees.	Ardusi	15.33	51.04	---	---
7.	*Aegle marmelos*L.	BaelPattra	16.00	48.76	---	---
8.	*Azadirachta indica* A. Juss.	Neem	13.67	56.46	---	---
9.	*Lantana camera* L.	Ghaneri	12.67	59.52	---	---
10.	*Melia azadirach*L.	Maha neem	12.00	61.68	---	---
11	*Annona reticulate* L.	Custard apple	11.00	64.94	---	---
12.	Control	---	31.33	0.00	53.83	53.83
	S.Em.±		**0.06**	**1.73**	**0.52**	**0.55**
	C.D. at 5%		**0.18**	**5.04**	**1.59**	**1.69**
	C.V. (%)		**8.55**	**4.93**	**7.83**	**7.73**

Table 2: Effect of antagonists on per cent growth inhibition of *Fusarium solani in vitro* and *in vivo*

Sr. No.	Antagonist	8th day		8th day	
		Mycelial growth (mm)	Percent growth inhibition (PGI)	Pre-Inoculation	Post-Inoculation
1	*Trichoderma viride*	10.67	68.00	7.30	11.10
2	*Trichoderma harzianum*	10.67	68.00	5.60	12.83
3	*Trichoderma virens*	12.33	62.91	11.55	13.76
4	*Trichoderma asperellum*	2.00	93.99	3.40	5.60
5	*Pseudomonas fluorescens*	9.33	72.01	13.83	14.76
6	*Bacillus subtilis*	12.67	61.99	16.43	16.46
7	Control	33.33	----	57.20	56.90

	S.Em.±	0.54	1.20	0.58	0.25
	C.D. at 5%	1.62	3.65	1.74	0.75
	C.V. (%)	7.12	3.74	6.04	2.27

T4 A158

EVALUATION OF RICE GENOTYPES FOR HIGH TEMPERATURE TOLERANCE IN NORTHERN PART OF KARNATAKA

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Abstract

Rice has been cultivated under a wide range of climatic conditions. However, the rice crop during the flowering and early grain-filling stages is currently exposed to temperatures higher than the critical threshold of 33°C in Asia and it has been reported that the rice yields are estimated to be reduced by 41% due to high temperature. With climate change, breeding for heat tolerance is one of the key research areas that may address problems related to temperature increase. As a part of development of rice varieties for high temperature tolerance an investigation was carried out to screen the fifty rice accessions received from the IRRI, India office, ICRISAT Hyderabad for heat tolerance during *summer* 2015 with two plantings i.e. normal and late at Agriculture Research Station, Gangavathi, University of Agricultural Sciences, Raichur following RBD in two replications with five checks viz., GGV-05-01, IR-64, MTU 1010, N-22 and ES-18. Among the fifty accessions screened for heat tolerance under late sowing, the accession EC792215 (83days) was the earliest followed by the accessions EC792183 and EC792226 (86days). Significantly highest thousand grain weight was recorded in the accession EC792257 (26.50g) under normal sown condition followed by the accessions EC792200 and EC792286 (25.50g), while the accessions EC792235, EC792226, EC792237 and EC792286 (22g) recorded significantly highest thousand grain weight when screened under late sowing condition followed by the accessions EC792216 and EC792186 (21.50g). Significantly minimum per cent of chaffyness (0.45%) was recorded in the accession EC792187 under normal sowing condition, followed by the accessions EC792199 (0.55%) and EC792179 (0.65%), whereas the accession EC792187 recorded significantly minimum per cent of chaffyness (1.85%) under late sowing condition followed by the accessions EC792199 (1.99%) and EC792215 (2.14%). Among accessions screened under normal sowing, the accession EC792239 recorded significantly highest grain yield per hectare (6347 kg/ha) followed by EC792285 (6017 kg/ha), EC792185 (5523 kg/ha) as against best check MTU-1010 (3560 kg/ha), while the accession EC792239 recorded significantly highest grain yield per hectare (6012kg/ha) when screened under late sown condition followed by EC792285 5709(kg/ha) and EC792185 (5256kg/ha) as against the best check MTU-1010 (2903kg/ha). Significantly minimum heat succeptibity index (0.41) was recorded in the accession EC792240 followed by the accessions EC792179 (0.43), EC792185 (0.44), EC792316 (0.47), EC792285 (0.47) and EC792239 (0.48) as against the best check MTU-1010 (1.69). Among the fifty five accessions screened for heart tolerance, 6 accessions were highly tolerant to heat, 14 accessions were moderately tolerant to heat and 35 accessions were susceptible to heat. The heat tolerant genotypes will be further confirmed by evaluating in multi locations under summer season and will be used as donors for heat tolerance in further breeding programme.

Key words: Key words: High temperature, heat tolerance, rice etc.

Introduction

Global warming caused by greenhouse gases has a huge effect on sustaining agricultural development. Since the early 20th century, the earth's mean surface temperature has increased by 0.8°C, with about 0.6°C of this hike occurring since 1980 (Jansen *et.al* 2007). Global mean surface temperatures for 2081–2100, relative to 1986–2005, is likely to increase by 0.3°C to 1.7°C for the lowest and by 2.6°C to 4.8°C for the highest greenhouse gas emission scenarios (IPCC). This temperature change will not be regionally uniform (Collins *et.al* 2013). These drastic changes in temperature in recent years have caused more frequent occurrence of extreme-weather events such as heat waves and drought, with serious consequences on rice yield. Rice yield losses due to high temperature have been reported in many tropical and subtropical countries, such as in Pakistan, India, Bangladesh, China, Thailand, Japan, Australia and the U.S. (Osada *et.al* 2011) (Hasegawa *et.al* 2009). Significant yield losses have also been predicted by using different crop models. Short term predictions indicated that, by 2030, rice production in South Asia could decrease by up to 10% (Lobell *et.al* 2008). Medium to long term predictions, i.e. by 2080, estimated rice yields in developing countries to decrease by 10% to 25%, on average, while yields in India could drop by 30% to 40% (Cline 2008). By 2100, rice and maize yields in the tropics are expected to decrease by 20–40% because of higher temperatures without accounting for the decrease in yields as a result of drought enhanced by temperature increases (Battisti *et.al* 2009). Spatial model simulation indicated that on average, rice yields could be reduced by up to 33% by 2081–2100 (Karim *et.al* 2012). As the global temperature continuously rises, incorporation of heat tolerance in new rice varieties is therefore, becoming more and more important in rice breeding programs. Hence in the present investigation, as the part of development of rice varieties for high temperature tolerance, fifty rice accessions were screened for heat tolerance during summer season.

Materials and Methods

The experiment was carried out to screen the fifty rice accessions received from the IRRI, India office, ICRISAT Hyderabad for heat tolerance during *summer* 2015 with two plantings i.e. normal and late at Agriculture Research Station, Gangavathi, University of Agricultural Sciences, Raichur following RBD in two replications with five checks viz., GGV-05-01, IR-64, MTU 1010, N-22 and ES-18. Nursery sowing was taken up on 10.12.2014 and transplanted on 10.01.2015 for normal planting while in late planting, sowing was taken up on 20.01.2015 and transplanted on 20.02.2015 in 4 rows of three meters length with a row spacing of 20cm between rows and 15cm between plants. Agronomic practices were followed as per the recommendations. The flowering stage of the crop was coincided with hottest month (April & May), recorded weather data of the testing location. The mean data was statistically analysed by adopting the appropriate methods outlined by Panse and Sukhatme (1978) and Sundarajan *et al.* (1972). The critical differences were calculated at five per cent level of probability, wherever 'F' test was significant.

Heat Susceptibility Index (HSI) was used to measure stress tolerance in terms of minimizing the reduction in yield caused by unfavorable versus favorable environments. HSI was calculated for each genotype according to the formula of Fisher and Maurer (1978):

HSI= $(1-Y/Y_p)/(1-X/X_p)$

Y= mean grain yield of a genotype under a stressed environment;

Yp= mean yield of the same genotype under a stress-free environment;

X= mean Y of all genotypes;

Xp= mean Yp of all genotypes.

In this experiment, stress implies high temperature. If HSI is < 0.5, then the genotype is highly stress tolerant, if HSI > 0.5 < 1.0, it is moderately stress tolerant, and if HSI > 1.0, it is susceptible to stress.

Results and Discussion

Among the fifty accessions screened for heat tolerance under late sowing, the accession EC792215 (83days) was the earliest to days to 50 per cent flowering followed by the accessions EC792183 and EC792226 (86days) while the accession EC792215 (83.00 days) was the earliest to days to 50 percent flowering when screened under late sowing condition followed by the accessions EC792183 and EC792226 (86.00 days). Plant height was significantly highest (106.50cm) in the accession EC792326 under normal sown condition followed by the IR-64 (102.80cm) and accession EC792310 (101.50cm) which were on par with each other whereas the accession N-22 recorded significantly tallest plant height (97.20cm) under late sowing condition followed by the accessions EC792257 (94.60cm) and EC792267 (93.20cm).

Significantly maximum panicle length (26.20cm) was recorded in the accession EC792240 under normal sowing condition, followed by the accessions EC792257 and EC792206 (26.00cm), whereas the accession EC792316 recorded significantly maximum panicle length (23.80cm) under late sowing condition followed by the accessions EC792240 and EC792236 (23.60cm). Among accessions screened under normal sowing, the accessions EC792195 and EC792234 recorded significantly maximum total number of tillers (20.10) followed by EC792203 and EC792178 (19.40), while the accession EC792195 recorded significantly maximum total number of tillers (18.30) when screened under late sown condition followed by the accessions EC792234 (17.80) and EC792203 (17.50).

Average weight of five panicles was significantly maximum (35.10g) in the accession EC792284 under normal sown condition followed by the accessions EC792286 (27.20g) and EC792237 (26.10g) which were on par with each other whereas the accession EC792284 recorded significantly maximum average weight of five panicles (33.20g) under late sowing condition followed by the accessions EC792286 (25.40g), EC792237 and EC792310 (23.80g). Significantly highest thousand grain weight was recorded in the accession EC792257 (26.50g) under normal sown condition followed by the accessions EC792200 and EC792286 (25.50g) while the accessions EC792235, EC792226, EC792237 and EC792286 (22g) recorded significantly highest thousand grain weight when screened under late sowing condition followed by the accessions EC792216 and EC792186 (21.50g).

Significantly minimum per cent of chaffyness (0.45%) was recorded in the accession EC792187 under normal sowing condition, followed by the accessions EC792199 (0.55%) and EC792179 (0.65%), whereas the accession EC792187 recorded significantly minimum per cent of chaffyness (1.85%) under late sowing condition followed by the accessions EC792199 (1.99%) and EC792215 (2.14%). Popular varieties in Asia, particularly in the India, have high yields, good grain quality, and resistance to pests and diseases. However, they lack heat tolerance. Due to the advent of climate change caused by global warming, breeding for heat-tolerant varieties has become important. New rice varieties should possess adaptability to rising temperatures in addition to the desirable traits that a variety should have. The breeding populations created through a regional collaboration project need to adapt to increasing temperatures in specific locations.

Genetic variability in any crop is pre-requisite for selection of superior genotypes over the existing cultivars. Variation was observed for all the characters among the genotypes studied, indicating the existence of sufficient amount of variability. These results were in conformity with the findings of Dhanwani *et al.* (2013), Dhurai *et al.* (2014) and Kavitha *et al.* (2015).

Among accessions screened under normal sowing, the accession EC792239 recorded significantly highest grain yield per hectare (6347 kg/ha) followed by EC792285 (6017 kg/ha), EC792185 (5523 kg/ha) as against best check MTU-1010 (3560 kg/ha), while the accession EC792239 recorded significantly highest grain yield (6012kg/ha) when screened under late sown condition followed by EC792285 5709 (5209 kg/ha) and EC792185 (5256kg/ha) as against the best check MTU-1010 (2903kg/ha). Yield data obtained from screening of the rice accessions showed the genotypic difference. The higher grain yield obtained in few genotypes could be attributed to reduced per cent of chaffyness and an increase in panicle length, number of tillers per plant, average weight of five panicles, test weight. Number of tillers per plant, panicle length, average weight of panicles and thousand grain weight had positive correlation with grain yield. Filled grains per panicle and thousand grain weight were found important yield contributing trails and confers with Manuel and Palanisamy (1991), Mehetre et al. (1994) and Akhtar et al. (2002).

Significantly minimum heat succeptibity index (0.41) was recorded in the accession EC792240 followed by the accessions EC792179 (0.43), EC792185 (0.44), EC792316 (0.47), EC792285 (0.47) and EC792239 (0.48) as against the best check MTU-1010 (1.69). Among the fifty five accessions screened for heart tolerance, 6 accessions were highly tolerant to heat, 14 accessions were moderately tolerant to heat and 35 accessions were susceptible to heat. Genetic diversity for heat tolerance is important for breeding varieties for areas affected by high temperatures during the rice-growing season. Some heat-tolerant varieties have been identified in previous studies in rice (Matsui *et al.*, 1997, 2001; Jagadish *et al.*, 2008) by using the parameter heat succeptibity index (HIS). In our study, we screened fifty rice accessions; however, very few accessions showed some degree of heat tolerance.

The heat tolerant genotypes will be further confirmed by evaluating in multi locations under summer season and will be used as donors for heat tolerance in further breeding programme.

Tolerance is a combined reaction of the plant ability to survive the stress conditions and to complete its developmental stages before, during or later the stress period (Levitt, 1980). This was clear that the few lines having passed through the period of high temperature are tolerant to high temperature stress. The present results support Liu *et al.* (1981), Chen *et al.* (1982) and Mohammad Sarwar and Ghulam Mustafa Avesi (1985). Factors responsible for the induction of sterility by high temperature during anthesis were not studied during the present study but it is likely that the tolerant lines were able to shed sufficient amount of viable pollen for self-pollination (Mackill *et al*., 1982). During heading, the average atmospheric temperature was ranged from 35^{o}C to 38^{o}C which was high enough to induce spikelet sterility.

In our study, we screened 50 varieties however; only six varieties (about 12%) showed high degree of tolerance to heat stress. The results from our study showed that large genotypic variation exists among the fifty accessions screened for heat tolerance. The identified donors of heat tolerance can be used for improving the heat tolerance traits of future rice varieties and for genetic studies to understand the mechanism of heat tolerance.

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Fig No 01. Field view of the experiment.

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CROP IMPROVEMENT STRATEGIES IN ARENA OF CLIMATE CHANGE

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Introduction

In this era of population explosion and climate change, there is an urgent need to accelerate crop improvement programmes which can achieve sustainable yield increase without further expanding farmland or damaging the environment (Varshney *et al*. 2014). Plant breeding deals with improvement of genetic potential of crop plants as per need and interest of mankind. Plant breeding continued to be as an art up till the end of the 19^{th} century when Mendelian Laws were rediscovered. Biometrical genetics dealing with choice of parents based on knowledge of gene action, use of the most appropriate breeding methodology, analysis and interpretation of data made even the art of selection fairly predictable. Breeders mix and match various breeding methods depending on objectives and they constantly modify and update their strategies to reshuffle desirable genes. Conventional breeding methods are based on phenotypic selection and progeny testing. Mode of pollination, choice of parents, ease of emasculation/hybridization and gene action involved are the key factors for deciding crop improvement strategies. Several mating designs like line x tester analysis, diallel analysis, biparental mating, generation mean analysis etc. have been extensively utilized to deduce gene actions involved with inheritance of yield and its attributes. Involvement of additive gene action suggests effectiveness of simple selection while involvement of non-additive gene action suggests effectiveness of heterosis breeding. However, if both additive and non-additive components govern the inheritance then biparental mating is suggested followed by recurrent selection and diallel selective mating. Additive gene action is fixable while non-additive gene action is not fixable through simple selection.

Most of the breeding strategies adopted by conventional plant breeders involve hybridizations followed by selection among segregating generations which takes lot of time and its success depends upon plant breeder's skill and techniques. Conventional plant breeding is helpless for improvement of those traits which are quantitative in nature with low heritability, highly influenced by environment and governed by polygenes. Due to advancement in the field of molecular marker techniques and genome sequencing, now it is possible to dissect the complex trait at molecular level by identification of molecular markers tightly linked to the loci governing them. The process of indirect selection of a particular trait using linked molecular marker is known as marker assisted selection (MAS). Marker assisted selection is accurate as compared to conventional morphological selection, as it directly deals with genetic cause and eliminates environmental influence on selection. A marker to be used for marker assisted selection should be polymorphic enough so that chromosome carrying the mutant gene can be distinguished from the chromosome with normal gene. Molecular markers are less influenced by environment and crop growth stages facilitating early screening without developing epiphytotic conditions. Many molecular markers are codominant in nature and can identify more number of alleles in a breeding population. There are many molecular marker techniques utilized for detection of DNA polymorphism. Of these, SSR (simple sequence repeat) are recently very popular because of their repeatability, codominance, genomic abundance, high polymorphism level, low cost and automation. However, there are certain advantages of utilizing SNP (Single Nucleotide Polymorphism) markers over SSRs, the higher cost of SNP detection (i.e. SNP genotyping) was the limiting factor. Fortunately, due to new whole genome sequencing techniques, SNP discovery, validation and genotyping is becoming cheaper and time saving day by day.

Gene Mapping

The objective of gene mapping is to find molecular markers tightly linked to the genes governing target traits making molecular breeding feasible. Linkage analysis and association mapping (AM) are the two most commonly used tools for dissecting complex traits. Identification of molecular markers involves two major steps (i) Assessment of as many as potentially polymorphic DNA segments from diverse parents which are phenotypic extremes utilizing molecular marker techniques and (ii) Identification of linked marker adjacent to the targeted gene among the potentially polymorphic DNA fragments with the use of mapping populations derived from diverse parents. Different mapping populations used for identification of markers are Near Isogenic Lines (NILs), Recombinant inbred lines **(**RILs**),** Double haploid (DH), F_2 population, Back cross derived inbred lines (BIL) and AIL (Advanced Intercross lines). Near isogenic lines are developed through back cross method. Two NILs are genetically identical except the locus under consideration and region surrounding it. RILs are created by SSD (Single Seed Descent) method from F_2 plants through atleast five to eight generations of continued selfing. Double haploids are obtained by chromosome doubling of anther culture derived haploid plants from F_1. F_2 population is produced by selfing or sib mating of the individuals in segregating populations generated by crossing between contrasting parents. BILs are developed from back cross population by SSD method. While, segregating individuals are intermated, hybrids derived from these crosses are handled as per SSD / chromosome doubling methods to produce AILs. Linked molecular markers can be identified by strategies like bulk segregation analysis, QTL (Quantitative Trait Loci) mapping and Association mapping.

Bulk Segregation Analysis

Bulk segregation analysis method proposed by Michelmore *et al*. (1991) is a simple method of identification of DNA polymorphism linked to target locus and relies on the use of segregating populations. When diverse parents are hybridized, the F_2 generation derived from the cross will segregate for alleles from both the parents at all loci throughout the genome. If the F_2 population is divided into two pools of contrasting individuals on the basis of screening at a single target locus (for which parents are diverse e.g. resistant and susceptible), these two pools (bulk 1 and 2) will differ in their allelic content at loci contained in the chromosomal region close to the target gene. Equal quantity of DNA obtained from individuals of bulk 1 is mixed to constitute Resistant Bulk (RB). Similarly, equal quantity of DNA is bulked from bulk 2 (e.g susceptible individuals) to constitute Susceptible Bulk (SB). Marker techniques such as RFLP, RAPD, AFLP, SSR etc. can be used to compare the genetic profiles of parents and bulks (RB and SB) to search for DNA markers (DNA polymorphism) near the target gene. Logic behind bulking of the DNA is to find out tightly linked or cosegregating marker to the trait under consideration. For other traits (other than the target trait), marker is segregating. As common gene is present in RP (Resistant parent) and RB (Resistant bulk), the marker if present in all these individuals, will always be there with resistant phenotype. This marker can be utilized for indirect selection of the gene of interest. When marker genotypes and phenotypes of many segregating individuals are available, a linkage mapping distance in terms of centiMorgan (cM) can be worked out between marker and target locus. Closer the distance, higher the efficiency of marker assisted selection.

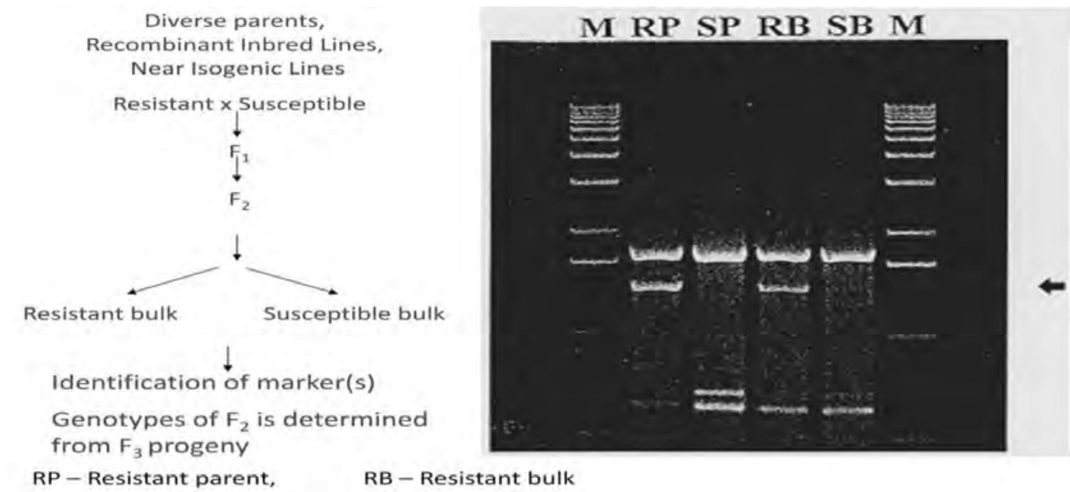

Fig. 1 Bulk segregation analysis (Black arrow indicates polymorphic marker between contrasting parents and bulks)

QTL (Quantitative Trait Loci) analysis

Quantitative traits are governed by polygenes, show discontinuous variation and highly influenced by environment. QTL analysis is performed for identification of loci which are linked or involved with quantitative traits. Loci involved with quantitative traits (QTLs) may be clustered together or distributed across the genome. Marker based methods applied to segregating populations have provided us with a means to locate QTL to chromosomal regions and to estimate the effects of QTL allele substitution (Lander and Botstein, 1989). QTL analysis provides information on number of genes influencing the expression of a quantitative trait, level of influence of each gene/locus on the trait, location of genes on the chromosomes and function of each gene utilizing regression and likelihood statistics. As compared to BSA, QTL analysis gives many markers or marker intervals which are linked with different loci. Different mapping populations like F_2, F_3, RILs, DHs and AILs are used for QTL analysis. Any molecular marker technique can be utilized to find out linked marker, SSRs /SNPs being the choice of molecular breeder. QTL analysis involves correlation between bands (electrophoretic results) and phenotypic characters. If two diverse parents are utilized to create segregating generations, one with highest pods per plant and other with lowest pods per plant, individuals of mapping population with varying pods per plant are studied. DNA samples are isolated from all these individuals. During molecular analysis, as you gradually proceed from individuals with higher number of pods per plant to lower number of pods per plants, certain bands will disappear and certain bands will appear which shows that disappearing bands are associated with more pods per plant and appearing bands are associated with less number of pods per plant. In other words, disappearing bands has positive association with higher pods per plant while negative association with lower pods per plant. If markers cover a large portion of the genome, then there is a good chance that some of the gene controlling the quantitative traits will be linked to some of the genetic markers. If the genes and the markers are segregating in a genetically defined mapping population, then the linkage relationship among them may be discoverable by looking the association between the traits and the marker segregating pattern.

Using a elaborate computer program (generally MAPMAKER programme is used), it is determined whether the variation in trait is correlated with marker or not. Looking within one family (generation derived from single cross) in the breeding experiment, if the trait is always high with a certain sequence of a markers and always low with another sequences, then probably the genes for the trait are close to the markers on the chromosomes. In contrast to this, if the variation in the trait is more or less random in relation to the marker, then there is little or no linkage between the trait and that marker. These markers can't be utilized for marker assisted selection or QTL analysis.

Statistical parameters like correlation, regression, coefficient of determination or % phenotypic variation expressed by marker (R^2) and Logarithm of odds (LOD score) are used for establishing marker trait relationships. Mapping function defines the relationship between recombination fraction and distance between genes. Kosambi's mapping function is normally utilized to establish linkage relationships between markers and trait which assumes non-additivity of mapping distance and presence of interference. QTL mapping utilizes single locus analysis or interval mapping for establishment of trait marker relationships. Single marker analysis focuses on single major putative (probable) QTL locus and linked marker (as shown in Fig. 2). It can not accurately measures QTL positions and effects, while interval mapping is based on joint frequency of flanking adjacent markers pair and a putative QTL. Here, interval (genetic region) between two flanking markers is associated with QTL. The method evaluates the target association between the trait values and the genotype of the hypothetical QTL at multiple analysis point between pair of adjacent flanking marker loci. Presence of putative QTL estimated if the LOD score exceeds a critical threshold value. As joint frequency of flanking markers is considered, interval mapping is more efficient as compared to single marker analysis. Power of QTL mapping is affected by number of genes controlling the traits, their genomic positions, distribution of genetic effects, existence of gene interaction (epistasis), heritability, number of genes segregating in segregating populations, mapping population type and size, statistical methodology and significance level used for QTL mapping.

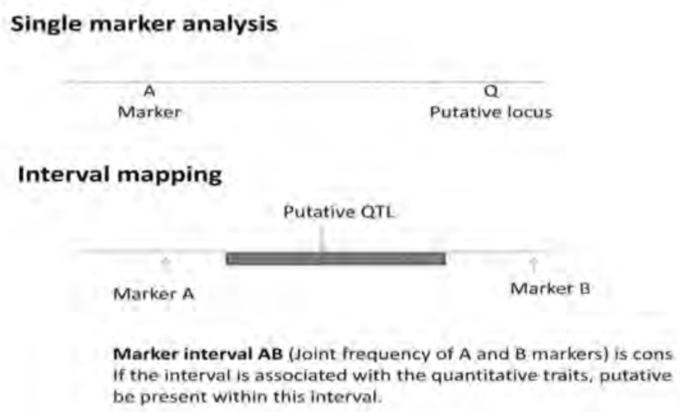

Fig. 2 Difference between Single marker analysis and Interval mapping

Next Generation Sequencing (NGS)

Genetic variability (DNA polymorphism) is pre-requisite for molecular crop improvement. The accurate method to access DNA polymorphisms is direct DNA sequencing. For 30 years after its discovery, Sanger's conventional sequencing chemistry remained irreplaceable which utilizes dideoxy nucleotide to create nested sets of randomly terminated DNA fragments followed by electrophoresis and base calling. Whole genome sequencing is preferable approach to detect genome wide polymorphisms. Though having highest accuracy, Sanger sequencing is time consuming and costly for genome-wide analysis.

Rapid developments in next generation sequencing (NGS) over the last decade have opened up new opportunities to explore the plant genome and its relationship with phenotype with greater resolution than achieved ever before at reduced cost and time. All NGS methods follow sequencing of a dense array of DNA features by iterative cycles of enzymatic manipulation and imaging-based data collection. All commercially available NGS platforms share common steps : (i) random fragmentation of DNA, (ii) ligation of adaptors (library preparation), (iii) amplification on solid surface or immobilization of single DNA molecule, (iv) direct step by step detection of each nucleotide base incorporated during sequencing reaction by image analysis and (v) data analysis utilizing bioinformatics tools (Shendure and Ji, 2008). There are many sequencing biochemistry and platforms for whole genome analysis, of these, illumine genome sequencing involving bridge amplification and sequencing by synthesis with reversible dye terminators is most widely utilized method. NGS technologies help crop improvement in an unprecedented manner facilitating analysis of genome-wide SNPs, transcriptome, epigenetics, DNA-protein interactions, miRNAs, nucleosome positioning and metagenomics (Shendure and Ji, 2008). Selection based on GBS (i.e. Genotyping by sequencing) allows marker discovery, marker validation and genotyping itself to occur simultaneously in turn reducing time period for variety development (Deschamps *et al*., 2012). Genotyping by sequencing (GBS) is expected to have a more profound impact on mapping strategies benefiting from saturated linkage maps which include Genome-Wide Association Studies (GWAS), QTL analysis, Bulked Segregant Analysis (BSA), Marker Assisted Backcrossing (MABC), Marker Assisted Recurrent Selection and Genomic Selection (GS). In case of saturated linkage maps, genome-wide marker maps are developed where average distance between any two markers is 5 cM. Saturated linkage maps increase accuracy of linkage mapping and association mapping.

Association mapping

Linkage analysis in plants typically localizes QTLs to 10 to 20 cM intervals because of the limited number of recombination events that occur during the construction of mapping populations at the cost for propagating and evaluating a large number of lines. Association mapping, also known as LD (Linkage disequilibrium) mapping, is used to identify trait-marker relationships based on linkage disequilibrium exploiting historical and evolutionary recombination events at the population level (Flint-Garcia *et al*, 2003). As a new alternative to traditional linkage analysis, association mapping offers three advantages : (i) increased mapping resolution, (ii) reduced research time and (iii) greater allele number (Yu and Buckler, 2006). Linkage disequilibrium refers to the non-random association between two markers or two genes/QTLs, while AM (Association mapping) refers to the significant association of a marker locus with a phenotype trait. Significant LD can occur between alleles at distant loci or even at different chromosomes, generated by different genetic factors other than linkage. The factors affecting LD are genetic diversity, mating system, population structure, genetic relatedness (Kinship), admixture or migration, genetic drift, selection, recombination and mutation rate (Zhu *et al*., 2008).

There are basically two approaches under association mapping (i) candidate gene association mapping and (ii) Genome wide association mapping. In candidate gene association mapping, trait specific candidate genes are selected based on prior knowledge from mutational analysis, biochemical pathway or linkage analysis of the trait of interest. An independent set of random markers needs to be scored to infer genetic relationships. It is a low cost, hypothesis-driven and trait-specific approach but will miss other unknown loci. Genome-wide association mapping takes into consideration large number of markers across the genome tested for association with various complex traits without prior information regarding candidate genes. Advances in high-throughput NGS and GBS technologies have markedly reduced the cost per data point of molecular markers, particularly single nucleotide polymorphisms through resequencing a core set of diverse lines and genotype thereby making genome wide association studies affordable. The basic steps of association mapping are (i) collection of diverse genotypes, (ii) precise phenotyping over years/environments, (iii) marker based genotyping (iv) determination of population structure and kinships to avoid false positives (v) quantification of LD extent using different statistics and (vi) marker trait association analysis (Sahu *et al*., 2015).

Table 1. Comparison between different mapping populations

Particulars	**F_2**	**Doubled haploid**	**Back cross**	**RIL**	**NIL**	**AIL**	**MAGIC**	**NAM**
Parents inolved	Two	Two	Two	Two	Two	Two	Multiple	Multiple
Resource type	Transient	Immortal	Transient	Immortal	Immortal	Immortal	Immortal	Immortal
Mapping individuals	Hetero- and homo- zygous	Homo-zygous only	Hetero- and homo-zygous	Homo-zygous only	Homo-zygous only	Homo-zygous only	Homo-zygous only	Homo-zygous only
Generation required	Two	Two	Two	Six to eight	Six to eight	Usually ten	More than eight	More than six
Multiple alleles/ traits	No	No	No	No	No	No	Allowed	Allowed
Recombinant events	Limited	Limited	Limited	Limited	Limited	High	High	High
Suitable for	Family based linkage mapping (FBL)	FBL	FBL	FBL	FBL	FBL	Dual linkage-LD mapping	Dual linkage-LD mapping
Mapping resolution	Coarse	Coarse	Coarse	Coarse	Fine	Fine	Fine	Fine
Replicated studies	Not possible	Possible	Not possible	Possible	Possible	Possible	Possible	Possible
Detection of minor QTLs	Low	Low	Low	Low	Low	High	High	High

<u>**Source**</u> :Bohra A. (2013)

As compared to linkage mapping, association mapping is based on historical / ancestral recombination events, studies more alleles, gives fine mapping resolution (with high genome-wide marker coverage), results are applicable to any population and can be applied to unrelated individuals also reducing the duration for marker detection. However, linkage mapping is good for initial detection but poor for fine mapping, while association mapping is poor for initial detection but good for fine mapping. Considering these, two combined strategies *viz*., Nested Association Mapping (NAM) and MAGIC (Multiple Advance Generation Inter Cross) have been proposed to combine the advantages of both linkage mapping and association mapping to improve mapping resolution without requiring excessively dense marker maps. NAM is an integrated mapping strategy used to (i) capture genetic diversity (ii) exploit ancestral recombination (iii) uses next generation sequencing technologies through genetic design (iv) develop a mapping population (normally RILs derived from multiple diverse founders) that has sufficient power to detect numerous QTLs and resolve them to a level of individual genes (v) evaluate mapping materials over a range of environments and (vi) provide a community resource (Yu *et al*. 2008). In MAGIC, RIL populations from multiple founder lines are created, in which the genome of the founders are first mixed by several rounds of mating and subsequently inbred to generate a stable panel of inbred lines through single seed descent method (Bandillo *et al*., 2013). These inbred lines are genotyped by GBS (Genotyping by Sequencing) approach and phenotyped for multiple traits including biotic and abiotic stresses. Comparison between different mapping populations is given in Table 1 (Bohra A., 2013).

Molecular breeding (strategies based on mapped genes)

Marker Assisted Backcrossing

Marker assisted backcrossing (MABC) has several advantages like effective selection of target loci, minimize linkage drag and accelerated recovery of recurrent parent over conventional backcrossing. Essential requirements of MABC (Fig. 3) are (i) Tightly linked marker to target locus for foreground selection, (ii) Flanking markers for recombinant selection and (iii) Markers (unlinked to target locus) for background selection (usually SSR or SNPs) (Frisch *et al*., 1999).

Tightly linked marker is used	Flanking markers are used	Unlinked markers are used

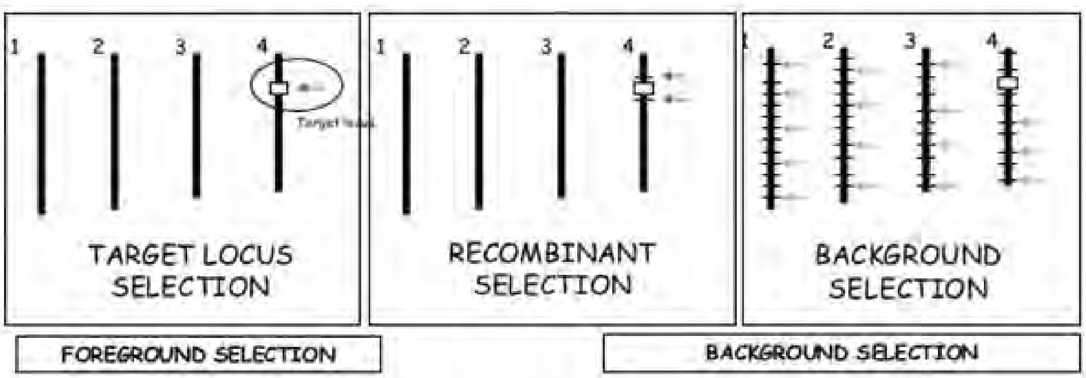

Fig. 3 Three components of MABC :Foreground selection, Recombinant selection and Background Selection

Foreground selection utilizes tightly linked marker for selection of target gene especially for the traits which are governed by recessive gene and difficult to evaluate. Recombinant selection utilizes flanking markers to select recombinants between the target locus and flanking markers which minimizes linkage drag. Recombinants selection requires large population sizes which depends on distance of flanking markers from target locus (closer the distance, higher population size). Recombinant selection can reduce linkage drag within 3-4 backcrosses as compared to conventional backcrossing which may require 15 to 20 backcrosses (Hospital *et al*., 2001). Background selection utilizes unlinked (unlinked to the target locus) markers to select against donor genome for rapid recovery of recurrent parent genome within 3 to 4 backcross generations as compared to conventional requirement of 6-8 backcrosses.

Marker assisted gene pyramiding

Plant breeders might be interested to combine desirable genes from multiple parental lines, particularly in case of disease resistance. The process of combining desirable traits in a single genotype from multiple genotypes is known as gene pyramiding. Marker assisted gene pyramiding could facilitate in pyramiding of genes effectively into a single genetic background (Joshi and Nayak, 2010). Use of molecular markers for gene pyramiding offers certain advantages like early screening at seedling stage, avoiding costly phenotypic screening, accurate genotyping for presence of desirable genes and no influence of environment error on selection. Depending upon the number of genes to be pyramided from numbers of parental lines, single cross, three way cross, double cross and multiple cross may be carried out followed by analysis of segregating generation as per pedigree or back cross method. However, the minimum size of population to kept for gene pyramiding becomes critical issue when number of genes to be pyramided increases.

Marker assisted recurrent selection

Recurrent selection utilizes alternate selection and intermating to increase frequency of recombination to break undesirable linkage. A specific form of marker-assisted selection is marker-assisted recurrent selection (MARS) in which (i) one generation of phenotypic selection in the target environment is conducted, (ii) markers with significant effects are used to predict the performance of individual plants, and (iii) several generations of selection are performed solely based on significant markers (Massman *et al*., 2013) .

Genomic selection (GS)

The limitations of linkage mapping are (i) study of few alleles in a biparental mapping population, (ii) not suitable for QTLs with minor effects, (iii) need for development of mapping population and (iv) poor resolution. While association mapping is prone to biased effect estimates (false positives) and unable to explain all variances of trait. To overcome these limitations, Genomic Selection (GS) utilizes a large number of significant and non-significant molecular markers to predict the performance of breeding value (GEBV – Genome Estimated Breeding Value) of lines of a particular crop species for a particular trait of interest. Conventionally, breeding value of an individual is judged from mean value of its progeny. If an individual is crossed with random selection of population (to produce half sibs), its breeding value relates to deviation from population mean. Breeding value is sum of average effects of all the genes carried by an individual.

In case of genomic selection, available lines are divided into training and validation sets. Individuals of training population are both genotyped and phenotyped to develop a model that takes genotypic data from a 'candidate population or validation set' of untested individuals and produces genomic estimated breeding values (GEBVs) (Jannink *et al*., 2010). Genomic selection is utilized when many genes or loci with small effects control the trait of interest, phenotypic selection is ineffective, cost of genotyping is less than phenotyping, heritability of trait is high in training population and low in untested population. Decreased genotyping costs and new statistical model enable simultaneous estimations of all marker effects. The factors affecting accuracy of GS are non-additive effects, relatedness of training set to predicted sets (validation sets), size of training data set, trait heritability, number of markers, genetic model and statistical model.

Other Approaches

Genetic transformation of plants and Genome editing

Uptake of naked DNA by cell is known as transformation. Genetic transformation has emerged as an additional tool to carry out single gene breeding of crop plants. In this approach, useful gene(s) cloned from related or unrelated organism can be introduced into plants. The alien gene which is inserted in this manner without involvement of normal sexual reproduction is known as transgene and plant carrying it, is known as transgenic plant. Unlike conventional breeding, only useful gene(s) are introduced without the co-transfer of undesirable genes. Among the various methods of gene transfer, *Agrobacterium* mediated (indirect) genetic transformation is commonly used for genetic modification of plants. This approach is very useful for quality improvement, biotic stress resistance, abiotic stress resistance, herbicide resistance, genetically engineered male sterility, biofortification and molecular pharming. Although, commercialization of transgenic plants is not allowed in many countries, it is a powerful tool to improve crop plants in context to climate change. However, this method does not provide opportunity to precisely edit plant genes.

Recently, invented genome modification technologies, such as ZFN (Zinc Finger Nuclease), TALEN (Transcription Activator-Like Effector Nuclease), and CRISPR/Cas9 nuclease (Clustered Regularly Interspaced Short Palindromic Repeats/Cas9 nuclease) can initiate genome editing easily, precisely and with no limitations by organism (Chen *et al*., 2014). Genome editing is a type of genetic engineering in which DNA is inserted, deleted or replaced in the genome of an organism using engineered nucleases, or "molecular scissors. CRISPR/Cas9 is a rapidly developing genome editing technology that has been successfully applied in many organisms, including model and crop plants. Cas9, an RNA guided DNA endonuclease, can be targeted to specific genomic sequences by engineering a separately encoded guide RNA (gRNA) with which it forms a complex. As only a short RNA sequence must be synthesized to confer recognition of a new target, CRISPR/Cas9 is a relatively cheap and easy to implement technology that has proven to be extremely versatile. Together with other sequence-specific nucleases, CRISPR/Cas9 is a game-changing technology that is poised to revolutionise basic research and plant breeding. (Belhaj *et al*., 2015).

Epigenomics

Epigenetics is the study of heritable changes in gene expression that occur without a change in the DNA sequence. Such processes involve a complex interplay between DNA methylation, histone modifications, and non-coding RNAs, notably small interfering RNAs (siRNAs) and micro RNAs (miRNAs). Epigenomics refers to the large scale study of epigenetic marks on the genome, which include covalent modifications of histone tails (acetylation, methylation, phosphorylation, ubiquitination), DNA methylation and the small RNAs machinery (Rival *et al.,* 2010). Mapping epigenomes helps to understand plant growth, development and adaptation to environment. Epigenetic regulation is not only important for generating differentiated cell types during plant development but also in maintaining the stability and integrity of their respective gene expression profiles. Sensing environmental changes and initiating a quick, reversible and appropriate response in terms of modified gene expression is of paramount importance for plants which are sessile autotrophs. Although epigenetic mechanisms help to protect plant cells from the activity of parasitic sequences such as transposable elements, this defense can complicate the genetic engineering process through transcriptional gene silencing. The success of sequencing projects on model plants has created widespread interest in exploring the epigenome in order to elucidate how plant cell decipher and execute the information stored and encoded in the genome in response to change in surrounding environmrnt. New high-throughput techniques are making it easier to map genome-wide DNA methylations, histone modifications and sRNAs (small RNAs) on a large scale and results have already provided surprises (Rival *et al.,* 2010). The transcriptomes of an organism are continually changing in response to developmental and environmental cues. Similarly, the epigenome is not static and can be molded by developmental signals, environmental perturbations, and disease states. Therefore, many epigenomes will need to be sequenced for a single organism, making epigenome sequencing perhaps even more challenging than genome sequencing. We are not far from the future where crop improvement programmes are assisted by epigenomic studies.

Conclusion

The development of improved breeding lines for commercial crop cultivation has traditionally been a time consuming and expensive task. With the deployment of genomics-assisted breeding, the generation of such lines is destined to become easier and faster, if also more expensive in the short term. To meet the demands of the human population and increasing volatility of the climate, we must accelerate the pace of our current breeding practices and apply genomics based selection approaches (Varshney, 2014). Specialized plant genetic stocks such as bi-parental (RILs, NILs, DH etc) and multi-parent mapping populations (MAGIC, NAM), mutant populations, and immortalized collections of recombinant lines may be generated to facilitate mapping and gene function analysis via association studies and QTL mapping in a crop species under varying environments. Next generation sequencing and genotyping by sequencing help to develop saturated linkage maps from mapping populations. Saturated linkage maps increase the accuracy of QTL and association mapping. Knowledge about the identity and map location of agriculturally important genes and QTLs provides the basis for parental selection and marker-assisted selection (MAS) in plant breeding. Alternatively, genotypic and phenotypic datasets of training populations can be used to develop models to predict the breeding value of lines utilizing genomic selection. Marker assisted backcrossing, marker assisted recurrent selection, marker assisted gene pyramiding and genomic selection are accurate methods over conventional phenotypic selection and reduce time period for variety development. Recent approaches like genome editing and epigenomics will be additional tools in future plant breeding programmes to combat climate change.

Extensive scientific trainings of young scientists within the country and across the globe in various fields like statistical genomics, molecular plant breeding, computer science, mathematics and bioinformatics are pre-requisite to make genomics-assisted breeding feasible in India. Generally in SAUs of India, young scientists are not allowed for foreign trainings which has delayed global collaborative research, fundamental genome research and progress in the field of genomics assisted breeding. Due to lack of genome sequence data of cultivated and valuable wild species of economically important crops in the country, molecular breeding, being the most powerful and revolutionary tool to combat climate change, has not yet been fully exploited.

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Theme 5
Current Systems and Challenges

T5 A088

ADAPTATION STRATEGIES FOR MINIMIZING ADVERSE EFFECT OF CLIMATE CHANGE ON RICE YIELD IN MIDDLE GUJARAT AGRO-CLIMATIC REGION

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Abstract

The climate projection data for 2071-2100 obtained from PRECIS (Providing Regional Climate for Impact Study) model output was down scale for different stations (Anand, Ahmedabad, Vadodara, Dahod , Panchmahal) of Gujarat. The daily data were derived for kharif season and was used in InfoCrop model to study the impact of climate change on rice yield. The various adaptation strategies *viz*. fifteen days early transplanting from normal, change in variety, better water management with additional fertilizer and combine all three early transplanting, change in variety and better water management with additional fertilizer were tried using the model. The result indicated that the annual rainfall during projected period would be 20.9 to 70.0 per cent higher than the baseline (1961-90) rainfall at different stations. Maximum temperature would increase by 4.0 to 5.0 ^{0}C, while minimum temperature would increase by 3.5 to 4.1 ^{0}C in different parts of middle Gujarat. The model simulated results showed that (irrespective of cultivars and dates of sowing) mean grain yield of rice will be reduced at all the stations ranged between 27 to 35 per cent. The adaptation strategies *viz*. fifteen days early transplanting from normal (6.3 to 8.8%), change in variety (4.2 to 8.2%), better water management with additional fertilizer (7.2 to 10.8%) and combine all three adaptation strategies (9.8 to 14.2%), can minimize the adverse effect of climate change at different stations of Gujarat.

Keywords: Climate change; PRECIS; A_2 Scenario; Adaptation; InfoCrop model

Introduction

The changes in climate parameters are being felt globally in the form of changes in temperature and rainfall pattern. The global atmospheric concentration of carbon dioxide, a greenhouse gas (GHG) largely responsible for global warming, has increased from a pre-industrial value of about 280 ppm to 387 ppm in 2010. Similarly, the global atmospheric concentration of methane and nitrous oxides, other important GHGs, has also increased considerably resulting in the warming of the climate system by 0.74°C between 1906 and 2005 (IPCC, 2007). Global mean temperatures will continue to rise over the 21st century if greenhouse gas emissions continue unabated. Under the assumptions of the concentration-driven RCPs, global-mean surface temperatures for 2081–2100, relative to 1986–2005 will likely1 be in the 5–95% range of the CMIP5 models;0.3°C–1.7°C (RCP2.6), 1.1°C–2.6°C (RCP4.5), 1.4°C–3.1°C (RCP6.0), 2.6°C–4.8°C (RCP8.5). With respect to preindustrial conditions, global temperatures averaged in the period 2081–2100 are projected to likely exceed 1.5°C above preindustrial for RCP4.5, RCP6.0 and RCP8.5 (high confidence) and are likely to exceed 2°C above preindustrial for RCP6.0 and RCP8.5 (high confidence). Temperature change above 2°C under RCP2.6 is unlikely (medium confidence). Warming above 4°C by 2081–2100 is unlikely in all RCPs (high confidence) except for RCP8.5 where it is as likely as not (medium confidence). It is virtually certain that, in the long term, global precipitation will increase with increased global mean surface temperature (IPCC, 2013). Researchers use several methods to assess the impact of climatic variability ranging from the traditional approach of historical data analyses by various statistical tools to controlled environment studies and Crop Growth Simulation models in order to understand the impact of temperature, rainfall and CO_2 on crop growth and yield (Aggarwal, 2008).

Rice is grown in an area of 7.5 lakh ha in Gujarat with production of 14.24 Lakh tones. Valsad district has maximum area (14%) and production (29%) middle Gujarat agro-climatic region, while Ahmedabad district has lowest area (9.3%) and production (19.1%) under rice cultivation. The highest productivity of rice in Kheda district (2270 kg/ha) and Ahmedabad district (2180 kg/ha), while lowest productivity was recorded in Vadodara districts (1146 kg/ha) of middle Gujarat region (Annon, 2010).

Material and Method:

Climate change study:

For climate change impact study, weather data for A_2 scenario was derived from PRECIS downscaled model output prepared by IITM Pune in a grid size of 0.4 degree. Two period of 30 years each, one for base line i.e., 1961-1990 (base line period) and another for A_2 projected scenario i.e., 2071-2100 (projected scenario) were considered for climate change impact study. There are gross difference between PRECIS base line daily weather data and actual weather data for the same period (Taylor et al, 2007). Thirty year monthly average of daily weather parameters of base line data was subtracted from corresponding projected A_2 scenario data and the difference obtained were used for computing weather data for projected period using actual observed data. In case of rainfall percentage difference on monthly sum of 30 years average data, between projected output and base line output were used as correction factor.

Data requirement for InfoCrop simulation model:

The InfoCrop model requires daily weather data of maximum and minimum air temperature, solar radiation and rainfall. For calibration and validation of the model, observed weather data (2009-2012) were obtained from Main Rice Research Station, Navagam, Anand Agricultural University, Anand, Gujarat. Top layer soil data file of similar texture were modified in Master using actual soil data of respective experimental site. The field experiment was carried out on rice for kharif with cv. GR-17 and Gurjari with two transplanting of sowing (D_1 – 15th July and D_2 – 30th July)) were used to calibrate and validate the InfoCrop-rice model. Secondly the study was extended to district level for Anand, Vadodara, Ahmedabad, Panchmahal and Dahod Districts to simulate rice yield using InfoCrop model under A_2 scenario.

Results and discussion

Projected Weather Over Base Line:

The maximum and minimum temperature of Anand, Ahmedabad, Vadodara, Dahod , Panchmahal to the tune of 6.0, 4.1, 4.0, 5.0, 4.5 and 5.1, 3.5, 4.3, 3.8, 4.1^{0}C, respectively against the base line periods (1961-90). While rainfall will be recorded at Anand, Ahmedabad, Vadodara, Dahod and Panchmahal districts to the 42.0, 28.14, 20.95, 70.0 and 49.7% respectively as compare to baseline period. The PRECIS model output showed that highest temperature (6.0 ^{0}C) will be rise in Anand district while it was lowest (4.0 ^{0}C) at Vadodara district. In case of rainfall the highest (70%) average rainfall of projected period under A_2 scenario will be rise in Dahod and lowest (20%) in Vadodara district in comparison to their respective baseline rainfall of all the districts, (Fig1).

Trends of rice yield, yield attributing characters and phenological variation during projected period

Impact on Anthesis Date:

The results indicated that rice crop showed advancement in anthesis date was seen at all study districts of Gujarat. Higher advancement in anthesis date was noted in Gurjari at Dahod, while it was lowest in Anand district. On and average mean anthesis date reduction advancement (irrespective of cultivars and dates of sowing) was 23, 25, 26, 33 and 35 % of base line at Anand, Vadodara, Ahmedabad, Panchmahal and Dahod respectively (Table 1).

Impact on Maturity Date:

The simulation result showed that the crop duration of rice was reduced in all five districts ranged between 10% to 32% in different transplanting dates and varieties. Less reduction in maturity days was noted at onset of monsoon transplanting at all the location as compared to 15 days later transplanting. Similarly lower reduction in maturity days was noted in cv. Gurjari as compared to GR-17 at all location. On and average mean maturity days reduction (irrespective of date and cultivars) was 14, 18, 21, 20 and 23 % at Anand, Vadodra, Ahmedabad, Panchmahal and Dahod respectively (Table 1).

Impact on Grain Yield:

The climate change impact on projected period of rice yield at Anand, Ahmedabad, Vadodara, Dahod and Panchmahal with % reduction from base line is presented in Table 1**.** The model simulated results shows that (irrespective of cultivars and dates of sowing) mean grain yield will be reduced at Anand, Ahmedabad, Vadodara, Dahod and Panchmahal were 27.8, 29.7, 32.9, 33.8 and 35.4 respectively. The highest yield reduction (40.4%) was noted at Panchmahal district in late transplanting (30 July) and Gurjari cultivar, while it was lowest (20.2%) at Anand district under timely transplanting (15 July) in GR-17. It might be due to Anand district have more irrigated area as compare to Panchmahal and Dahod districts. Similar results were also reported by Mohandass *et al*,(1995). and Hundal *et al*,(1997)

Impact on Biomass Yield:

The simulation analysis indicated that rice is likely to lose the biomass yields ranged between 13.1 to 39.9 % at different districts in study area. The highest reduction was noticed at Dahod district and lowest was in Anand district. On an average mean biomass reduction (irrespective of cultivars and dates of sowing) was 20,26,21,33 &35 % under A_2 Scenario as compare to baseline biomass yield at Anand, Vadodara, Ahmedabad, Panchmahal and Dahod respectively. (Table 1)

Adaptation strategies for minimizing adverse effect of climate change

The district-wise impacts, adaptation and net vulnerability are worked out and presented in Table 2. The adaptation strategies viz. fifteen days early transplanting from normal, change in variety, and better water management with additional fertilizer and early transplanting were tried for study.

Early Transplanting From Normal

The shifting of transplanting windows fifteen days early from the normal transplanting (15 July) adaptation benefited 6.3 to 8.8 % in different districts of study area highest benefited district was (8.8) Anand, while lowest was(6.3) in Vadodara district. The yield gain by adaptation of Anand, Vadodara, Ahmedabad, Panchmahal and Dahod was 8.8, 6.3, 8.4, 7.2 and 6.8% respectively.

Change In Variety

The analysis showed that change in variety alone can make farmers better equipped to face the climate change impacts on rice crop. Yield gain by change in variety (GR-417) in place of traditional variety in all districts of study areas was significantly increased. The yield gain by this adaptation strategy of Anand, Vadodara, Ahmedabad, Panchmahal and Dahod was 5.2, 4.2, 7.1, 5.6 and 8.2 % respectively (Table 2).

Better Water Management with Additional Fertilizer

Nitrogen application and irrigation should be provided to suit the changed phenology of the crop in a changed environment. In this situation, the adaptation gains are projected to be up to 10.8% underA_2 scenario in projected period (2071-2100). The highest yield gain (10.8%) by this adaptation was recorded at Dahod district, while it was lowest (7.9%) in Ahmedabad district. It might be due to Dahod district has lowest irrigated area and Ahmedabad has highest irrigated area. It may be noted that the application of additional nitrogen is particularly in the context of farmers who are applying less than the recommended dose of fertilizer (Table 2).

Combine Effect Of Early Trans Planting, Change In Variety, Better Water Management With Additional Fertilizer

This is the combined above three adaptation strategies. The model simulated output showed highest benefited rice yield up to 14.2 %. The yield benefited by this adaptation at Anand, Vadodara, Ahmedabad, Panchmahal and Dahod was 9.8, 12.5, 11.8, 13.6 and 14.2 respectively. Similar result were observed by Aggarwal *et al*, (2002) (Table 2).

Vulnerability Analysis

The vulnerability showed that in Anand, Vadodara, Ahmedabad, Panchmahal and Dahod, the rice crop is projected to be vulnerable to climate change with a net vulnerability of up to 21.8 %. The highest (-21.8 %) vulnerable district for rice yield from current yield to climate change was Panchmahal, while lowest (-18.0 %) vulnerability was found in Anand district even after following all adaptation strategies like early transplanting, Change in variety, Better water management with additional fertilizer (Table 3).

Summery and Conclussion

The maximum and minimum temperature will be high under A_2 scenario in 2071-2100 at Anand, Ahmedabad, Vadodara, Dahod, and Panchmahal to the tune of 6.0, 4.1, 4.0, 5.0, 4.5 and 5.1, 3.5, 4.3, 3.8, 4.1^{0}C, respectively against the base line periods (1961-90). While rainfall will be higher at of Anand, Ahmedabad, Vadodara, Dahod and Panchmahal districts to the 42.0, 28.14, 20.95, 70.0 and 49.7% respectively as compare to baseline period. The model simulated results shows that (irrespective of cultivars and dates of sowing) mean grain yield will be reduced at Anand, Ahmedabad, Vadodara, Dahod and Panchmahal are 27.8, 29.7, 32.9, 33.8 and 35.4 respectively. The adaptation strategies viz. fifteen days early transplanting from normal, change in variety, better water management with additional fertilizer and early transplanting change in variety and better water management with additional fertilizer, the crop yield benefitted 6 to 14%. Rice crop is projected to be vulnerable to climate change with a net vulnerability of up to 21.8 %. The highest (-21.8 %) vulnerable district for rice yield from current yield to climate change was Panchmahal, while lowest (-18.0 %) vulnerability was found in Anand district even after following all adaptation strategies.

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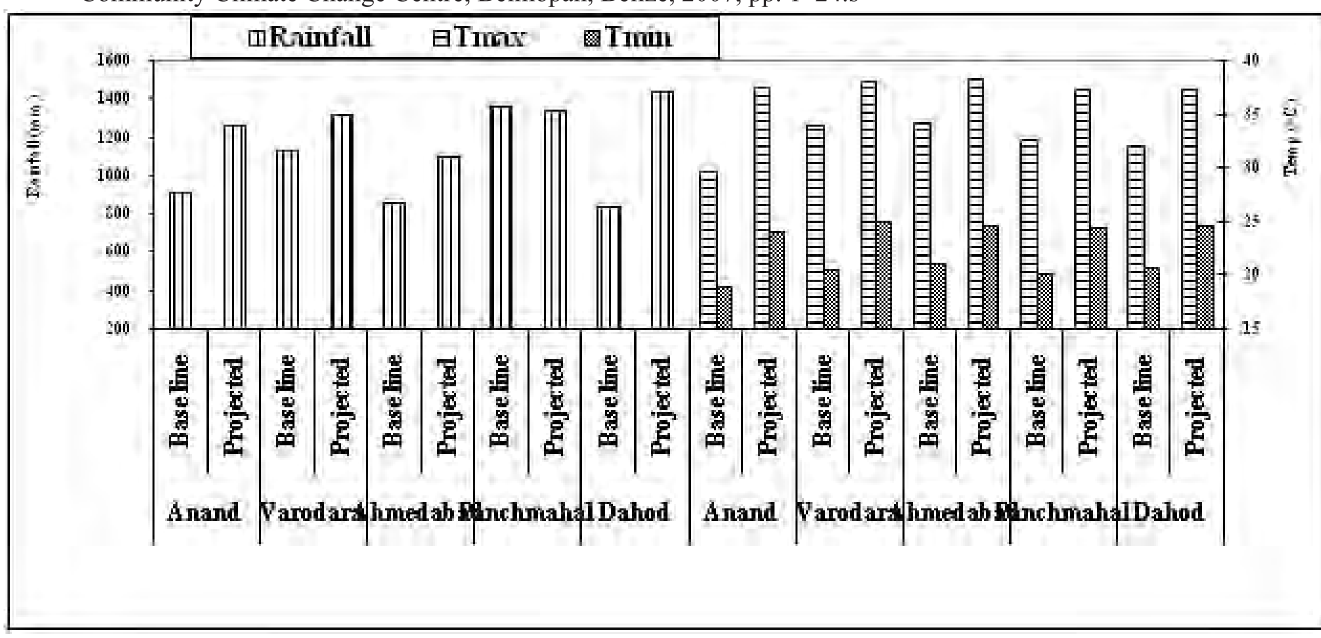

Fig. 1: Comparison of Base line and Projected weather at different locations

Table 1: Percent reduction in different parameters under projected climate over Base line climate on rice across various locations

Place	Date of Sowing	Cultivars	Lai	Anth	Mat	Bio-mass	Grain Yield
Anand	15th July	GR-17	-32	-33	-12	-16	-20
		Gurjari	-39	-22	-10	-13	-30
	30th July	GR-17	-28	-23	-19	-21	-24
		Gurjari	-30	-19	-17	-29	-37
Ahmedabad	15th July	GR-17	-33	-26	-18	-18	-28
		Gurjari	-28	-27	-23	-21	-25
	30th July	GR-17	-32	-23	-22	-20	-31
		Gurjari	-23	-29	-21	-25	-34
Dahod	15th July	GR-17	-23	-29	-15	-31	-30
		Gurjari	-41	-38	-27	-37	-34
	30th July	GR-17	-33	-31	-18	-33	-32
		Gurjari	-47	-41	-32	-40	-38

Panch-mahal	15th July	GR-17	-40	-27	-19	-25	-31
		Gurjari	-48	-37	-17	-33	-38
	30th July	GR-17	-41	-29	-14	-38	-32
		Gurjari	-51	-40	-31	-29	-40
Vado-dara	15th July	GR-17	-31	-19	-15	-27	-32
		Gurjari	-36	-28	-10	-25	-28
	30th July	GR-17	-38	-22	-22	-28	-34
		Gurjari	-34	-34	-27	-24	-36

Table 2: Adaptation and vulnerability analysis of rice in middle Gujarat Agro-climate region

Districts	% Yield change in projected period (2071-2100) Under A_2 Scenario from baseline yield (1960-90)	% yield gain by adaptation 15 days early trans planting from normal transplanting date(15 july)	% yield gain by Change in variety	Better water management with additional fertilizer	early trans planting Change in variety Better water management with additional fertilizer	Net vulnerability under A_2 2071-2100 (Yield reduction even after adaptation)			
						Even after change in planting date (A_2 2071-2100)	Even after change in Change in variety	Even after change in Better water management with additional fertilizer	Even after early trans planting Change in variety Better water management with additional fertilizer
Anand	-27.8	8.8	5.2	7.2	9.8	-19.0	-22.6	-20.6	-18.0
Ahmedabad	-32.8	6.3	4.2	10.2	12.5	-26.5	-28.6	-22.6	-20.3
Dahod	-29.7	8.4	7.12	7.9	11.8	-21.3	-22.6	-21.8	-17.9
Panch-mahal	-35.4	7.21	5.6	9.9	13.6	-28.2	-29.8	-25.5	-21.8
Vado-dara	-33.8	6.8	8.2	10.8	14.2	-27.0	-25.6	-23.0	-19.6

T5 A262

IRON AND ZINC BIOFORTIFICATION IN RICE (*ORYZA SATIVA* L.) THROUGH GENETIC, TRANSCRIPTOME AND CROP MANAGEMENT APPROACHES IN CHANGING ENVIRONMENT

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Abstract

Rice (*Oryza sativa L.*) is a "Global Grain" and is especially important in biofortification efforts. Combination of breeding and fertilizer strategies is an excellent complementary approach to alleviate zinc-deficiency related problems in human nutrition.

Keywords: *biofortification, rice, gene expression, candidate gene*

Introduction

Dietary deficiency of iron (Fe) zinc (Zn) is a substantial global public health and nutritional problem. One third of the world population is at risk due to low dietary intake of Fe/Zn, including 2 billion people in Asia. The low Fe/Zn concentration is thought to indirectly result from breeding for high yield, and for pest and disease resistance. In addition, modern high yielding varieties remove large quantities of soil Fe/Zn at every harvest, lowering the residual concentration of soil Fe/Zn and contributing to lower future grain Fe/Zn concentration. Further, the availability of Fe/ Zn for plant uptake from the soil is affected by the concentrations of macro- and micro- nutrients, the physico- chemical and biological properties of a soil, as well as temperature and water availability. Elevated atmospheric carbondioxide concentration (e[CO2]) also reduces the grain micronutrient concentrations. The aim of FE/Zn biofortification of human food grains is to increase Fe/Zn concentration and its bioavailability in food, and this appears to be the most feasible, sustainable, and economical approach to address Fe/Zn deficiency in the human diet. Biofortification could be accomplished genetically through plant breeding and agronomically through Zn fertilization. Identification of the amount of genetic variability for Zn concentration in the germplasm is the initial step, then improving rice Fe/Zn concentration (Anuradha et al., 2012).

Rising [CO2] and Grain Fe/Zn

Effects of elevated [CO2] (e[CO2]) on the climate and on food production have become a major concern for global food and nutrient security. Importantly, e[CO2] is likely to have a profoundly affect on plant growth, yield, and grain quality. Without nutrient and water limitations, e[CO2] increases yield by enhancing photosynthesis and reducing crop water use. In addition, substantial reductions in grain quality of a number of species including rice and wheat have been reported under e[CO2].

Conventional breeding as an effective tool for Fe/Zn biofortification

Germplasm screening is the initial step for a breeding program to raise grain Zn concentration and to achieve breeding objectives there should be a wide genetic variation in grain Zn concentration. In addition, substantial genetic variation of Fe/Zn concentration in brown rice (13.5–58.4 mg/kg) has been reported for a large collection of rice germplasm at the International Rice Research Institute (IRRI), with an average of 25.4 mg/kg.

Expression study to identify the candidate genes

Sperotto *et al*., (2010) analysed the expression of 25 metal related genes from rice, including rice homologoues for YSls, NRAMPs, ZIPs, IRTI, VIT (coding for the known potential metal transporter), as well as NACs, FROs, and NAC5 (involved in metal homeostasis) in flag leaves of eight rice cultivars during panicle emergence (R3) and grain filling stage (R5). The expression of nine genes in flag leaves exhibited significant correlations with FE/Zn concentrations in the seeds.

QTL mapping for Fe/Zn concentrations

Identifying QTLs/genes for iron and zinc in rice grains can help in biofortification programs. 168 RILs were used for to map QTLs for iron and zinc concentrations in unpolished rice b Anuradha *et al*., (2009). They identified the high priority candidate gens for high Fe/Zn in seeds are OsYSL1, OsMPT1 for iron, OsARD2, OsIRTI1, OsNAS1, OsNAS2 for zinc and APRT for both iron and zinc based together.

Conclusion:

Iron and zinc concentration in rice grains is influenced by plant related factors (genetic factors), environmental factors, and crop management strategies (agronomic factors). Greater understanding of how these factors interact to influence grain Fe and Zn accumulation is vital for enriching Fe and Zn concentration in rice grain. Improved Fe and Zn uptake and efficient remobilization are identified as key bottleneck for Fe and Zn biofortification. These bottlenecks should be addressed by exploiting the wide genetic diversity of rice germplasm. The rising atmospheric [CO2] is likely to reduce grain Fe and Zn concentrations and the underlying mechanism is not fully understood. Fe and Zn fertilization will also play an important role, especially where soils are inherently low in bioavailable Fe and Zn. Consequently, new genetic and management strategies need to be developed to minimize Fe and Zn deficiency for people whose staple diet is rice.

Future Research Focus

Fe and Zn -efficient and -inefficient genotypes need to be evaluated under Fe and Zn sufficient and deficient conditions at different stages of growth and development to identify the genetic capacity for Fe and Zn uptake, utilization and loading into grain. Further, manipulation of Fe and Zn transporters is likely to be a major target for biofortification of rice. The interaction of environmental and genetic factors on Zn homeostasis should also be established. Different processing technologies, and promoters and inhibitors of Zn bioavailability in rice grains, need special attention.

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T5 A097
DEVELOPING SCENARIOS FOR CLIMATE CHANGE ADAPTATION IN INDIA USING CMIP5 CLIMATE MODEL SIMULATIONS

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Abstract
Adaptation is a key feature of sustainable agro-ecosystems. As the projected degree and pace of climate changeaccelerates, exacerbed by other biophysical limits such as declining per-capita land and waterand rising demand for agricultural products, the need for a systemic, powerful adaptation ofagro-ecosystems is increasingly obvious. Given, the complex, dynamic and multidisciplinary nature of agro-ecosystems, climate system and adaptive management systems, understanding these complex systems is not well developed and is likely to remain so into the foreseeable future. Additionally, there is a need for obtaining understandable information about climate change risks information that can support adaptation-related decision-making, provide straightforward estimations of variability, and be tailored to specific user groups.

The objective of our study is to address some aspects of this need by to providing the information in ways which can be more readily used by climate change impact assessment community for developing adaptation and mitigation strategies needed to respond to these changes. Monthly simulations of precipitation from 35 CGCMs which participated in the CMIP5 are investigated for baseline (1971–2005) and future [RCP4.5, RCP8.5 (2006–2099)] experiments. The percent change between the historical and future ensemble means for each 1.5º grid square is calculated for each category, story-line and future time-periods. From the percent changes, scenarios were created using innovative methodologies to provide the information that can support adaptation-related decision-making

T5 A103
DIVERSIFICATION OF AGRICULTURAL CROPS TO ADAPT TO CLIMATE CHANGE: A CASE STUDY OF GUJARAT

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Abstract
Acreage under major food-gains like wheat and rice, most of cash crops and horticultural crops were increased mainly due to increase in rainfall, irrigation and higher prices; whereas acreage under coarse cereals, pulses, oilseeds was declined. Amongst the different regions, North Gujarat reported the highest level of crop diversification followed by Middle Gujarat, South Gujarat and Saurashtra-kutch. Overall, Gujarat state reported a moderately high level of crop diversification, which secured farmers against climate risk but it was slightly declined during last decade.

Key words: Climate change, diversification, instability index, globalization, sustainable development

Introduction
Climate change is a global environmental challenge that is threatening sustainable development around the world. It is a continuing long-term process manifesting itself with gradual increase in temperature, greater variability in rainfall, rise in sea level and increased frequency, intensity and duration of extreme weather events, such as drought, flood, cyclone and storm surge (IPCC, 2007). In India, agriculture is inherently a risky venture due to uncertainty in production and volatility in price, and more so in the context of increased climatic aberrations and globalization. Therefore, there is a great need for diversification to provide food & nutrition security, economic support to farmers, stabilize farm income, induce farmers to invest in agriculture, environmental improvement and reduce indebtedness (Swain, 2014).

Climate change has affected crops and livestock in a number of ways resulting in unstable productivity. This paper looks at diversification as a key factor in reducing risk and means of coping with an uncertain climate. This paper has identified different combinations of agricultural crops that reduce current and future climate related risks in Gujarat state and changes in the cropping pattern will provide the highest risk security.

Material and methods

The time series data on area, production and productivity of major crops of Gujarat State were collected from the website of Department of Agriculture and Cooperation, Government of Gujarat, Gandhinagar (www.agri.gujarat.gov.in) for the period from 2001-02 to 2014-15. Compound Growth Rate (CGR) was calculated by fitting the exponential function and Instability Index **(**Cuddy Della Valle Index) was used to correct the co-efficient of variation (CV). A variety of measures of crop diversification which indicate the extent of dispersion and concentration of activities in a given time and space by a single quantitative indicator have been used in the literature of agricultural diversification (Birthal, *et al.*, 2007, Joshi *et al*., 2003, Kumar and Gupta, 2015). The Herfindahl Index (HI), Entropy Index (EI), Modified Entropy Index (MEI) and Composite Entropy Index (CEI) were used in present study to measure the crop diversification.

Results and Discussion

Compound Growth Rates and Instability Indices

The compound growth rates (CGRs) and Instability Indices (IIs) were worked out for area production and productivity of major crops of Gujarat state for the period from year 2001-02 to 2014-15, which are presented in Table 1.

The results revealed that production and yield of cereals increased significantly *i.e.* 4.52% and 3.87% respectively. There was highly significant rise in area (1.47% and 7.45%), production (5.12% and 9.62%) and productivity (3.66% and 2.17%) in rice and wheat, respectively. It may be due to increase in rainfall and irrigation facility during last years in the State. The area under bajra was significantly decreased by 5.41% even though its productivity was increased significantly by 4.51%.

All pulses except gram showed negative growth in area. Gram showed highly significant rise in area (7.91%), production (13.15%) and productivity (5.23%). In case of oilseeds, area under Groundnut and Sesamum significantly declined by 2.14% and 6.17%, respectively. Castor's area and production were increased significantly *i.e*. 7.05% and 9.6%, respectively due to its high demand in various industries and high prices.

Under cash crops, the area, production and yield of cotton was significantly increased by 4.13%, 10.75% and 6.6%, respectively. Similarly, the area under potato and cumin were also increased significantly by 7.94% and 6.83%, respectively where as area under sugarcane and Isabgul significantly declined by 1.75% and 1.38%, respectively.

The area, production and productivity of fruits, vegetables and flower crops were significantly increased. Overall horticultural crops showed significant rise in area, production and yield by 3.87%, 7.45% and 3.58%, respectively.

This further revealed that high growth and low instability *i.e.* in case of major cereals, cash crops and horticultural crops shows risk security of farmers in terms of economic returns as well as in terms of climactic adaptation.

Table 1: Compound Growth Rates and Instability Indices in Area, Production and Productivity of Major Crops of Gujarat State during 2001-02 to 2014-15

Crop	Area		Production		Productivity	
	CGR%	**II**	**CGR%**	**II**	**CGR%**	**II**
Cereals						
Rice	1.47**	5.86	5.12**	12.76	3.66**	10.57
Bajra	-5.41**	11.84	-0.9	21.12	4.51**	14.46
Maize	-0.69	9.82	-0.07	33.07	0.61	28.22
Jowar	-3.24	22.20	-0.78	21.15	2.47**	7.61
Wheat	7.45**	20.30	9.62**	26.25	2.17**	9.01
Total Cereals	0.66	10.63	4.52**	17.22	3.87**	9.16
Pulses						
Tur	-3.00**	7.29	0.71	11.48	3.71**	12.06
Gram	7.91**	27.80	13.15**	32.94	5.23**	12.03
Mung	-1.23	22.73	-0.68	28.36	0.55	17.96
Udad	-1.82*	9.43	0.69	19.47	2.44	14.98

Total Pulses	-0.68	13.02	3.05*	17.03	3.73**	10.44
Oilseeds						
Groundnut	-2.14**	8.78	1.42	46.12	3.55	42.90
Sesamum	-6.17**	15.94	-5.15*	29.69	1.03	21.69
Rapeseed	-1.49	19.84	0.63	25.61	2.13*	11.18
Castor	7.05**	21.58	9.6**	19.57	2.55	8.44
Total oilseeds	-0.48	6.67	3.57	31.67	4.05	27.58
Cash crops						
Cotton	4.13**	8.22	10.75**	27.07	6.6*	24.92
Tobacco	4.74	39.62	4.45	42.33	-0.24	8.31
Sugarcane	-1.75*	10.68	-1.95*	10.02	-0.19	6.86
Potato	7.94**	16.70	8.03**	21.75	0.12	10.05
Fennel	-1.08	33.07	0.63	33.49	1.68*	7.96
Cumin	6.83**	18.08	11.78**	21.50	4.94**	10.98
Chillies	5.19	57.51	-4.65	55.69	0.52	3.70
Isabgul	-1.38**	24.78	-12.4**	29.19	1.12	10.71
Onion	2.53	38.47	2.55	41.39	0.05	7.02
Garlic	2.70	50.69	1.77	54.87	-0.9	9.33
Guar	-0.63	31.94	1.86	57.98	2.48	29.06
Horticultural Cops @						
Fruits	3.34**	3.45	6.41**	5.73	3.07**	2.99
Vegetables	5.89**	5.05	8.32**	6.16	2.44**	2.15
Spices	2.05	10.65	5.6	20.00	3.55	15.52
Flowers	11.02**	7.19	15.71**	10.93	4.88**	8.07
Total horticultural crops	3.87**	4.17	7.45**	4.52	3.58**	4.09

* Significant at 5% level, ** Significant at 1% level @ Results pertained to the year 2005-06 to 2014-15

Crop Diversification

To know the regional changes in level of crop diversification, the whole Gujarat was divided into four regions *viz.*, Saurashtra, North, Middle and South Gujarat. The diversification indices for the first TE 2003-04 and the last TE 2012-13 and their temporal changes for all different regions as well as the State as a whole were worked out and the results are presented in Table 2.

Table 2: Region-wise Crop Diversification Indices, temporal changes and their Rank

Region	Diversification Index	First TE 2003-04	Last TE 2012-13	Actual change	% change	Rank
North Gujarat	**1-HI**	0.8962	0.8941	-0.0021	-0.23	1
	EI	2.5612	2.4850	-0.0762	-2.98	
	MEI	0.8169	0.7925	-0.0243	-2.98	
Middle Gujarat	**1-HI**	0.8878	0.8880	0.0003	0.03	2
	EI	2.4512	2.4657	0.0145	0.59	
	MEI	0.7818	0.7864	0.0046	0.59	

South Gujarat	**1-HI**	0.8604	0.8730	0.0126	1.46	3
	EI	2.2109	2.3526	0.1417	6.41	
	MEI	0.7051	0.7503	0.0452	6.41	
	[redacted]					
Saurashtra-kutch	**1-HI**	0.7700	0.7813	0.0114	1.48	4
	EI	1.9499	1.9538	0.0040	0.20	
	MEI	0.6219	0.6231	0.0013	0.20	
	[redacted]					
Gujarat State	**1-HI**	0.9028	0.8934	-0.0094	-1.04	-
	EI	2.6490	2.5922	-0.0568	-2.14	
	MEI	0.8448	0.8267	-0.0181	-2.14	
	[redacted]					

The results revealed that the extent of diversification was found highest in North Gujarat as none of the crops was pre dominant in this region. Though it ranked first position, the extent of diversification was declined by about 3% during the study period. The Composite Entropy Index (CEI) was 0.7813 and 0.7581 in the first and the last trienniums, respectively. Middle Gujarat occupied second rank with CEI 0.7478 and 0.7522 in the first and the last trienniums, respectively. It showed that the level of diversification was found stable, showing climactic adaptation in this region during the study period. South Gujarat with third rank reported 6.41% rise in level of diversification. The CEI worked out to 0.6745 and 0.7177 in the first and the last triennium, respectively. Saurashtra-kutch region reported the lowest diversification among all regions in Gujarat state. It was due to crops like cotton and groundnut were found very dominant over other crops. It was also noticed that the level of crop diversification remained stagnant during the study period. Overall, crop diversification in Gujarat state was moderately high with CEI 0.8081 and 0.7908 in first and last trienniums, respectively, which secured farmers against climate risk. It showed that the level of crop diversification was slightly declined by 2.14% during the study period.

Conclusions

The acreage under major food-gains like wheat and rice, most of cash crops and all the horticultural crops were increased whereas acreage under all coarse cereals, pulses, oilseeds was declined, which was mainly due to increase in rainfall, irrigation facility, high prices and introduction of Bt cotton variety. Amongst the different regions, North Gujarat reported the highest level of crop diversification followed by Middle Gujarat, South Gujarat and Saurashtra-kutch. The pre dominant crop like cotton and groundnut in Saurashtra-kutch was responsible for low level of diversification in the region. Overall, Gujarat state reported a moderately high level of crop diversification but it was slightly declined during last decade, which secured farmers against climate risk. In nut cell, there is a need to formulate policy by the government to sustain the level of crop diversification in the state.

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T5 A184

DROUGHT ADAPTATION AND EXPONENTIAL DECREASE IN NITROUS OXIDE EMISSIONS FROM SUSTAINABLE GROUNDNUT CULTIVATION IN SEMI-ARID PENINSULAR INDIA.

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Abstract

Climate mitigation, drought resilience, yield and farm-profit enhancement by sustainable groundnut farming in comparison to mainstream high input farming practices were assessed. Regional emission factors established were found to be higher than that of IPCC and Indian national estimates. High input rainfed farming resulted in exponential increase of nitrous oxide emissions.

Key words: *Mitigation, yield, Groundnut, Emission factor, Nitrous oxide, Exponential*

Introduction

Studies reporting agricultural greenhouse gas (GHG) emission data from tropical upland crops or the climate adaptation and mitigation potential of farming practices that involve sustainable nutrient management and/or organic farming are very limited in number. Groundnut is an important food and cash crop of India accounting for 55% of total oilseed production in the country (Madhusudhana, 2013). The state of Andhra Pradesh is the second largest producer of groundnut and Anantapur district (which often experiences agricultural drought and is part of agro-ecological zone 3.0 in semi-arid peninsular India) covers 50% of area under groundnut in the state (Kritee et al., 2015). During our three-year study from 2012-2014, we tested the hypothesis that as compared to baseline "business as usual" groundnut cultivation practices, alternate/organic production practices (1) can result in better crop yield and improved farm income; (2) provide better climate (drought) resilience as well as climate (nitrous oxide) mitigation; and (3) Nitrous oxide emissions increase exponentially with increasing chemical N use.

Materials and Methods

Yield, econometric and high sampling intensity nitrous oxide measurements were done from three replicates each of baseline high chemical nitrogen input and alternate organic inputs (or low chemical N input) treatments at farmer-managed plots for three years (2012-2014). The baseline practices were determined by surveys conducted amongst regional small-holder groundnut farmers. Alternate practices were determined by multi-stake holder processes and included use of locally prepared fermented manures (e.g., *jeevamrutha* and *ghanajeevamrutha*) and organic inputs like FYM, neem cake, green leaves.

Results and Discussion

Inspite of a 40-60% reduction in chemical nitrogen use, alternate organic practices resulted in 35-50% higher crop yield along with an increase in net profit of 70-120% when compared to conventional practices for 2012 *kharif* and *rabi* seasons respectively. Nitrous oxide emission reduction from alternate organic practices in 2012 and 2013 ranged 0.13-to 0.24-tCO2e ha−1 season−1. Seasonal emission factor for conventional and alternate organic practices ranged from 1.7 to 3.4.% and 1.6 to 4.5% of applied nitrogen for rainfed and irrigated systems, respectively. Thus, the average IPCC and Indian national emissions factors of 1 and 0.58 %, respectively, underestimate GHG emissions during groundnut cultivation. In addition, our data from 2014 which included plots with several different nitrogen input rates shows an exponential increase in nitrous oxide emission with increasing nitrogen input for rainfed groundnut cropping systems (R^2=0.68), which is in congruence with other global studies.

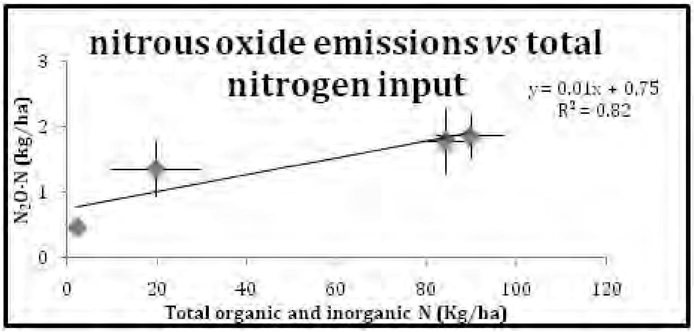

Figure 1: Irrigated cropping system: Linear increase in nitrous oxide emission with increasing nitrogen input. Error bars represent ±1 SE

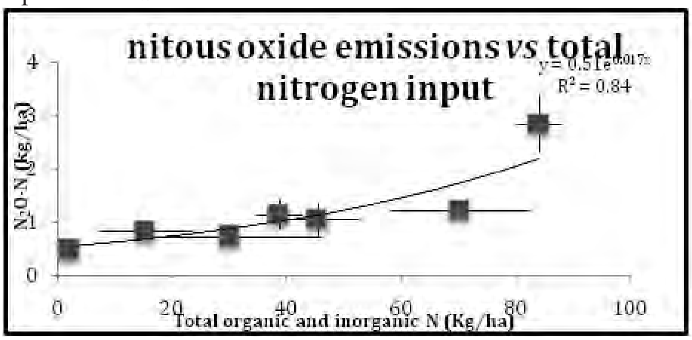

Figure 2: Rainfed cropping system: Exponential increase in nitrous oxide emission with increasing nitrogen input, Error bars represent ±1 SE

Conclusion

Our results showcase climate mitigation, drought resilience, yield and farm-profit enhancement potential of alternate organic farming practices.

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T5 A204

TRENDS IN CLIMATE CHANGE IMPACTS ON FARMERS AND THEIR LIVELIHOODS: EVIDENCE FROM WESTERN ODISHA, INDIA

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Abstract

The paper analyses the perceptions of the farmers on various aspects of present as well as future vulnerability to drought and climate change in western Odisha. The trends in various climatic factors like rainfall, temperature, drought frequency and intensity during last three decades have been assessed. The farmers' experiences on hardships faced, natural and human induced causes of the changes observed have been examined. The perceptions on changes/trend in various vulnerability factors such as water availability, soil quality, early warning system, deforestation, social safety nets, institutional support system, degradation

of wild life habitat, loss of wetland and water bodies, and damage to plant species etc. have been scrutinized. Besides, the future vulnerability to climate change has been assessed by ranking the vulnerability factors (economic/environmental/social/institutional) with respect to their effects during past, present and future climatic risks in the matrix form, thereby identifying the vulnerability factors posing greater threat in future.The study is based on the survey of 139 households.The study finds that the nature of changes in climatic factors in western Odisha shows that it is heading towards a gradual desertification. The factors that are posing greater threat in future are increasing temperature and rainfall variability, frequent pest attack and plant diseases, gradual decline in grazing land and fodder availability, reduction and degradation of wild life habitat and loss of wetland and water bodies.Among different economic impacts of drought related to crop farming, the impacts showing clear increasing trend are drought induced insect infestation and plant diseases, disruption in water supply, unemployment from production decline and increase in food prices. Due to increasing frequency of drought and moisture stress, the resistivity of plants is gradually falling, that in turn, results in increasing risks towards frequent pest attack.The increasing occurrence of political and management conflicts, political nepotism and corruption are expected to further increase the vulnerability of rural poor. The quality of life is perceived to be deteriorated in the coming days due to rising degradation in environmental, social and economic spheres. On all these accounts, the mental and physical stress levels are expected to increase for vulnerable rural poor.

Key Words: present and future vulnerability, trend in climatic factors, farmers' perception, western Odisha

T5 A212

CROP-LIVESTOCK-AGRO FORESTRY BASED INTEGRATED FARMING: A WAY TO CLIMATE CHANGE RESILIENCY

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Climate change is indeed perhaps one of the major challenges facing the world today. The concept of Climate Smart Agriculture (CSA) mainly on sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and, reducing and/or removing greenhouse gas emissions. In this context, NRRI developed a sustainable crop- livestock-agro forestry integrated farming system (CLAIFS) model for enhancing livelihood security of the small and marginal farmers. The system developed with suitable land scaping with ecological engineering concepts of soil and water conservation, rain water harvesting, nutrient and farm waste recycling with multitier farming system having components of rice, other crops, pulses, seasonal vegetables farming, horticultural plants (banana, papaya, mango, guava, coconut), livestock (fish, duckery, poultry, goatry) and agro forestry etc.

The system established in 2004-05 and results indicated significant increase in the percentage rice yield, rice equivalent yields (REY), the ratios of output value to the cost of cultivation (OV-CC ratio), water productivity (WP), gross water productivity (GWP) and net water productivity (NWP) in comparison to the rice-monocropping(RMC). The adoption of CLAIFS system helpful in terms of soil health, carbon sequestration and water conservation, energy efficient, climate change resilient and mitigation/ reduction of green house gas(GHG) emission, biodiversity and provide food security to farm families and is moreresilient against global warming and climate change than a specialized system of farming. For building suitable climate change resilience agro ecosystemthe system has biodiversification,agro forestry, and crop-livestock integration which reducesthe vulnerabilities of climate change effectsand maintaining the farm production and profit withenhancing the stability and resiliency in climate changing scenario. Further, as the system having animal components integration and have nutrition recycling through organic manure and farm waste composting resultingless quantity of fertilizer and pesticide application as well as enhanced the nitrogen use efficiency of the plants. The CLAIFS are more energy efficient and presence of agro forestry system contributing comparatively less towards the global warming as compared to mono cropping. The presence of fish and ducks in the rice field reduced the methane emission substantially.In conclusion the CLAIFS model ensures the growth and stability in overall farm productivity and profitability and having an potential for climate change resiliency, adoption and mitigation strategies and thusenabling the farmer's management/ participation of climate risks, adoption and mitigation processes for building a climate resilient production systems for national food security.

T5 A280
CLIMATE CHANGE, NATURAL RESOURCE DEGRADATION&AGRICULTURE IN INDIA

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Abstract
An attempt has been made in this paper to review the impact of climate change and environmental degradation on Indian agriculture. The world is facing many challenges; prominent among these are climate change, environmental degradation, sustainable development and food security for growing population. The threat of climate change is now considered as an established fact and talked as a global common problem. The rapid increase in greenhouse gases in the atmosphere, land degradation, increasing floods and droughts, marching deserts and deteriorating conditions of fragile ecosystems, deforestation, loss of biodiversity and environmental pollution have become subjects of serious concerns. The overall impact of these phenomena is likely to result in depletion of ozone layer, change in climate, rise in sea-level, loss of natural resources, reduction in their productivity ultimately leading to an ecological crisis affecting livelihood options for development and overall deterioration in quality of life. It is generally recognised that climate change has an impact on agriculture. Agriculture is the main source of livelihood for more than half of the world's population, and constitutes the cornerstone in the economy of many developing countries. Climate change, although a global phenomenon, will have serious implication for the poor in India, making them more vulnerable to food insecurity and hunger. Climate change will have a overall negative impact on Indian agriculture, with varying seasonal and regional implications and likely to reduce yields of most crops in long-term. Increased climatic variability could cause significant fluctuations in production even in short-term. Producing enough food for meeting the increasing demand against the background of reducing resources in a changing climate scenario, while also minimizing further environmental degradation, is a challenging task. This would require increased adaptation and mitigation research, capacity building, changes in policies, regional cooperation, and support of global adaptation and mitigation funds and other resources. Simple adaptations such as change in planting dates and crop varieties could help in reducing impacts of climate change to some extent. Additional strategies for increasing our adaptive capacity include bridging yield gaps to augment production, development of adverse climate tolerant genotypes and land use systems, assisting farmers in coping with current climatic risks through providing weather linked value-added advisory services to farmers and crop/weather insurance, and improved land and water use management and policies.

Theme 6
Soil Health and Input Management

T6 A012
DEVELOPMENT OF METHYLOTROPHIC BACTERIAL CONSORTIUM AND ITS EFFICACY ON PADDY *CV*. GURJARI

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Abstract
Methylotrophic native, selected bacterial isolates of wetland paddy were studied for methane degradation and plant growth promoting traits. Phyllospheric and rhizospheric methylotrophic efficient isolates were formulated to developed liquid consortium followed with testing of efficacy on paddy *cv*. Gurjari, showed improved growth and yield attributes with possibility of saving chemical fertilizers (20%) in rice.
Key Words Phyllosphere, Rhizosphere, Methylotrophs, Plant growth, PGPR, Paddy

Introduction of green revolution technologies during recent past in agriculture has led us for more dependence on the supply of synthetic inputs (like chemical pesticides and fertilizers), which have several adverse effects due to the excess and imbalanced uses in last five decades and have adversely affected the soil health as well as useful bacterial fauna. Methylotrophic bacteria in soil and crop are capable of using methane as a source of carbon and energy predominantly present in aerobic soil layer, in roots and surrounding the roots (Dubey and Singh, 2000) and on the stem bases of flooded rice plants. The rice crop rhizosphere appears to have heterogeneous habitat for methylotrophs because, both methane concentrations and oxygen released by the roots are highly variable. Methane availability increases population of methylotrophic bacteria. Besides beneficial methylotrophic bacteria role in methane degradation, have also the ability to promote plant growth through one or more mechanisms. In this regards, several studies have conclusively shown that methylotrophs improve plant growth through the production of phytohormones like indole-3- acetic acid (IAA) and cytokinines (Madhaiyan *et al*., 2006) and enzymes like 1- aminocyclopropane-1-carboxylate (ACC) deaminase involved in lowering the ethylene levels in plants, production of siderophores and protection against pathogens through induced systemic resistance are mainly documented in different parts of the world (Idris *et al*., 2004). Methylotrophs are also able to nodulate legumes and fix nitrogen either symbiotically (Sy*et al*., 2001) or in free living state (Raja *et al*., 2006). Potential methylotrophic bacteria have great application purposes for environment friendly and sustainable agriculture system. The association of Methylobacterium with plants possesses an associative symbiotic relationship, in which Methylobacterium utilizes methanol emitted from leaves of the plants as sole source of carbon and energy. Co-inoculating PPFMs with other compatible bacterial communities will enhance possibility of better efficacy over conventional species specific single microbial plant probiotics in soil and foliage (Meena *et al*., 2011).

Phyllospheric methylotrophic (methane consumer) native bacterial isolates were recovered from leaf surface of wetland paddy grown at Agricultural Research Station for Irrigated Crops as well as from farmer's fields of Thasra Taluka growing paddy customarily. Isolation was carried out on AMS medium by leaf imprinting technique. Screening, identification and characterization by 16S *r*RNA sequencing, *in vitro* assessment of enzyme activity for methane degradation as well as plant growth promotion activity were studied. Three native phyllospheric methylotrophic efficient bacterial isolates (M-3, M-10 and M-15) selected for compatibility with three rhizospheric methylotrophic bacterial AAU rhizospheric strains, *Bacillus aerius* AAU M-8, (*Panibacillus illinoisensis* AAU M-17 and *B. megaterium* AAU M-29 (Jhala *et al,* 2015)for consortium development. Based on above six selected methylotrophic bacteria, consortium formulated in liquid form and tested efficacy on paddy *cv*. Gurjari.

The experiment laid out in Randomized block design with four replication at ARS, Thasra in 2014. Treatments comprises as, T_1: 100% RDF, T_2: 80% RDF, T_3: 60% RDF, T_4: T_2 + consortia, T_5: T_3 + Consortia, T_6: only consortia and T_7: absolute control. The results indicated that T_4 treatment showed significantly higher growth parameters viz., plant height, root length, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, yield attributing component viz., number of tiller/plant, number of panicle/plant, length of panicle, number of seed / penicle, seeds weight, grain yield, straw yield and methylotrophic bacterial population followed by T_1, T_2 and T_5 treatments as compared to other treatment as well as uninoculated control with indicating possible 20% chemical fertilizer reduction in rice.

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Table 1: Methylotrophic bacterial consortium and its efficacy on paddy cv. Gurjari

Treatments	Growth attributing characters			Yield attributing characters		
	Chlorophyll content (µg/cm^2) at 30 DAT	Plant height (cm) at 30 DAT	Root length (cm) at harvest	Seeds wt./penicle (g) at harvest	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1- 100% RDF	54.53	95.90	26.05	5.04	5392	7217
T_2- 80% RDF	54.40	94.65	25.50	4.73	4875	6800
T_3- 60% RDF	51.85	91.25	23.93	4.23.	4584	6092
T_4- T_2 + Consortia	55.15	96.28	28.38	5.11	5533	8092
T_5- T_3 + Consortia	52.68	92.20	24.85	4.24	5292	6467
T_6- Only Consortia	49.65	89.10	23.50	4.07	3792	6598
T_7- Absolute Control	49.13	86.30	22.25	3.97	3584	5542
SEM at 5%	1.18	2.37	1.20	0.28	381	360
C. D. at 5%	3.52	NS	3.56	0.83	1133	1069
C. V. %	4.51	5.15	9.61	12.45	16.15	10.76

T6 A032
DESCRIPTION AND RECORD OF NATIVE METHANOTROPHIC BACTERIA ABLE TO MITIGATE METHANE FROM WETLAND PADDY

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Five potential methane oxidizing bacteria were isolated containing methane oxidizing enzymes enabling them to consume methane for their growth. They showed positive plant growth promoting traits with rice growth promotion. These novel indigenous methanotrophic isolates indicates prospect as agriculturally beneficial bioinput with inherent capacity of methane mitigation from rice.

Key words: Methanotroph, Rice, Indigenous, Bioinput, Inherent, Mitigation

Introduction

The atmospheric trace gas methane (CH_4) is a prominent “greenhouse” gas accounting for 15-20% of global warming. Up to 70 to 80% of atmospheric CH_4 is biogenic. The contribution from rice cultivation is estimated to range from 39-112 Tg CH_4 y^{-1}. About 80% of the rice harvest is grown under the more productive flooded conditions (wetland paddy) and thereby major source of methane emission. The only known biological sink for atmospheric methane is its oxidation in aerobic soils by "methanotrophic bacteria". All methanotrophs are having highly conserved key enzymes *viz.* particulate methane monooxygenase (pMMO), soluble methane monooxygenase (sMMO) and methanol dehydrogenase (MDH), so that detection of enzymatic activity may offer the possibility of detecting all known methanotrophs (Hanson and Hanson, 1996). The present investigation was undertaken with the aim of isolation of methanotrophic bacteria having PGPR activity which can present a great opportunity to reduce methane emission from agriculture sector and easily adoptable technology by farmers without need to modify conventional farming practices. Present research first time uncover five methane degrading bacterial strains within the known PGPB group of organisms from wet land paddy agro-ecosystem which are not previously reported.

Materials and Methods

Isolation, screening and characterization of methane utilizing bacteria

Isolation of methylotrophic bacteria from wet land paddy was done using enrichment culture technique as described by Hoppe *et al.* (2011). All the suspected isolates were screened for growth in the evacuated tubes containing water as the basal media with 1% methane in the head space of the tube. Growth of each isolates has been observed by colorimeter to screen their methylotrophic property. Selected isolates were characterized on the basis of morphological, biochemical and 16S *rRNA* profiling.

In vitro Conformation of methylotrophic activity

Molecular characterization was carried out using PCR detection of genes *mmo*X, *pmo*A and *mxa*F gene in the isolates, encoding sMMO, pMMO and methanol dehydrogenase which are key enzymes in bacterial methane metabolism pathway (Horz *et al.*, 2001). For identification and phylogenetic relationship of the potential isolates, 16S *rRNA* sequencing was carried out.

In vitro enzyme activities for methane degradation

Qualitative and quantitative determination of enzyme activities for two key enzymes *viz.* methane monooxygenase (Graham *et al.,* 1992, Koh *et al.*, 1993) and methanol dehydrogenase Eggeling and Sahm (1980) involved in methane oxidation were carried out according to standard literature.

Plant growth promoting activity of the isolates

All the isolates were tested for PGPR traits *viz.* presence of *nif*H gene, phosphate solubilization, potash solubilization, production of indole acetic acid, siderophore, cell wall degrading enzymes and inhibition of phytopathogens and rice growth promotion under pot trial conditions.

Results and Discussion

Isolation, screening and characterization of methylotrophic bacteria from wetland paddy

All five isolates were found to multiply in 1 % methane + water. After 10 days of inoculation, there was fourfold increase in cell numbers confirming methanotrophic nature of isolates. So inspired from the results, these five potent isolates *viz.* M 8, M 10, M14, M 17 and M 29 were chosen for further study. Based on morphological, biochemical and molecular characterization of selected methylotrophic isolates, M 8 as *Bacillus aerius* AAU M 8, Isolate M 10 as *Rhizobium* sp. AAU M 10, isolate M14 as *B. subtilis* AAU M 14, isolate M 17 *as Paenibacillus illinoisensis* AAU M 17 and M 29 as *B. megaterium* AAU M 29. The sequence analysis of partial 16S *rRNA* gene of isolate M 8, M 10, M 14, M 17 and M 29 have been deposited in NCBI, GeneBank under accession numbers KC787582, KC787583, KC855269, KC787584 and KC787585 respectively. The analysis named.

Detection of methane metabolism genes

Among all the tested isolates *B. aerius, Rhizobium* sp., *B. subtilis* and *P. illinoisensis* showed ~ 518 bp, 536 bp, 518 bp and 527 bp respectively, indicating these isolates may possess pMMO enzyme responsible for capacity of methylotrophs to utilize methane. Among the five tested isolates, *Rhizobium* sp., P. *illinoisensis, B. megaterium* and *M. extrorquens* strain gave single band of ~ 870 bp indicating these isolates may also have capacity to utilize methane using soluble methane monooxygenase enzyme. Similarly, *Rhizobium* sp. and *P. illinoisensis* showed single band of ~507 and ~579 bp size indicating presence of *mxa*F gene.

In vitro detection of methane metabolizing enzymes activities

Chosen isolates were further subjected to qualitative and quantitative detection of two key enzymes of methane degradation pathway *viz.* methane monooxygenase catalysing oxidation of methane to methanol and methanol dehydrogenase catalysing oxidation of methanol to formaldehyde (Murell, 1994). Methanotrophic colonies expressing sMMO turned deep purple when exposed successively to naphthalene and o-dianisidine. Isolate M 10, M 17, M 29 and *M. extrorquens* (MTCC 298) were found positive for sMMO activity in absence of copper ions in media. Moreover, when media was supplemented with $CuSo_{4,}$ sMMO activity was not detected. The soluble methane monooxygenase activity of all the isolates ranged from 22.5 to 37.0 nmol min^{-1} mg of $protein^{-1}$. All the isolates were found positive for methanol dehydrogenase activity. Methanol dehydrogenase activity of all the isolates ranged from 35-75 nmol min^{-1} mg of $protein^{-1}$ (Table 1). The ability of methanotrophs to oxidize methane is due to the possession of the enzyme called methane monooxygenase (MMO). There are two distinct forms of this enzyme, a membrane-bound particulate methane monooxygenase (pMMO) and cytoplasmic soluble methane monooxygenase (sMMO) (Hanson and Hanson, 1996). All the isolates showed methanol dehydrogenase enzyme activity which is the second key enzyme responsible for bacterial methane metabolism pathway which degrade second product of the pathway i.e. methanol. In methane-oxidizing bacteria (methanotrophs), MDH is the second enzyme in the methane oxidation pathway and it oxidizes the methanol produced from the oxidation of methane by methane monooxygenase.

Plant growth promoting activity of the isolates

In vitro characterization of isolates for PGPR traits showed presence of *nif*H in *B. aerius* and *Rhizobium* sp. All the isolates were capable of solubilizing TCP in liquid media with *B. megaterium* showing the highest solubilization capacity with 305.6 µg /ml 3 DAI followed by *Rhizobium* sp. All the isolates were capable of producing IAA, *B. aerius* and *Rhizobium* sp. showed presence of ACC deaminase. All the isolates showed variable pattern of antagonistic activity against pathogenic fungi. Moreover, all the isolates were capable of producing siderophore and lipase enzyme. Except *B. subtilis* all the isolates produced chitinase enzyme. These results confirms that methylotrophic isolates were found to have one or more PGPR traits *viz.* nitrogen fixation, phosphate and potash solubilization and thereby increase the availability of nutrients. Moreover, all the isolates were capable of producing IAA which plays a central role in plant growth and development as a regulator of numerous biological processes which improves root growth and surface area providing a large surface area for nutrient and water uptake which directly affects plant development. In addition, all the isolates showed production of biocontrol molecules such as siderophores and lipase enzymes and showed antagonistic activity against some soil borne pathogens as well as some of them were also capable of producing stress release enzyme ACC deaminase together provides good plant growth.

Results showed that inoculation of methylotrophic bacteria can significantly influence rice plant growth parameters with reduction of 25 % chemical fertilizers (N:P) and soil health parameters of rice *cv.* Gurjari and IR 64 in pots. Among all the isolates *B. megaterium* was the best plant growth promoting methylotroph followed by *P. illinoisensis, Rhizobium* sp., *B. aerius* and *B. subtilis*. Moreover, these methylotrophs also showed improvement of soil fertility by increasing total organic carbon and nitrogen content as well as soil bacterial population. Moreover, inoculation of methylotrophic isolates via seed dressing or seedling dip makes its application suitable for farmers growing drill as well as transplanted paddy. Madhaiyan *et al.* (2009) evaluated the effects of co-inoculating *M. oryzae* along with nitrogen-fixing *A. brasilense* or a phosphate solubilizing bacterium *B. pyrrocinia* on the growth and nutrient uptake of tomato, red pepper and rice. Seed inoculation and soil/foliar application of the bacterial strains alone or under dual inoculation significantly increased the plant growth in terms of shoot or root length with increased nutrient uptake in the treated plants compared to uninoculated plant.

Table 1: Methanotrophic and PGPR traits of methanotrophic bacterial isolates

Isolates	Methane degrading enzyme activity		PGPR traits			
	sMMO activity activity*	MDH activity**	P solubilization***	IAA production****	ACC deaminase	Biocontrol traits*****
B. aerius	ND	41.0	93.6	15.74	+	+
Rhizobium sp.	22.5	49.0	134.5	9.83	+	+
B. subtilis	ND	37.0	67.3	11.80	ND	+
P. illinoisensis	37.0	75.0	103.8	13.77	ND	+
B. megaterium	30.0	63.0	305.6	14.75	ND	+
M. extrorquens	26.7	35.0	ND	ND	ND	ND
S.Em.±	0.42	1.00	-	-	-	-
CD at 5%	1.30	3.10	-	-	-	-
CV %	3.77	3.48	-	-	-	-

Note: ND-not detected;

* Soluble methane monooxygenase activity (Naphthalene oxidation nmol min^{-1} mg of $protein^{-1}$), ** Methanol dehydrogenase activity (nmol DCPIP reduced min^{-1} mg of $protein^{-1}$), *** Soluble P content (µg/ml), **** IAA production (µg/ml), ***** Biocontrol traits: Inhibition of phytopathogenic fungi *Fusarium* sp., *A. parasiticus* (78 %) and *M. phaseolina* siderophore production and lipase enzyme production

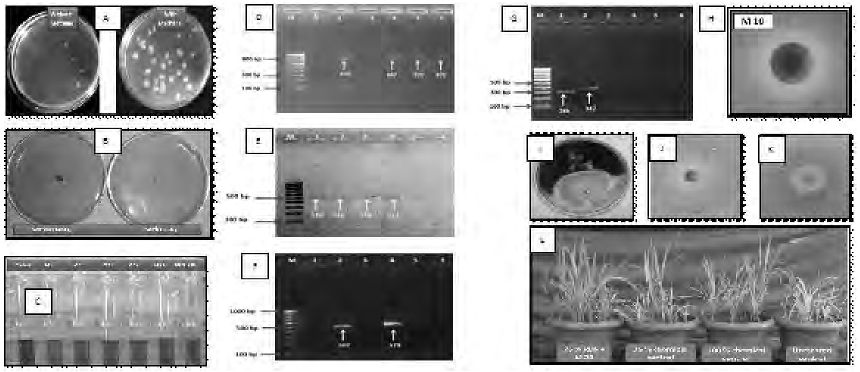

Figure 1: Methanotrophic and PGPR traits of methanotrophic bacterial isolates. A: Survival on methane as sole carbon source (*B. megaterium* M 29), B: Soluble methane monooxygenase production (P. *illinoisensis* M17, C: Methanol dehydrogenase assay, D: presence of *mmo*X gene, E: Presence of *pmo*A gene, F: Presence of *mxaF* gene, G: nif H gene profiling, H: zone of phosphate solubilization, I: Biocontrol activity (*M. phaseolina* vs. M29*),* J: siderophore production, K: Lipase production, L: Efficacy on rice cv. Gurjari.

Description of lanes for D,E,F,G: lane M: 100 bp marker, lane 1: Standard strain, lane 2: *B. aerius* M8, lane 3: *Rhizobium* sp. M10, lane 4: *B. subtilis* M14, lane 5: *P. illinoisensis* M17, lane 6: *B. megaterium* M 29.

Conclusion

The results of present study clearly brought out that, all the five tested isolates from wetland paddy efficiently utilized methane as sole source of carbon and confirmed the presence of genes encoding enzymes responsible for methane degradation pathway of bacteria. In addition they may reduce 25 % chemical (N:P) fertilizers in rice. Due to their multidimentional utility these novel isolates can be promoted as newer bioinputs to reduce methane emission and reduce chemical fertilizer load entering in to wetland paddy agro-ecosystem.

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T6 A118

FEASIBILITY OF ORGANIC FARMING FOR GROUNDNUT-WHEAT CROPPING SEQUENCE

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Abstract

A field experiment was conducted at Junagadh on clayey soil during 2010-11 to 2012-13 at Junagadh (Gujarat) to evaluate the potentiality of organic farming in groundnut-wheat cropping sequence in terms of productivity, profitability and soil health. Treatments comprised farmyard manure (FYM), farm compost (FC), vermicompost (VC, poultry manure (PM), biofertilizer (BF) and recommended dose of fertilizers (RDF). The organic manures were applied on equivalent N basis. Biofertilizer viz., *Rhizobium* for groundnut and *Azotobacter* for wheat was applied as seed treatment. Results revealed that application of FYM and VC recorded significantly higher pod yield (1786 and 1665 kg/ha) and haulm yield (3147 and 2978 kg/ha) of groundnut

as compared to RDF. While RDF and VC recorded significantly higher grain yield (4332 and 3885 kg/ha) and straw yield (6404 and 5967 kg/ha) of wheat. Maximum net return and B:C ratio were obtained with FYM in groundnut and RDF to wheat. Overall maximum net return and B:C ratio from groundnut-wheat cropping system were realised with FYM. Application of organic manures to groundnut-wheat sequence significantly improved bulk density, organic carbon content, post harvest soil fertility, and increased uptake of N, P and K over RDF.
***Key words*:** Fertilizer, FYM, compost, poultry manure, vermicompost, biofertilizer, *Rhizobium*, *Azotobacter*

Introduction

Indiscriminate and excessive use of chemicals has put forth a question mark on sustainability of agriculture in the long run calling attention for sustainable production which will address soil health, human health and environmental health and eco-friendly agriculture. Groundnut-wheat is one of the pre-dominant cropping sequences found suitable especially under Saurashtra conditions. The nutrient requirement of any crop must be based on entire cropping sequence. Hence it is highly essential to apply organic sources which are easily available and feasible. Maintenance of soil organic matter is pre-requisite for maintaining soil health and crop productivity. Therefore, the present study of organic farming in comparison to chemical fertilizers was undertaken in groundnut-wheat crop sequence.

Material and methods

A field experiment was conducted at Junagadh during 2010-10 to 2012-13 at Department of Agronomy, Junagadh Agricultural University, Junagadh (Gujarat) to evaluate the potentiality of organic farming in groundnut (*kharif*)-wheat (*rabi*) crop sequence. Treatments comprising farmyard manure (FYM), farm compost (FC), vermicompost (VC), poultry manure (PM), biofertilizer (BF) and recommended dose of fertilizers (RDF) were tried in randomized block design with four replications. The soil of the experimental site was clayey in texture, slightly alkaline in reaction, low in available N and P and high in available K. The RDF for groundnut and wheat was 12.5-25-0 and 120-60-0 kg N-P_2O_5-K_2O/ha, respectively. The FYM, farm compost, vermicompost and poultry manure were applied @ 2.500, 3.125, 0.625 and 1.250 t/ha to groundnut and 24.000, 30.000, 6.000 and 12.000 kg/ha to wheat on equivalent N basis. Biofertilizer viz., *Rhizobium* for groundnut and *Azotobacter* for wheat were treated with seeds @ 10 g/kg seed. Groundnut (cv. GG 20) and wheat (GW 366) were raised with recommended package of practices. Economics of different treatments was worked out on the basis of prevailing market price of inputs and produce. For organic treatments, 20% higher market price of produce was considered. Soil analysis for bulk density, organic carbon, and available NPK after harvest as well as plant analysis for NPK content were carried out by standard procedures.

Results and discussion

Crop Yield

Groundnut : Significantly higher pod yield of 1786 kg/ha was recorded with application of FYM in pooled results, which remained statically at par with vermicompost (1665 kg/ha). On the other hand, significantly the lowest pod yield (1106 kg/ha) was recorded with biofertilizer (Table-1). Application of FYM recorded significantly the highest haulm yield of 3147 kg/ha, however it remained statistically at par with vermicompost (2978 kg/ha). While, significantly the lowest haulm yield (2045 kg/ha) was registered with biofertilizer (Table-1). Sagarka *et al.* (2010) and Sutaria *et al.* (2010) also reported similar results.
Wheat: Significantly higher grain yield of 4332 kg/ha and straw yield of 6404 kg/ha were recorded when crop was fertilized with RDF, but it remained statistically equivalent to vermicompost in respect of straw yield (5967 kg/ha). On the contrary, application of biofertilizer registered significantly the lowest grain yield of 2795 kg/ha and straw yield of 4541 kg/ha (Table-1). Similar results were also reported by Chaturvedi (2006) and Rajkhova and Borah (2008).

Economics

Groundnut: Application of FYM recorded higher net returns of Rs. 65470/ha and B:C ratio of 5.13, followed by that of vermicompost which recorded net returns of Rs. 59663/ha and B:C ratio of 4.67 (Table-1).
Wheat: Fertilizing the crop with RDF recorded higher net returns of Rs. 57074/ha and B:C ratio of 3.60, followed by FYM in case of net returns (Rs. 48341/ha) and biofertilizer in case of B:C ratio (3.34) (Table-1).
Cropping sequence: Application of FYM resulted in higher net returns of Rs. 113810/ha and B:C ratio of 3.45, followed by vermicompost in case of net returns (Rs. 107882) and RDF in case of B:C ratio (3.42) from the groundnut-wheat cropping sequence (Table-1).

Nutrient Uptake

N uptake: Application of FYM recorded significantly higher N uptake by groundnut (123 kg/ha). The seed treatment with biofertilizer recorded significantly lower uptake of N (74 kg/ha) (Table-2). Significantly higher uptake of N by wheat (127 kg/ha) was registered under RDF. Significantly lower uptake of N (82 kg/ha) was observed under biofertilizer (Table-2).

P uptake: Significantly higher uptake of P (12.8 kg/ha) by groundnut was recorded with FYM. Seed treatment with biofertilizer resulted in lower removal of P (7.6 kg/ha) (Table-2). Whereas, significantly higher uptake of P (19.3 kg/ha) by wheat was registered with RDF, but remained at par with vermicompost (18.1 kg/ha). The biofertilizer resulted in lower removal of P (12.7 kg/ha) (Table-2).

K uptake: Manuring with FYM recorded significantly higher uptake of K (31.2 kg/ha) by groundnut. Whereas, significantly lower uptake of K (17.9 kg/ha) was observed under biofertilizer (Table-2). Significantly higher uptake of K (78.9 kg/ha) by wheat was registered under RDF, but it was at par with vermicompost and FYM. Significantly lower uptake of K (58.7 kg/ha) was recorded with biofertilizer (Table-2).

Post Harvest Soil Fertility

Application of organic manures improved soil health by decreasing bulk density and increasing organic carbon, and available N, P and K status after harvest of groundnut and wheat.

Conclusion

Higher net return along with sustained soil health can be achieved by application of FYM to groundnut and wheat. Hence, under organic farming, groundnut-wheat crop sequence can be manured with FYM on equivalent N basis on clayey soil of south Saurashtra agro-climatic zone.

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Table 1. Effect of different treatments on crop yield and net returns (Pooled over three years)

Treatment	Groundnut yield (kg/ha)		Wheat yield (kg/ha)		Net returns (Rs/ha)			B:C ratio		
	Pod	Haulm	Grain	Straw	Groundnut	Wheat	Sequence	Groundnut	Wheat	Sequence
FYM	1786	3147	3627	5566	65470	48341	113810	5.13	2.58	3.45
FC	1554	2775	3323	5034	54958	41710	96667	4.47	2.36	3.08
VC	1665	2978	3885	5967	59663	48219	107882	4.67	2.33	3.05
PM	1359	2620	3068	4770	46405	33448	79853	3.91	2.00	2.62
BF	1106	2045	2795	4541	36250	42681	78931	3.54	3.34	3.42
RDF	1248	2282	4332	6404	32926	57074	90000	3.15	3.60	3.42
LSD (P=0.05)	131	233	296	535						

Table 2. Effect of different treatments on nutrient uptake by crop (Pooled over three years)

Treatment	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	Ground-nut	Wheat	Groundnut	Wheat	Ground-nut	Wheat
FYM	123	100	12.8	17.8	31.2	76.9
FC	104	95	10.9	16.0	26.1	65.2
VC	111	110	11.6	18.1	27.4	80.8
PM	95	90	10.2	15.5	24.8	64.6
BF	74	82	7.6	12.7	17.9	58.7
RDF	86	127	8.6	19.3	21.3	78.9
LSD (P=0.05)	8	8	0.9	1.5	2.2	11.7

Table 3. Effect of different treatments on post harvest bulk density, organic carbon and available nutrients (Pooled over three years)

Treatment	Bulk density (g/cm^3)		Organic carbon (%)		Available N (kg/ha)		Available P (kg/ha)		Available K (kg/ha)	
	Groundnut	Wheat	Groundnut	Wheat	Groundnut	Wheat	Groundnut	Wheat	Groundnut	Wheat
FYM	1.350	1.422	0.78	0.70	223	219	36.0	35.8	252	242
FC	1.382	1.426	0.76	0.68	214	215	38.2	38.3	244	239
VC	1.386	1.449	0.73	0.63	199	209	43.3	41.4	247	236
PM	1.393	1.445	0.74	0.66	206	213	52.1	46.7	254	257
BF	1.412	1.475	0.71	0.61	196	197	32.8	31.2	226	218
RDF	1.460	1.478	0.49	0.51	190	203	29.9	34.6	236	228
LSD (P=0.05)	0.060	0.015	0.10	0.05	9	8	8.7	6.8	8	17

FYM = Farmyard manure, FC = Farm compost, VC = Vermicompost, PM - Poultry manure, BF = Biofertilizer

RDF = Recommended dose of fertilizers

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CLIMATE CHANGE IMPACT ON AGRICULTURE, LIVESTOCK AND HEALTH & EDUCATION INSAHARIYA TRIBAL COMMUNITY LIVING IN BARAN, RAJASTHAN

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Introduction

In the present scenario climate change is a burning and debatable issue for every country of common concern. The scientists, scientific and environmental organizations and government of every country having prudent conscience, that the changing climate is a result of the human activities. And India is not left behind from getting the effects of climate change, although India is food self-sufficient country where agriculture is an important component of the economy. More than 56% of workers are engaged in agriculture allied sectors, while many others earn their living in coastal areas through tourism of fishing; in indeed most of the poorest people live in rural areas and are most completely reliant on natural resources for their food and shelter (UN Human Development Report 2007/8). In India drastic effects and trends of the climate change are seen in the last few years in the form of natural disaster, increased in pollution and raised sea level and change in the monsoon pattern etc. In Rajasthan around two third of its population (56.5 million) is still dependent on agricultural activities for their livelihood. Only 34.5 per cent of the net sown area is irrigated. Climate change is one of the greatest challenges of our time. Fossil fuel burning and deforestation have emerged as principal anthropogenic sources of rising atmospheric carbon dioxide (CO2) and other green-house gases and consequential global warming. Proxy records of variability in temperature, precipitation, sea level and extreme weather events provide collateral evidence of global climate change. Observational data from land and oceans as well as model results suggest that several ecological, economic and social systems are being affected by climate change. Rajasthan is the largest state in India with two-third of its area as Thar Desert. The entire State receives scanty rainfall. Thar Desert in Western Rajasthan is characterized by low and erratic rainfall, high air and soil temperature, intense solar radiation and high wind velocity. Context-specific interactions of these factors not only give rise to frequent droughts and famines, they also make local livelihoods highly vulnerable.

Literature review

(Mahato, 2004) are of the opinion that Climate change is likely to directly impact food production across the globe. Increase in the mean seasonal temperature can reduce the duration of many crops and hence reduce the yield. In areas where temperatures are already close to the physiological maxima for crops, warming will impact yields more immediately (IPCC, 2007). The greenhouse effect is a natural process that plays a major part in shaping the earth's climate. It produces the relatively warm and hospitable environment near the earth's surface where humans and other life-forms have been able to develop and prosper. However, the increased level of greenhouse gases (GHGs) (carbon dioxide (CO2), water vapor (H2O), methane (CH4), nitrous oxide (N2O), hydro fluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) etc) due to anthropogenic activities has contributed to an overall increase of the earth's temperature, leading to a global warming . Increase in CO2 to

550 ppm increases yields of rice, wheat, legumes and oilseeds by 10-20%. A 1oC increase in temperature may reduce yields of wheat, soybean, mustard, groundnut, and potato by 3-7%, much higher losses at higher temperatures. Recent studies done at the Indian Agricultural Research Institute indicate the possibility of loss of 4 – 5 million tons in wheat production in future with every rise of 1oC temperature throughout the growing period. Rice production is slated to decrease by almost a tonne/ hectare if the temperature goes up by 2 o C. In Rajasthan, a 2oC rise in temperature was estimated to reduce production of Pearl Millet by 10-15%. So Climate is the primary determinant of agricultural productivity which directly impact on food production across the globe. Agriculture sector is the most sensitive sector to the climate changes because the climate of a region/country determines the nature and characteristics of vegetation and crops

In post-hunter-gatherer societies, extra-somatic energy has greatly expanded and intensified the catching, gathering, and production of food. Modern relations between energy, food, and health are very complex, raising serious, high-level policy challenges. Food provides energy and nutrients, but its acquisition requires energy expenditure.

(McMichael, W, Butler, & Uauy, 2007). Together with persistent widespread under-nutrition, over-nutrition is causing obesity and associated serious health consequences. Substantial and widespread public-health problems of under-nutrition and over-nutrition exist—often coexisting within the same population. Meanwhile, the world's agricultural sector, especially livestock production, accounts for about a fifth of total greenhouse-gas emissions, thus contributing to climate change and its e□ects on health, including on regional food yields. Climate change is doubly relevant here: first, climate changes will a□ect food yields and therefore health; second, food production itself contributes substantially to climate change and hence to its diverse e□ects on health. Assessments of the e□ects of climate change (entailing changes in temperature, rainfall, humidity, and extreme weather events) on the quantity and security of food supplies requires complex modelling, spatially di□erentiated across Earth's productive land surface. In the 1990s, first-order models forecast that climate change would result in agricultural winners and losers, in rough balance, but with developing countries being more vulnerable.

Climate change is one of the greatest challenges of our time (Rathore & Verma, 2013). Fossil fuel burning and deforestation have emerged as principal anthropogenic sources of rising atmospheric carbon dioxide (CO) and other 2 green-house gases and consequential global warming. Rajasthan, the largest state of India area-wise falls within the areas of great climate sensitivity. The vicissitudes of climate are likely to have a considerable impact on the physical and socio- economic fabric of the state. In more recent times, Rajasthan has experienced severe and frequent spells of droughts than any other region in India. The Aravalli hill region of South Rajasthan served its area and the people as a rich resource area providing forest products; fuel wood; fodder; timber; water through springs, streams and rivers; minerals, rich forest clad habitat; safe and secured locations to former rulers and their public. The environmental status has changed alarmingly during last six decades with ruthless destruction of forest cover over the hills followed with increase in soil erosion, sediment transportation, siltation, drying-up of lakes, dams and surface water sources, lowering of water table from 5 to 10 m to 50 to 100 m. The continuous change in the nature of rainfall, increasing pressure of population and livestock on the water resources in the South Rajasthan and depletion of environmental resources particularly, vegetation, soil resources have led to decline to water-table. Decline in the Actual Forest Area:The interpretation of multi-date RS data products had revealed that the parts of sixteen Aravalli districts recorded only 10,462 sq km of area under various categories of forest cover during 1972-75. The actual forest area left was only 6,116 sq km, in 1982-84 [6,7] period as per RS data products of the South Rajasthan Aravalli hill region. The duration of rainy season has shrunk from 101 days in 1973 to only 46 days in 2010. The continuous change in the nature of rainfall, increasing pressure of population and livestock on the water resources in South Rajasthan and depletion of environmental resources particularly, vegetation, soil resources have led to decline in water-table. Consequently, the drinking water crisis along with the shortage of water for irrigation and other purposes is being felt very seriously.

(Sathaye, Shukla, & Ravindranath, 2006) According to author climate change is one of the most important global environmental challenges facing humanity with implications for food production, natural ecosystems, freshwater supply, health, etc. Further evidence shows that most of the warming (of 0.1°C per decade) observed over the last 50 years, is attributable to human activities. The Intergovernmental Panel on Climate Change (IPCC) projects that the global mean temperature may increase between 1.4 and 5.8 degrees Celsius (C) by 2100. The global carbon cycle involves interaction among the atmosphere, oceans, soils and vegetation and fossil fuel deposits. The oceans contain 39,000 gigatonnes of carbon (GtC), fossil fuel deposits about 16,000 GtC, soils and vegetation about 2500 GtC, and the atmosphere about 760 GtC2. Since 1850, land-use change is estimated to have released about 136 GtC and fossil fuel combustion, about 270 GtC. Of this, 180 GtC has ended up in the atmosphere, while 110 GtC has been absorbed by growing vegetation and the remainder by the oceans. It is the increasing concentration of atmospheric CO_2 that is the cause for concern about global climate change. Historically, the industrialized countries have been the primary contributors to emissions of CO_2 and According to another estimate, developing countries accounted for only 37% of cumulative CO_2 emissions from industrial sources and land-use change during the period 1900 to

1999 (Figure 1), whereas industrialized countries accounted5 for 63%, but because of their higher population and economic growth rates, the fossilfuel CO2 emissions from developing countries are likely to soon match or exceed those from the industrialized countries.

Impacts of climate change in India in broader perspective.

Introduction

In the present scenario climate change is a burning and debatable issue for every country of common concern. The scientists, scientific and environmental organizations and government of every country having prudent conscience, that the changing climate is a result of the human activities. And India is not left behind from getting the effects of climate change, although India is food self sufficient country where agriculture is an important component of the economy. More than 56% of workers are engaged agriculture allied sectors, while many others earn their living in coastal areas through tourism of fishing; in indeed most of the poorest people live in rural areas and are most completely reliant on natural resources for their food and shelter (UN Human Development Report 2007/8). In India drastic effects and trends of the climate change are seen in the last few years in the form of natural disaster, increased in pollution and raised sea level and change in the monsoon pattern many more. Change in the climate adversely affecting very sector and important components of the human survival.

Agriculture

In the era of the information technology India is an agrarian society where *agriculture remains the principal source of livelihood for more than 58% of the population* (Annual report 2010-11 Department of Agriculture and Cooperation, Ministry of Agriculture Government of India March, 2011). In the last four decade the agricultural productivity has increased tremendously and the table given below anecdotes yields of last few decades.

Agriculture productivity in India, growth in average yields from 1970 to 2010

Crop	Average YIELD, 1970-1971	Average YIELD, 1990-1991	Average YIELD, 2010–2011
	kilogram per hectare	kilogram per hectare	kilogram per hectare
Rice	1123	1740	2240
Wheat	1307	2281	2938
Pulses	524	771	1325
Oilseeds	579	771	1325
Sugarcane	48322	65395	68596
Tea	1182	1652	1669
Cotton	106	225	510

But according to the **Annual report of 2014-15 Department of Agriculture and Cooperation, Ministry of Agriculture Government of India March, 2014** a share of agriculture in GDP is continuously decreasing and even yield of some crops is also declining due to increasing temperatures and changes in rainfall.

Crops	Yield (kg/hectare)	Yield (kg/hectare)	Yield (kg/hectare)
	2010-11	2011-12	2012-13
Rice	2239	2393	2,462
Wheat	2989	3177	3,117
Coarse Cereals	1531	1591	1617
Pulses	691	699	789
Food- Grains	1930	2079	2179
Oilseeds	1193	1133	1168
Sugarcane	70091	66868	68254
Cotton	499	491	486

Studies by the Indian Agricultural Research Institute (IARI) indicate the possibility of loss of 4-5 million tons in wheat production with every rise of 1^{o} C temperature throughout the growing period. In the last few years changing environment exerting pressure on Indian agriculture, in addition to decline in the yield. It is estimated that by 2020, food grain requirement would be almost 30-50% more than the current demand (Paroda and Kumar, 2000).

Livestock

Climate changes are not only affecting to agricultural yield but also to livestock production as many studies suggested.

India have largest livestock population in the world (520.6million), and accounts for the largest number of cattle (world share 16.1%), buffaloes (57.9%), second largest number of goats (16.7%) and third highest number of sheep (5.7%) in the world (FAOSTAT).The average daily milk yield of the crossbred animals in the hot–humid eastern part of the country was significantly reduced by the rise in minimum temperature and not maximum temperature, as rise in minimum temperature crossed the critical temperature of comfort while the maximum temperature was already above the comfort zone (Kale and Basu1993).The influence of climatic conditions on milk production is also observed for local cows which are more adapted to the tropical climate of India. The rising temperature decreased the total dry matter intake and milk yield in Haryana cows (Lal et al. 1987). The productivity of Sahiwal cows also showed a decline due to increase in temperature and relative humidity (Mandal et al. 2002b). As in the present days the average annual temperature in most parts of the country is 25°C or higher, which is at or above the thermal-comfort zone of cattle and buffaloes for maximum milk yield. In India, the upper temperature limit of comfort zone for maximum milk production is 27°C (Dutt et al. 1992), about two degrees higher than the same reported in temperate countries. As per the Fourth National Biodiversity report to CBD, 2009, almost all indigenous breeds of livestock are showing declining trends in the country. Estimates indicate that 50 percent of indigenous goat, 30 percent of sheep, 20 percent of cattle, and almost all poultry breeds are threatened. A drought in 1987, affected over 168 million cattle in India, due to decline in feed and fodder availability and serious water shortages. In one of the worst draught affected state of Gujarat, 18 million cattle out of 34 million were reported to have died before it rained the next year. A 1999–2000 drought in the arid state of Rajasthan in the north-western part of the country, which is highly drought-prone affected 34.5 million cattle; in the subsequent year about 40 million cattle were affected by drought (CSO 2000, p.186, 190 In Banni grassland region of Gujarat state, 45% pastoral families migrate with livestock during draught (Geevan et al. 2003). In 1999 tropical cyclone that hit the state of Orissa, on the eastern coast of the country, which resulted in a death toll of about 55,000 cattle (CSO 2000, p.189).

Livelihood

Climate change has affected the livelihoods of huge population because of repeated floods, droughts and other disasters. India's population is currently in excess of 1.1 billion people and predictions state that by 2050, the population will have grown by another 500 million(UN2008). The widespread affect that climate change is expected to have on agriculture and rural livelihoods will leads to greater migration from rural areas to urban, further staining resources in these centers (Liggans 2008). One of the study of world bank group expressed his concern for the alternations in the flows of the Indus, Ganges, and Brahmaputra rivers could significantly impact irrigation, affecting the amount of food that can be produced in their basins as well as the livelihoods of millions of people (209 million in the Indus basin, 478 million in the Ganges basin, and 62 million in the Brahmaputra basin in the year 2005).

The climate change harshly impacting the livelihood because of the natural catastrophe for an instance in

Tsunami 2004	Coastline of Tamil Nadu, Kerala, Andhra Pradesh, Pondicherry and Andaman and Nicobar Islands of India	10749 deaths, 5640 persons missing, 2.79 million people affected, 11827 hectares of crops damaged and 300000 fisher folk lost their livelihood
Kosi Floods 2008	North Bihar	527 deaths, 19,323 livestock perished, 2,23,000 houses damaged, 3.3 million persons affected
Gujarat Earthquake 2001	Rapar, Bhuj, Bhachau, Anjar, Ahmedabad and Surat in Gujarat State	13,805 deaths and 6.3 million people affected
Cyclone 1977	Andhra Pradesh	10,000 deaths and hundreds of thousands homeless 40,000 cattle deaths

Biodiversity

Climate change is one of the most important global environmental challenges affecting all natural ecosystems. The Millennium Ecosystem Assessment (MEA) identified climate change as one of the major drivers having adverse effects on biodiversity and associated goods and services.Today climate change is happening at an increasingly rapid rate. According to the prevailing extinction theory, the larger and more specialized species are likely to be lost due to habitat destruction. This is a special risk factor for high altitude species which are sensitive to climate change and more likely to be at risk of extinction. Under continuing climate change, tree species will be affected in different ways and ranges will adjust at different rates and by different process. The fourth IPCC Report (2007) states that by the end of this century climate change will be the main cause of biodiversity loss. If there is an increase of the average global temperature by 1.5-2.5° C, then approximately twenty to thirty percent of known plants and animal species will be threatened by extinction30. Climate change will increase the pressure on land degradation and habitat loss, as well as genetic erosion which is already intensifying because of the growing uniformity in agricultural systems across the world. By mid-century, most species could lose half of their geographical range and size because of habitat fragmentation. Due to the climate changes endangered species in India including all animals and birds which occur in India and are rated as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) in the 2004 International Union for Conservation of Nature and Natural Resources (IUCN) and Wildlife Institute of India (WII). Critically Endangered are Jenkin's Shrew,Ganges Shark, Himalayan Wolf, Indian Vulture etc. Endangered are Andaman Shrew,Asiatic Black Bear, Asiatic Lion, Asiatic Wild Dog, Blue Whale, Ganges River Dolphin etc. Vulnerable are Wild Goat, Wild Yak, Tiger Indian Wolf, Squirrel,Jerdon's Palm Civet etc.

Health

The major effect of climate change in terms of adverse health impact is on the poor and developing countries, even though the rich and industrialized countries account for maximum greenhouse gas emission.Alteration in rainfall because of climate change, availability of surface water and water quality could affect the health. The diseases can be classified by route of transmission, thus distinguishing between water-borne (ingested) and water-washed diseases (caused by lack of hygiene). Diarrhoeal disease is one of the most important causes of disease burden, particularly in developing countries.There is strong evidence that diarrhea, particularly the one caused by the bacteria and protozoan pathogens which predominate in developing regions, is highly sensitive to variations in both temperature and precipitation over daily, seasonal, and inter-annual time periods.A study conducted by the National Physical Laboratory, New Delhi, on the impact of climate change on malaria reveals that the transmission windows (TWs) for malaria are predicted to increase with climate change. Currently, all of India's population is at risk for contracting malaria except for those in the areas above 1700 m above sea surface. More than 973 million persons are exposed to vector-borne malarial parasites in India, and in 1998 an estimated 577,000 disability adjusted life years (DALYs) were lost due to malaria.

Women

Everyone is affected by the climate changes, but not equally. Vulnerability to climate change will be determined by a community or individual's ability to adapt. Every individual of a society is affected by the climate change, but the most vulnerable section who is affected and jeopardized by the climate change is women. An Oxfam Report (March 2005) on the impact of the 2004 Asia Tsunami on women raised alarms about gender imbalances since the majority of those killed and among those least able to recover were women. The Human Development Report (HDR) of 2007-08 revealed that India's women born during floods in the 1970s were 19% less likely to have attended primary school. Aside from this, climate change has resulted in serious health crises of various kinds in regions where health care delivery is almost non-existent. The most vulnerable groups identified in this context are small and marginal farmers, women, the aged, and children. The experts and scholars of global warming has their views that the climate change has a significant impact on securing household water, food, and fuel —activities that usually are the responsibility of women and girls. In times of drought and erratic rainfall, women and girls must walk farther and spend more of their time collecting water and fuel. Girls may have to drop out of school to help their mothers with these tasks, continuing the cycle of poverty and inequity. This inequity can be attributed to many possible and interrelated causes, but the fact that this effect is most pronounced where women have lower socioeconomic status and power leads experts to believe that the causes are more cultural than biological or physiological.

Climate change impacts in Shahbad Region of Baran District

We visited ten villages of Shahbad tehsil of Baran district to understand impact of climate change on tribal and rural people. Shahbad is a tehsil of a Baran district of Rajasthan were average rain fall is 1345mm in 2011, 931mm in 2012, 1281 in 2013, 1268 in 2014 and 1266mm in 2015. Dialect is very similar to Bundelkhand and also having an influence of Syopur, Shivpuri and Gwalior district of Madhya Pradesh state. Total area of Shahbad is 1,46,897 hectare under which forest is 72,158, barrel land 6160, posture land 6969, irrigated land 39708 and non irrigated land 33000 hectare. Almost every caste is residing in Shahbad and some of them are Brahmin, Jhangid, Dhobi, Baniya, Panjabi, Jatav, Dhakad, Kirad, Luhar, Bheel, Shehriya etc. In Shahbad there were large forests, Herbs and Shrubs were found, rivers, wells and water reservoirs were there for agriculture and Shahbad was very rich in biodiversity but now due to personal interest of the few Shahbad lost very thing and its biodiversity is almost diminished. From the individual interaction and FGDs trainee understood that the

CROPS	Last five year average (2009-10 to 2013-14)			Last year 2014-2015		
	Area (Hectare)	Productivity (Kg/Hectare)	Yield (metric ton)	Area (Hectare)	Productivity (Kg/Hectare)	Yield (metric ton)
Juar	59	2400	141.6	7	2000	14
Millet	2640	1800	4752	1410	1200	1692
Maize	1037	2400	2488.8	836	1500	1254
Rice	1362	4000	5448	1927	4500	8671.5
Sum	5098		12830.8	4180		11631.5
Soybean	31121	1500	44681.5	30667	1200	36800.4
Till	854	600	512.4	551	600	330.6
Groundnut	------	------	------	------	-----	------
Sum	31975		47193.5	31218		37131
Pulses crops	-----	------	-----	---	----	---
Black gram	1239	1500	1239	1009	800	807.2
Green gram	52	900	46.8	6	700	4.2
Tordal	-----	------	-----	---	----	---
Sum	1291		1285.5	1015		811.4

Impact on Agriculture

In shabadRabi crops they cultivate are Fenugreek, Wheat, Mustard, Gram, rice, Coriander; Kharib crops are Millet, Maize, Soybeans, Guar, Black gram and Tele and in vegetables they grow Tomato, onion and chilly. For kharib crops they are dependent on monsoon. Due to change in climate their crop yield of wheat, mustard, gram,maize and soyabeans has decreased. So to cope with crop failure they have changed their crops and even some of them stopped farming like Fenugreek, Groundnut, mungphali and crop yield is very much affected by the climate change. Before 10 to 15 years back their crop yield of millet, wheat, and mustered was 5-7, 4-5 and 7-8 Quintals respectively but in last three years crop yield has reduced to 1-2, 2-3 and 1-2respectively While during a discussion on climate change and its impact they told author that from last three years they are experiencing scanty rainfall due to which they are facing crop failure. On the failure of the crops have not received an adequate compensation from the government and even some of the farmers not got any compensation amount from the government. On the damage of their crops nobody visited village including Sarpanch, MLA and MP. Although government running so many schemes for the farmers but they are not aware of any scheme and even no agriculture officer visited their village and aware or to provide government schemes.

Small farmers to sustain their life they are taking loans from bank through KCC for agriculture purposes and in case of any one fallen ill or for marriage they barrow money from local money lenders on rate of 2, 3, and 4% in case of not returning money moneylenders occupy their lands. From last three years they are facing lose to crop and the yield is not that much they can feed their family members, to save family from hungers the villagers especially small farmers are migrating to cities for labor work and in cities they get wages 200-250 but in the villages or in MNREG they get 110 or less than 100 rupees.

Livestock quantity

Tribal community have a few of livestock in which cow, Buffaloes, and goat etc. at present time because Rainfall also decrees last five year like: 1345mm in 2011, 931mm in 2012, 1281 in 2013, 1268 in 2014 and 1266mm in 2015 and Scanty of rainfall and increase in the days of summer, no fodder and grasses are left on the bank of the river and in the posture land for animals to feed due to which milk production is decreased. Buffaloes are yielding from 1 to 2 kg and cows are 500 gm to 1 kg.Agriculture and agriculture allied sector is primary source of livelihood for the villagers but due to continuous crop failure forcing them to take painstaking efforts with the hope of good yield. Yield of crops is even not that much from which they sold and it is also not sufficient for their consumption. Agriculture and animal husbandry is a main source of income of the villager but this is not sufficient for them to sustain their family. Therefore to sustain their family and to manage family expenditures villagers are migrating especially small farmers to the cities and others state.

Education

A greater impact is seen on the education on tribal community. The tribal people consider education as useless, as they are trained in hunting and gathering the food. During the past six decades as deforestation has been occurring, in the name of development many tribals were displaced and consequently forced migration occurred. Such migrants landed up in civilizied populations and from hunters they gradually became cultivators. The impact of climatic change was noticed when the crop yield was not sufficient, these people had to adjust to the stark realities by working as labourers in far of places. In the present times it is noticed that a large number of tribal adults do not have formal education. They live on semi nomadic life, wherein, they keep moving from one place to other for contractual labour, once in three months and returning back to their houses in Baran. When these tribal families move out in search of labour in other places, their children also accompany them. This lead their children inaccessible to proper educational services. Frequently these children are found to be engaging in labour work with their parents. This leads to low learner motivation, poor parent participation in the education of children, illiterate family background, irregular attendance and uninteresting curriculum. These factors of climate change indirectly impacts on their education.

Health

Overwhelming evidence shows that climate change presents growing threats to public health security - from extreme weather related disasters to wider spread of such vector-borne diseases as malaria and dengue. The impacts of climate on human health will not be evenly distributed around the world. The Third Assessment Report (Intergovernmental Panel on Climate Change-2001) concluded that vulnerability to climate change is a function of exposure, sensitivity, and adaptive capacity.

As discussed in education section, the impact of climate change leads to a condition of semi nomadic tribal situation. The adults work in the labour sector living with improper shelter and facilities to procure or prepare food in an hygienic condition. Many times the food is basically carbohydrate and with not much of micronutrient. The young children are left under the care of older children, who does not know much about child care and child rearing. Food is prepared in the morning and left for the children to consume until dusk. The older children are mostly found playing in dust and unhygienic condition and feed the younger children without any cleanliness. Shahbad region is also known for its malnutrition situation for children under five. The older adults when they return home are mostly tired and engage in consuming illicit liquor available in cheap value. Personal hygiene and personal care is seldom spoken and seldom practiced among these tribal communities. These people are also victims of tuberculosis. The people neither have opportunity nor money to access proper health care.

Discussion

Rajasthan is the largest state of India, located in the north-western part of India. Geographically it lies between 23030’ to 30012’ longitude and 69030’ and 78017’ latitude. The most striking geological feature of Rajasthan are the Aravalli ranges – the oldest mountain range in the world, which runs from Khetri in north east to Khed Brahma in south west, a length of about 550 km. The variability in climate, edaphic, and topographic conditions causes diversity of vegetation in the Aravalli ranges. Most of the areas in Rajasthan state can be categorized as arid and semi-arid zones, a large part of Rajasthan is also covered under desert region. Agriculture in Rajasthan is primarily rain fed covering country’s 13.27 per cent of available land. The diversity in climatic conditions of the state creates potentiality to develop certain belts of horticultural crops. The arid part of the state which receives not more than annual rainfall of 25 cm thrives on agriculture that is done with irrigation systems and painstaking efforts of the poor farmers of Rajasthan.

Agriculture and allied sector plays an important role in State’s economy. Though its contribution in NSDP has fallen from about 35 per cent in 1990-91 to around 23 per cent in 2011-12, agriculture yet forms the backbone of state economy. Around two third of its population (56.5 million) is still dependent on agricultural activities for their livelihood. Only 34.5 per cent of the net sown area is irrigated.

The food grains production in Rajasthan has increased by about 11.7 percent during two decades period, i.e. from 10.9 million tons in 1990-91 to 23.6 million tons in 2010-11. The share of the State food grains production in national basket has increased by 3.6 percent points, i.e. from 6.2 per cent in 1990-91 to 9.8 per cent in 2010-2011(GoR 2012)

The gross cropped area has increased by about 7 percent points (to reporting area) in 2009-10 over 1990-91. The increase in GCA was due to significant increase in area sown more than once. The cropping intensity has also considerably increased over the years. It has increased from 121.2 per cent in 2000-01 to 129.9 per cent in 2007-08 and thereafter declined to 128.1 per cent in 2009-10. It may be also worth to note here is that gross irrigated area has declined from 80.9 lakh hectares in 2007-08 to 73.1 lakh hectares in 2009-10.

The Eighteenth Livestock Census has placed total livestock population in India at 529.7 million and total of poultry birds at 648.8 million (GoI, 2009). Out of total, Rajasthan state accounts for 10.9 percent of livestock (579.0 lakh) and 0.4 percent of poultry birds (26.5 lakh). It may be noted that total livestock population in the state has increased by 15.3 per cent in 2007 over 2003 (increased from 491.4 lakh in 2003 to 566.6 lakh in 2007); while total poultry has been reduced by 19.3 per cent, i.e. declined from 61.92 lakh in 2003 to 49.94 lakh in 2007(GoI,2005; 2009). Rajasthan is the second highest producer of milk in the country (amounting to nearly 17 lakh kg per day). But the current annual loss in milk production due to heat stress in

Rajasthan is 98.65, 40.55 and 29.74 litres per animal per year in crossbred cows, local cows and buffaloes respectively. Rajasthan has a livestock population of about 49.1 million and ranks among the top three states for having the highest livestock population. And although they significantly contribute to the improvement of dairy farmers' economy, unsatisfactory nutritional status and lack of knowledge of balanced feeding and lack of proper marketing facilities for animal products like goat and camel milk, meat and wool in addition to scarcity of fodder are aspects that may lead to an unsustainable future.

Conclusion

In light of the above information and discussion it is suggested that proper facilities for living must be provided by the government. The contractors who engage these people in labour works should provide proper shelter, health accessibility, and education for children and many other facilities under their CSR practices. The Govt. of Rajasthan should have a wider role in preparing policy for protection and help of these people. The Govt. of India should look into prevention and protection of climate change to prevent forced migration. Specific policies should be brought up for protection of climatic change to prevent deforestation.

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T6 A262

IRON AND ZINC BIOFORTIFICATION IN RICE (*ORYZA SATIVA* L.) THROUGH GENETIC, TRANSCRIPTOME AND CROP MANAGEMENT APPROACHES IN CHANGING ENVIRONMENT

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Abstract

Rice (*Oryza sativa L.*) is especially important in biofortification efforts because it is staple food for more than half of the world's population, and rice grains contain low available levels of important micronutrients, such as Fe and Zn. Combination of genetic, crop management and molecular biology strategies is an excellent complementary approach to alleviate hidden hunger.

Keywords: *biofortification, rice, flag leaf, candidate gene, iron, zinc*

Introduction:

Rice is agronomically and nutritionally, one of the world's most important staple food crops, with approximately half of the world's population dependent on it for a significant proportion of their caloric intake. Climate change particularly rising atmospheric carbon dioxide concentration, reduces grain Zn accumulation. Apart from the human dietary needs Fe and Zn ions are essential microelements for plants as they are important components of several cellular functions, chlorophyll biosynthesis, photosynthesis, respiration etc. Plants have therefore evolved with complex regulatory mechanism for metal ion acquisition and transport and as well as preventing their hyper accumulation which is collectively called metal ion homeostasis (Zimmermann and Hurrel, 2002). Several transporters potentially involved in metal ion homeostasis have been identified in the rice genome. Flag leaves are the major source of phloem-delivered photo-assimilates for rice developing seeds, and are believed to be one of the sources of remobilized metals of the seeds (Sperotto *et al*., 2013).

Material & Method:

Plant growth conditions

Six rice genotypes (GR-11, Madhukar, Jalmagna, PTB-49, Sambha Masuri and Krishna Kamod) having high Fe/Zn content were grown in soil during the rice growing season. Iron and Zinc were supplied as fertilizers (Fe, Zn, Fe+Zn) and also as foliar spray. Entire flag were collected during panicle emergence (R3) and grain filling stages (R5).

RNA Extraction and cDNA synthesis

Total RNA was extracted using TRI reagent (Chomczynski, 1995) and cDNA was prepared using First Strand cDNA synthesis Kit (Invitrogen) according to the manufacturer's instructions.*Quantitative RT-RCR and data analysis*

qRT-PCR were carried out in an Applied Biosystem 7500 Real time cycler. All the primers were designed at similar Tm values. Gene expression was evaluated by the $2^{-\Delta\Delta CT}$ method. For each sample three technical replicates and three biological replicates were analysed.

Result & Discussion:

The expression pattern of 4 Fe and/or Zn-homeostasis related candidate genes (three from the YSL family of metal-phytosiderophore transporters: OsYSL10, OsYSL15 OsYSL18 and one from ZIP family of divalent metal transporter: OsZIP5) were analysed from the six different rice genotypes showing contrasting levels of Fe and Zn in the seeds during two different developmental stages i.e. R3 and R5.

YSL gene family: The YSL family of transporters is believed to transport NA-metal chelates across plant cell membranes. Experimental evidences points to the role of YSL proteins in the long distance and intracellular transport of metals (Ishimaru *et al.*, 2010). Three of the OsYSL genes were expressed in all the genotypes at both the developmental stages.

OsYSL10: The increased level of expression of OsYSL10 at R3 stage was comparatively lesser at R5 stage, indicating that the gene might not play role in regulating supply of metal ions to developing grains.

OsYSL18: There was no major difference in gene expression during the R5 stage and R3 stage among the six genotypes and between the treatments. The genotypic specific variation of OsYSL18 gene in flag leaf at R3 and R5 stage was correlated to high grain Fe and Zn containing rice genotypes which suggested its role in Fe and Zn uptake and transport in rice.

OsYSL15: A consistently high level of expression was also found among the genotypes at R5 stage. The expression pattern of OsYSL15 gene suggested that the gene might play a role in governing movement of Zn ions in leaf tissue during early stages (R3) whereas its uniform high level of expression in R5 stage suggested temporal expression to facilitate maximum Zn remobilization to developing grains and hence contribute to higher grain Zn values.

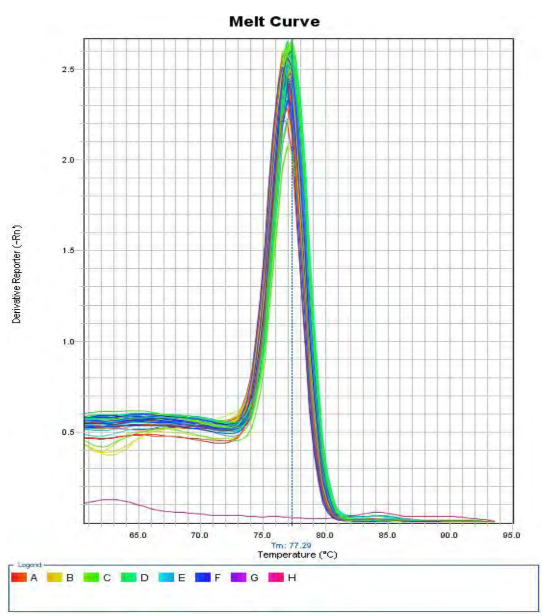

Figure 1: Melt curve analysis showing single product and no product inall the samples and No Template Control (NTC), for the OsYSL10 in flag leaf samples of *Oryza sativa*

OsYSL15: A consistently high level of expression was also found among the genotypes at R5 stage. The expression pattern of OsYSL15 gene suggested that the gene might play a role in governing movement of Zn ions in leaf tissue during early stages (R3) whereas its uniform high level of expression in R5 stage suggested temporal expression to facilitate maximum Zn remobilization to developing grains and hence contribute to higher grain Zn values.

ZIP gene family:

The ZIP family genes are known to participate in divalent metal transport in plants. Genotype specific variation observed at both the developmental stages under Fe+Zn treatment revealed higher level of expression of this gene in Sambha Masuri followed by GR-11 and Krishna Kamod at R5 stage. Accumulation of OsZIP5 transcript was higher in all the treatments and among all the genotypes at R5 stage than R3 suggesting their role in uptake and transport of ions. Increased uptake of Fe and Zn during grain development stage contributes to increased deposition of Fe and Zn into developing rice seeds (Banerjee and Chandel, 2011).

The expression of the tested genes varied among the six tested rice genotypes. There was only one gene (OsYSL10) which upregulated in R3 and not in R5 in all the genotypes and all the treatments whereas the rest showed the upregulation in R5 as compared to OsUBQ (endogenous gene).

Conclusion:

Zinc concentration in grain is influenced by plant related factors (genetic factors) and environmental factors, and crop management strategies (agronomic factors) to increase the dietary minerals. Biofortification of edible crops is the better alternative for micronutrient supplementation. SambhaMasuri a white rice genotype which revealed high iron and zinc contents showed high expression levels for two markers OsYSL15 and OsZIP5. It is inferred that these genes can be exploited further as candidate genes for enhancing iron and zinc levels. The findings also reveal their functional involvement in the complex phenomenon of transport and accumulation of iron and zinc content in the rice grains. Further the generation of new generation candidate gene based marker can be used for fine mapping of QTLs and effective MAS programs for grain nutritive traits. The rising atmospheric carbon dioxide is likely to reduce grain Zn concentrations and the underlying mechanism is not fully understood. New genetic and management strategies need to be developed to minimize Zn deficiency for people whose staple diet is rice.

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T6 A303
CARBON SEQUESTRATION AND CLIMATE CHANGE

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Introduction

Population growth and climate change are the challenges of the 21st Century. It is now widely accepted that the change in climate is unusual nature of environment. All quantitative assessments show that climate change will adversely affect food security. Analysis of the impact of climate change suggests that agro-ecological systems are the most vulnerable sectors. Agriculture in developing countries lying at low latitudes is expected to be especially more vulnerable, because climate of many of these countries is already too hot. Main climate change related drivers: temperature, precipitation, sea level rise, atmospheric carbon dioxide content and incidence of extreme events may affect the agriculture sectors in many ways like reduction in agricultural productivity, limitations on water resources, exacerbation of drought periods, reduction in soil health, pest and disease outbreak etc.

Climate change is mainly caused by anthropogenic emissions of greenhouse gases (GHG: CO_2, CH_4, N_2O, HFC, PFC and SF_6), which accumulate in the earth's atmosphere and trap heat. The concentration of atmospheric carbon dioxide, a leading cause of global warming, continues to increase with world population growth and economic development.

In India, climate change has caused tremendous changes in the weather patterns across different parts of the country. Extended summers, unpredicted rainfall are all some of the effects of climate change.

It is a known fact that global temperature levels will rise anywhere between 2 – 5° over the next century. Climate change will also cause health problems which mainly come from water related diseases. Some of the ways of reducing impact of climate change is by finding alternate energy sources for transport which has fewer emissions. Awareness about the impacts of climate change has to be passed on to the common man who is not aware of what the impacts of half a degree increase in temperature would be like!!!

Factors contributing to climate change – GHG emissions

The global carbon cycle involves interaction among the atmosphere, oceans, soils and vegetation and fossil fuel deposits. The oceans contain 39,000 giga tonnes of carbon (GtC), fossil fuel deposits about 16,000 GtC, soils and vegetation about 2500 GtC, and the atmosphere about 760 GtC2. Since 1850, land-use change is estimated to have released about 136 GtC and fossil fuel combustion, about 270 GtC. Of this, 180 GtC has ended up in the atmosphere, while 110 GtC has been absorbed by growing vegetation and the remainder by the oceans. It is the increasing concentration of atmospheric CO2 that is the cause for concern about global climate change. The combustion of fossil fuels and other human activities are the primary reasons for increased concentrations of CO2 and other greenhouse gases. Between 1990 and 1999, an estimated 6.3 GtC/year was released due to thecombustion of fossil fuels, and another 1.6 GtC/year was released due to the burning of forest vegetation. This was offset by the absorption of 2.3 GtC/year each by growing vegetation and the oceans. This left a balance of 3.3 GtC/year in the atmosphere. Controlling the release of greenhouse gases from fossil fuel combustion, land-use change and the burning of vegetation are therefore obvious opportunities for reducing greenhouse gas emissions. Reducing greenhouse gas emissions can lessen the projected rate and magnitude of warming and sea level rise. The greater the reductions in emissions and the earlier they are introduced, the smaller and slower the projected warming and the rise in sea levels. Future climate change is thus determined by historic, current and future emissions. Of the six aforementioned GHGs, CO2 accounted for 63%, methane 24%, nitrous oxide 10%, and the other gases the remaining 3% of the carbon equivalent emissions. Thus in addition to CO2, global mitigation efforts need to focus on the two largest and rapidly increasing GHGs.

Impact of Climate change in India

In developing countries like India, climate change could represent an additional stress on ecological and socioeconomic systems that are already facing tremendous pressures due to rapid urbanization, industrialization and economic development. With its huge and growing population, a 7500-km long densely populated and low-lying coastline, and an economy that is closely tied to its natural resource base, India is considerably vulnerable to the impacts of climate change.

The various studies conducted in the country have shown that the surface air temperatures in India are going up at the rate of 0.4oC per hundred years, particularly during the post-monsoon and winter season. Using models, they predict that mean winter temperatures will increase by as much as 3.2oC in the 2050s and 4.5oC by 2080s, due to Greenhouse gases. Summer temperatures will increase by 2.2oC in the 2050s and 3.2oC in the 2080s.

Extreme temperatures and heat spells have already become common over Northern India, often causing loss of human life. In 1998 alone, 650 deaths occurred in Orissa due to heat waves.

Climate change has had an effect on the monsoons too. India is heavily dependent on the monsoon to meet its agricultural and water needs, and also for protecting and propagating its rich biodiversity. Subtle changes have already been noted in the monsoon rain patterns by scientists at IIT, Delhi. They also warn that India will experience a decline in summer rainfall by the 2050s, summer rainfall accounts for almost 70% of the total annual rainfall over India and is crucial to Indian agriculture. Relatively small climatic changes can cause large water resource problems, particularly in arid and semi-arid regions such as northwest India. This will have an impact on agriculture, drinking water and on generation of hydro-electric power.

What is carbon sequestration?

Carbon concentration in the atmosphere is increasing at the rate of about 4 billion mt (2 parts per million) per year, with transfer primarily from the fossil fuel, biotic, and soil pools. This in crease is a double jeopardy. One, the loss of carbon from the terrestrial pools reduces the ecosystem services and goods that these systems provide. In particular, decline in soil quality adversely affects use efficiency of inputs, decreases agronomic yields, and exacerbates food insecurity. Two, increase in atmospheric pools accentuates global warming with the attendant impact on pole-ward shifts of ecosystems and the increase in frequency and intensity of extreme events including droughts, melting glaciers and Arctic ice sheet, rising sea level, and loss of biodiversity. One solution to this problem is to transfer atmospheric CO_2 into other long-lived pools (such as the soil and biotic pools); this is called carbon sequestration. Increasing carbon pools in the soil beyond a threshold level (about 1.2 percent in the surface layer) is essential to enhancing soil quality, increasing agronomic productivity, and improving quality of natural waters. The strategy of carbon sequestration in soils and biota is cost effective,safe, and has numerous co-benefits over leaving carbon in the atmosphere or sequestering it in geologic and oceanic strata. Biotic,or plant-based, sequestration is based on a natural process wherebyCO$_2$ is photosynthesized into organic substances and stored for the long term in plant products and soil organic matter. The natural rate of photosynthesis in the global biosphere is about 120 billion mt of carbon per year. Fossil fuel combustion emits about 8 billion mt of carbon annually, and deforestation and land-use conversion emit another 1.6 billion to 2 billion mt of carbon per year, for a total of9.6 to 10.8 billion mt of carbon emissions per year. Thus, if roughly8 percent of the carbon being photosynthesized by the biosphere is retained within the soil and biotic pools, the global carbon budget would be balanced.

Role of soil organic matter in carbon sequestration

The soil organic matter pool contains humified products formed by biological transformation of carbon compounds. The inert pool consists of charcoal and pyrolysed carbon with half lives of centuries to millennia.

The amount of soil carbon in these different fractions depends on the quality of the organic matter being added to the soil as well as their decomposition products through the biological process of humification. Humified soil carbon products have highly aromatic structures such as poly-phenols and hence very slow decomposition rates. Their formation is constrained by low levels of N, P and S (Lal, 2008). They also have much lower C/N ratios than labile SOM due to both loss of carbon and incorporation of soil nitrogen.

Soil organic carbon is of fundamental importance to soil health as it affects all three aspects of soil fertility, namely chemical, physical and biological fertility. The activity of living organisms in soil is dependent on regular inputs of organic matter.

Soil Organic Carbon (SOC) is part of the global C cycle and the global SOC pool (1580 Gt) is twice as large as that in the atmosphere and nearly three times that of the vegetation biomass carbon pool. Soil organic carbon sequestration refers to the storage of carbon in soil and is being considered as a strategy for mitigating climate change.

Carbon Sequestration to Mitigate Climate Change

Human activities, especially the burning of fossil fuels such as coal, oil, and gas, have caused a substantial increase in the concentration of carbon dioxide (CO_2) in the atmosphere. This increase in atmospheric CO_2 —from about 280 to more than 380 parts per million (ppm) over the last 250 years—is causing measurable global warming. Potential adverse impacts include sea-level rise; increased frequency and intensity of wildfires, floods, droughts, and tropical storms; changes in the amount, timing, and distribution of rain, snow, and runoff; and disturbance of coastal marine and other ecosystems. Rising atmospheric CO2 is also increasing the absorption of CO_2 by seawater, causing the ocean to become more acidic, with potentially disruptive effects on marine plankton and coral reefs. Technically and economically feasible strategies are needed to mitigate the consequences of increased atmospheric CO_2.

Soil C sequestration is also important at the farm level to build soil fertility, protect soil from compaction, and nurture soil biodiversity. In addition to its vital role of mitigating greenhouse gas emissions, soil C sequestration provides many other significant off-farm benefits to society. These benefits include the protection of streams, lakes, and rivers from sediment, nutrient, and pathogen runoff from agricultural fields, as well as enhanced wildlife habitat. A full-system cost-to-benefit ratio of soil C sequestration from various conservation agricultural practices has not been adequately addressed, but is needed to more fully appreciate this important pathway. Conservation agricultural systems promote soil C sequestration by tipping the balance in favor of C inputs relative to C outputs. Carbon sequestration can be achieved by maximizing C inputs and minimizing C outputs (Table 1).

Table 1: Strategies to sequester soil organic C.

(1) **Maximizing C input**	**(2) Minimizing C loss from soil**
Plant selection	**Reducing soil disturbance**
• Species, cultivar, variety • Growth habit (perennial/ annual) • Rotation sequence • Biomass energy crops **Tillage** • Type • Frequency **Fertilization** • Rate, timing, placement • Organic amendments	• Less intensive tillage • Controlling soil erosion **Utilizing available soil water** • Promotes optimum plant growth • Reduces soil microbial activity **Maintaining surface residue cover** • Increased plant water use and production • More fungal dominance in soil

Estimation of Carbon Sequestration

Carbon flow (as CO_2) in crop or forest production depends on two processes: fixation (assimilation) and emission processes. The former represents the biomass growth in living crop/trees (in CO_2 equivalents) due to the photosynthesis, while the latter represents the biomass decay of the wood (in CO_2 equivalents), as a consequence of natural mortality or human related removals and end-uses.

The changes in carbon status of plant-soil system annually are recorded as the difference between total carbon gains and losses for each system. Gains for plant-soil system carbon are from the atmosphere, as photosynthesis or net primary production, and from additions of organic material from outside the system. Soil carbon arising from organic matter or leaf litter decomposition is accounted for in the gains from photosynthesis. Carbon losses, on the other hand, are due to harvesting, burning, erosion and oxidation.

For accounting purposes, greenhouse gases are counted in ***carbon dioxide equivalents***:

– CO_2 = 1 CO_2 equivalent
– CH_4 ~ 20 CO_2 equivalents
– N_2O ~ 300 CO_2 equivalents

The technical potential for soil carbon sequestration

Soil organic carbon has been depleted through (1) the long-term use of extractive farming practices and (2) the conversion of natural ecosystems (such as forest lands, prairie lands, and steppes) into croplands and grazing lands. Such a conversion depletes the soil organic carbon pool by increasing the rate of conversion of soil organic matter to CO_2, thereby reducing the input of biomass carbon and accentuating losses by erosion. Most agricultural soils have lost 30 to40 mt of carbon per hectare, and their current reserves of soil organic carbon are much lower than their potential capacity. Soil carbon sequestration involves adding the maximum amount of carbon possible to the soil. The technical potential for this process is higher in degraded/desertified soils and soils that have been managed with extractive farming practices than it is in good-quality soils managed according to recommended management practices(RMPs). Thus, converting degraded/desertified soils into restorative land and adopting RMPs can increase the soil carbon pool. While no single technology is appropriate for all soils, climates, or cropping and farming systems, the goal is to identify site-specific technologies that create a positive soil carbon budget. The rate of soil carbon sequestration through the adoption of RMPs on degraded soils ranges from 100 kilograms per hectare (kg/ha) per year in warm and dry regions to 1,500 kg/ha per year in cool and temperate regions.

A recent estimate of the technical potential of soil organic carbon sequestration through adoption of RMPs for world cropland soils(1.5 billion hectares) is 0.4 billion to 1.2 billion mt of carbon per year. Examples of soil and crop management technologies that increase soil carbon sequestration include:

• no-till (NT) farming with residue mulch and cover cropping;
• integrated nutrient management (INM), which balances nutrient application with judicious use of organic manures and inorganic fertilizers;
• various crop rotations (including agro forestry);
• use of soil amendments (such as zeolites, biochar, or compost);and
• improved pastures with recommended stocking rates and controlled fire as a rejuvenate method.

Another good strategy for soil carbon sequestration is the restoration of degraded/desertified soils (about 2 billion hectares),which can be achieved through afforestation and reforestation. The technical potential of soil carbon sequestration through restoration of degraded/desertified soils is 0.6 billion to 1 billion mt of carbon per year. The establishment of energy plantations can also improve ecosystem carbon pools. It is estimated that afforestation and establishment of energy plantations can offset 25 billion mt of carbon between 2000 and 2050.The technical potential of carbon sequestration in world soils may be 2 billion to 3 billion mt per year for the next 50 years. Thus,the potential of carbon sequestration in soils and vegetation together is equivalent to a draw-down of about 50 parts per million of atmospheric CO_2 by 2100.

The economic potential for soil carbon sequestration

One way to think of soil carbon is as a commodity. It can be produced and, if carbon markets exist, traded like any other farm produce. Additional income can be an important incentive for the resource poor farmers in developing countries to invest in soil restoration and adopt RMPs. The economic potential may be as much as 60 percent of the technical potential, or 1.2 to 2.0 billion mt of carbon per year. Furthermore, measuring and monitoring protocols of change in carbon pools at the landscape, farm, and regional scales are available to facilitate carbon trading.The greatest potential for sequestration is in the soils of those regions that have lost the most soil carbon. These are the regions where soils are severely degraded and have been used with extractive farming practices for a long time. Among developing countries, these regions include Sub-Saharan Africa, South and Central Asia, the Caribbean, Central America, and the Andean regions. Most soils have a technical or maximum sink capacity of 20 to 50 mt of carbon per hectare that can be sequestered over a 20-to-50-year period.

Soil carbon sequestration can enhance productivity and resilience Increases in soil organic material have important productivity and resilience benefits. These benefits include improvement in soil quality,increase in use efficiency of inputs, reduction in soil erosion and sedimentation, decrease in non point source pollution, and lower rates of anoxia or hypoxia (dead water) in coastal ecosystems. Global food security cannot be achieved without restoring the quality of degraded soils, for which soil carbon sequestration is an essential prerequisite.

Soil carbon sequestration is a win–win strategy. It mitigates climate change by offsetting anthropogenic emissions; improves the environment, especially the quality of natural waters; enhances soil quality; improves agronomic productivity; and advances food security. It is a low-hanging fruit and a bridge to the future, until carbon-neutral fuel sources and low-carbon economy take effect.

Future needs:

Carbon sequestration in soils and plants is the only strategy that can remove carbon from the atmosphere and, over time, reduce atmospheric concentration of CO_2. Initiatives to support reduced emissions from deforestation (REDD) are well underway. Funds for soil carbon mitigation should also be made available. Support should be provided for

• crop mixes to include more plants that are perennial or have deep-root systems in order to increase the amount of carbon stored in the soil;

• cultivation systems that leave residues and reduce tillage,especially deep tillage, in order to encourage the buildup of soil carbon;
• shifting land use from annual crops to perennial crops, pasture,and agro forestry in order to increase both above- and below ground carbon stocks; and
• activities that restore degraded and desertified soils and ecosystems, especially those affected by accelerated erosion,salinization, and nutrient depletion.

Carbon offset payments should be allowed for carbon sequestered in soils where low-cost monitoring is available. Funds for the development of these monitoring systems should be part of any outcome.

Paying resource-poor farmers and smallholders in developing countries like India for soil carbon sequestration would contribute to GHG mitigation, provide much needed resources to support development and adaption of improved crop technologies, and reduce rural poverty.

Some terminology

The greenhouse effect is the rise in temperature that the Earth experiences because certain gases in the atmosphere trap energy from the sun. These gases are referred to as greenhouse gases. The concentration of atmospheric carbon dioxide, a leading cause of global warming, continues to increase with world population growth and economic development.

Soil Organic Carbon (SOC) refers to the carbon in soils associated with the products of living organisms. It is a heterogenous mixture of simple and complex organic carbon compounds which can be divided into different pools dependent on their ease of decomposition and functions in soil. The use of soil to sequester carbon needs to consider at least 3 significant soil carbon pools.

These carbon pools are the labile, less labile (recalcitrant) and inert fractions. The labile soil carbon pool consists mainly of soil organisms, polysaccharides, celluloses and hemi-celluloses with a half life in soils varying from weeks to months. The recalcitrant pool consists of lignins, lipid polymers, suberins, resins, fats, and waxes with half lives varying from years to decades.

Carbon sequestration is the term used to describe a broad class of technologies for capturing and permanently sequestering, or storing, carbon dioxide (CO_2). A number of carbon sequestration approaches are being explored to help mitigate global climate change.

Carbon dioxide emissions from the production and consumption of fossil fuels are the largest contributor to man-made emissions of greenhouse gases.

Global Climate Change refers to the variation in the Earth's global climate or in regional climates over time. It describes changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years. These changes can be caused by processes internal to the Earth, external forces (e.g., variations in sunlight intensity) or, as scientists have more recently theorized, human activities.

The Carbon Credit is a new currency and one Carbon Credit is equal to one Tonne of CO_2 and is called a CO_2e (CO_2 equivalent).

Carbon tradingis the process of buying and selling carbon credits. Large companies or organizations are assigned a quota of carbon that they are allowed to emit. If a company's emissions are less than its quota then it can sell credits if emissions are more then it will need to buy carbon credits.

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ROLE OF ORGANIC FARMING IN MITIGATION OF CLIMATE CHANGE

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Introduction

Population growth and climate change are the challenges of the 21st century. It is now widely accepted that the changes in climate is unusual nature of environment. All quantitative assessments show that climate change will adversely affected food security. Analysis of the impact of climate change suggests that agro-ecological systems are the most vulnerable sectors. Agriculture in developing countries lying at low latitudes is expected to be especially more vulnerable, because climate of many these countries is already too hot. Main climate change related drives, temperature, precipitation, sea level rise atmospheric carbon dioxide content and incidence of extreme eventsmay affect the agricultural sectors in many ways like reduction in agricultural productivity, limitations on water resources, exacerbation of drought periods, reduction in soil health, pest and disease outbreak etc.

Agriculture and Climate

Agriculture and climate are inextricably linked such that agriculture is both a victim and a cause of climate change. Agricultural production relies fundamentally on the weather. Increasing sever weather patterns such as droughts, floods, desertification and disruption of the growing seasons in many parts of the world have resulted in negative impact on agricultural production. This negative impact is region specific and is more severs in developing regions such as Africa, Latin America and India, which are already facing food security problems, than in developed countries (William, 2007). According to the food and agriculture organization (FAO, 2008), an increase of 2-4^{0}C in the average global temperature above the pre-industrial levels could reduce crop yields by 15-35% in Africa and western Asia, and by 25-35 % in Middle East. The impact has also adversely affected the ecosystems and biodiversity (WWF,2006). Agricultural practices exacerbate climate change. Agriculture is a major contributor to the emission of CH_4, $CO_2$and NO_2. A considerable amountof CO_2 has been released to the atmosphere from the combustion of fossil fuels, agricultural and forestry activities, deforestation and other land use charges (Lal *et.al.*, 1997). Rice production in flooded paddy fields, lagoon storage of FYM, and ruminant digestion of pasture herbage result in production of CH_4 while N_2O originated from the microbial transformation of nitrogen (N) from fertilizers, manures and soil organic matter. Per unit mass of gas, $CH_4$and N_2O cause considerable greater global warming potential (GWP, 21 and 310 time, respectively) than CO_2. According to IPCC agriculture contributes 13.5% of GHG emissions. When direct and indirect (Land use, transportation, packaging and processing) sources are included, the contribution could be as high as 32% (Green peace, 2008). Green peace (2008) reported that the largest sources of total non CO_2emissions in 2005 were from soil N_2O (32 %) and CH_4 (27%) from enteric fermentation of cattle. Emission of N_2o arose from N fertilizers and manure applied to soils and during manure storage. The livestock sector in agriculture has been identified as a major contributor to globalGHG emission. The FAO (2006) report on the "livestock's long shadow" indicated that 18% of global GHG emissions were from livestock, includes one third of this from deforestation. This exceeded that from global transport. The total annual amount of GHGs emitted by the agricultural sector in 2005 was estimated to be between 5.10 and 6.10 Gt. CO_2 equivalents (CO_2-eq) (Barker *et.al*., 2007). This estimate showed that CH_4, CO_2 and N_2O accounted for 3.3, 0.04 and 2.8 Gt CO_2-eq, respectively. According to current projections, total GHG emissions are expected to reach 8.36 Gt CO_2-eq per year in 2030 (Smith *et.al.,* 2007). However, agriculture also has a significant mitigation potential for climate change and cloud be improve from being the GOH second largest global GHG emitter to a much less important emitter or even a net sink for GHGs. Thus, the solution to present day climate change problems caused by agriculture lies in changing the farming practices of agriculture.

Direct effects of climate change on crop growth and yield

Some of the simulation model studies explain the effect of climate change on crop growth and yield.

1. Most of the simulation studies have shown a decreased in the duration and yield of crops as temperature increased in different parts of the India.
2. Yields of both *kharif* and *rabi* crops decreased as temperature increased a 2^{0}C increase resulted in 15-17 percent decrease in the grain yield of both crops, but beyond that the decrease was very high in wheat (Rao, 2007).
3. Since, there is greater probability of increase in temperature in *rabi*, it is likely that the productivity of wheat and other *rabi* crops would be significantly reduced.
4. Wheat yields in central India are likely to suffer by u to 2 per cent in pessimistic scenario but there is also a possibility

that these might improve by 6 per cent if the global changes is optimistic.

5. Sorghum, being a C_4 plant, does not show any significant response to increase in CO_2 hence the different scenarios do not affect its yield.
6. However, if the temperature increase are higher, western India may experience some negative effect on productivity due to reduced crop durations.
7. The impacts of warming scenarios becomes apparent at higher levels of fertilizer application from 2030 onwards.
8. In futures, therefore, much higher levels of fertilizers may need to be applied to meet the increasing demand for food.
9. The production of fruits may be significantly affected if the changes in climate happen to coincide with the critical periods. Global warming will push the snow line higher and dense vegetation will shift upwards. This shift will be selective and species specific due to the differential response of plants to changing environmental conditions.
10. The nutritional quality of cereals and pulses may also be moderately affected which in turn will have consequences for our nutritional security.
11. The loss in farm level net revenue may range between 9 per cent and 25 per cent for a temperature rise of 2-3.5^{0}C.
12. Changes in rainfall, temperature and wind speed pattern may influence the migratory behavior of the locust.

The potential of organic agriculture in mitigating climate change

There is considerable world wide support at present in advocating organic agriculture for mitigating climate change. The potential of organic agriculture in mitigating climate change depends on its ability to reduce emissions of GHGs, nitrous oxide and methane, increase soil carbon sequestration, and enhance effects of organic farming practices which favour the above two processes. Reduction of greenhouse gas emissions recent experiments results suggested that organic agriculture can significantly reduced GHG emissions. For example, two long term experiments in Switzerland showed that the GWP of all organic crops can reduced by 18% (Mader *et.al*., 2002). As both N_2O and CH_4 are more potent than CO_2 their emission will have considerable impact on global warming that CO_2. Thus, these gases should be included in assessing the effects of any farming practice on global warming by using carbon footprint measurements. Recently, Hiller *et.al.*, (2009) reported that organic farms showed a significantly lower carbon footprint than conventional and integrated farms, due to N fertilizer use on the latter two.

Organic farming

Organic farming system in the India is not new and is being followed from ancient time. It is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (Crop, animal and farm wastes aquatic wastes) and other biological materials along with beneficial microbes (bio-fertilizer) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment.

Its main potential lies in its significant capacity to sequester CO_2 in soils and in its synergies between mitigation and adaptation. This potential is best utilized employing sustainable agricultural practices such as organic agriculture (OA). Conservation estimates of the total mitigation potential of OA amount to 4.5-6.5 Gt CO_2eq/yr of ca. 50 Gt CO_2 eq total global greenhouse emissions) Depending on agricultural management practices, much higher amounts seem however possible.Organic agriculture complements emission reduction efforts with its major sequestration potential, which is based on the intensive humus production (required CO_2) of the fertile soils. In comparisons to convention agriculture, OA also directly contributes to emission reductions as its emits less N_2O from nitrogen application (due to lower nitrogen input), less N_2O and CH_4 from biomass waste burning (as burning is avoided), and requires less energy mainly due to zero chemical fertilizer use, Its synergies between mitigation and adaptation also expert a positive influence. This is part due to the increased soil quality, which reduced vulnerability to drought periods, extreme precipitation events and water logging. In addition, the high diversity of crops and farming activities in organic agriculture, together with its lower input costs, reduced economic risks. OA has additional benefits beyond it direct relevance for mitigation and adaptation to climate change and climate variability, as it helps to increase food security and water protection (Muller and Davis, 2009). Organic plots, carbon was sequestered into the soil at the rate of 875 lbs/ac/year in a crop rotation utilizing raw manure and at a rate of about 500 lbs/ac/year in a rotation using legume cover crops.

During the 1990s, results from the compost utilization trial (CUT) at Rodale Institute (USA) a 10 years study compared the use of compost, manures and synthetic chemical fertilizer show that the use of composted manure with crop rotations in organic systems can result in carbon sequestration of up to 2000 lbs/ac/year. By contrast, fields under standard tillage relying on chemical fertilizers lost almost 3000 pounds of carbon per acre per year. Storing or sequestering up to 2000 lbs/ac/year of carbon means that more than 7000 pounds carbon dioxide are taken from the air and trapped in the field soil.

- Increasing soil organic carbon in agricultural systems has been out as an important mitigation option by the IPCC.

Organic agriculture has huge capacity in this respect, its practices further the production of soil organic matter, a process requiring CO_2, which is this withdrawn from the atmosphere. Conservative estimates for the annual global sequestration potential of OA amount to 2.4 – 4 Gt CO_2 eq, while other estimates point at a potential of 6.5-11.7 or even more.

- Organic agriculture has lower N_2O emissions from nitrogen application, due to lower nitrogen input than in conventional agriculture. This leads to a potential emission reduction of 1.2 – 1.6 Gt.
- In organic agriculture, biomass is not burned. This reduces the CH_4 and N_2O emissions by ca 0.6 -0.7 Gt CO_2 eq in comparisons to conventional agriculture, where crop residues are often burnt on the field (Smith *et.al.*, 2007).
- 1% of global fossil energy consumption is used for chemical nitrogen fertilizer production, emitting ca 0.23 Gt CO_2 eq. Organic agriculture avoids these emissions, as no chemical nitrogen fertilizers are used. In organic agriculture, nitrogen inputs stems from application of manure and compost, or is fixed from the air by leguminous plants.
- Conventional stockless arable farms depend on the input of synthetic nitrogen fertilizers, while manure and slurry from livestock's farms create additional environmental problems. For both these farm types, high emissions of CO_2 and N_2O and CH_4 are likely. Organic farms prevent such problems by on farm or cooperative use of FYM between both crop and livestock operations.
- Organic agricultural has a significant potential to cover on farm energy use (more than 100 % on test farms) by biogas production from slurry and compost. Soils under organic management practices are also less prone to erosion. Organic agriculture accordingly addresses key consequences of climate change, namely increased occurrence of extreme weather events, increase water stress and drought.
- Organic agriculture uses a higher level of diversity among crops, crop rotations and farm activities than commonly employed in conventional industrialized agriculture, which often leads to monocultures. This improves ecological and economical stability. The diversity of income sources, as well as the resilience to cope with adverse effects of climate change is thus increased. A concrete example of the benefits the enhanced biodiversity reduces pest outbreaks and severity of plant and animal disease, which also improving utilization of soil nutrients and water.
- Organic agriculture is a low risk farming strategy based on lowering external chemical inputs and optimizing biological functioning. Besides lowering toxicity, reduced input costs make organic agriculture competitive economically. In addition, organic price premiums can be realized. These factors working together lower the financial risks and improve the rewards. They provide a type of low cost but effective insurance against crop reduction of failure.
- Since the coping capacity of the farms is increased, the risk of indebtedness in general is lowered. Organic agriculture is thus a viable alternative for poor farmers. Risk management, risk reduction strategies and economic diversification to build resilience are also prominent aspects of adaptation, as mentioned in Bali action plan.
- Organic agriculture has the best premises to utilize local and indigenous farmer knowledge, adaptive learning and crop development, which are seen as important sources for adaptation to climate change and variability in farming communities. A further benefit of organic agriculture is tis role for water protection. Absence of pesticides and chemical fertilizers reduces water pollution in general and the eutrophication of water bodies. Reduced irrigations needs due to the better water holding capacity of soils, increase water availability.
- Organic agriculture also increases soil quality and fertility, not only due to higher organic matter content but also to increased soil nutrients, improved soil structure and aeration and water availability. The biological diversity of soil microbes, insects and earthworm is increased all of which have important roles for soil quality. By not using synthetic fertilizers, organic manures avoids an increase in soil avidity caused by them.

Role of organic matter in carbon sequestration

The soil organic matter pool contains humified products formed by biological transformation of carbon compounds. The inert pool consists of charcoal and pyrolysed carbon with half-lives of centuries to millennia.

The amount of soil carbon in these different fractions depends on the quality of the organic matter being added to the soil as well as their decomposition products through the biological process of humification. Humified soil carbon products have highly aromatic structures such as poly-phenols and hence very slow decomposition rates. Their formation constrained by low levels of N, P and S (Lal, 2008). They also have much lower C/N ratios than labile soil organic matter due to both loss of carbon and incorporation of soil nitrogen.

Soil organic carbon is of fundamental importance to soil health as is affects all there aspects of soil fertility, namely chemical, physical and biological fertility. The activity of living organisms in soil is dependent on regular inputs of organic matters.

Soil organic carbon is part of the global C cycle and the global soil organic carbon pool (1580 Gt) is twice as large as that in the atmosphere and nearly three times that os the vegetation biomass carbon pool. Soil organic carbon sequestration refers to the storages of carbon in the soil and is being considered as a strategy for mitigation climate change.

Carbon sequestration to mitigate climate change

Human activities, especially the burning of fossil fuels such as coal, oil and gas, have caused a substantial increase in the concentration of carbon dioxide (CO_2) in the atmosphere.

The increase in atmospheric CO_2 from about 280 to more than 380 ppm over the last 250 yrs is causing measurable global warming. Potential adverse impacts include sea levels rise increased frequency and intensity of wildfires, floods, drought and tropical storms changes in the amount, timing and distribution of rain, snow and runoff and disturbance of coastal marine and other ecosystems. Rising atmospheric CO_2 is also increasing the absorption of CO_2 by seawater, causing the ocean to become more acidic, with potentially disruptive effect of marine plankton and coral reefs. Technically and economically feasible strategies are needed to mitigate the consequences of increased atmospheric CO_2.

Soil C sequestration is also important at the farm level to build soil fertility, protect soil from compaction and nurture soil biodiversity. In addition to its viral role of mitigating greenhouse gas emissions, soil C sequestration provides many other significant off farm benefits to society. These benefits include the protection of streams. Lakes and rivers from sediment, nutrient and pathogen runoff from agricultural fields, as well as enhanced wildlife habitat. A full system cost to benefit ration of soil C sequestration from various conservation agricultural practices has not been adequately addressed, but is needed to more fully appreciate this important pathway. Conservation agricultural systems promote soil S sequestration by tipping the balance in favor of C inputs relative to C outputs. Carbon sequestration can be achieved by maximizing C inputs and minimizing C outputs (Table-1).

Important mitigating effects

Nitrogen oxide emission are directly linked to the concentration of available mineral N in soil arising from the nitrification and denitrification of available soil and added fertilizer N. High emissions rates are detected directly after mineral fertilizer additions and are very variable (Bouwman, 1995). The banning of mineral N fertilizer use and the reduced livestock units per hectare in organic farms are expected to reducedthe concentration of easily available mineral N in soils resulting in decreased N_2O emissions. In addition, organically managed soils are better aerated due to the improved soil organic levels resulting in better soil structure and physical conditions than that of conventionally managed soils. This leads to less denitrification occurring in organically managed soils causing the release of N_2O. Zeddies (2002) found that farms in southern Germany gave 50 % lower N_2O emissions without mineral N fertilizer inputs and also with minimum inputs of animal feed from outside the farm.

Table: 1 Strategies to sequester soil organic C

• **Maximizing C inputs**	• **Minimizing C loss from soil**
o Plant protection o Species, cultivar and variety o Growth habit (Perennial/Annual) o Rotation sequence o Biomass energy crops	**o Reducing soil disturbance** o Less intensive tillage o Controlling soil erosion
o Tillage o Types o Frequency	**o Utilization available soil water** o Promotes optimum plant growth o Reduces soil microbial activity
o Fertilization o Rate, timing, placement o Organic amendments	**o Maintaining surface residue cover** o Increased plant water use and production o More fungal dominance in soil

Reduction of greenhouse gasses (GHGs)

The reduction or avoidance of CH_4 emissions is of special importance in global warming from the agriculture sector because two thirds of global CH_4 emissions are of anthropogenic origin, mainly from enteric ruminant fermentation in animals (FAO, 2006) and in paddy rice production (Smith and Canan, 2004). In general, the CH_4 emission from ruminants and rice production are not significantly different between organic and conventional agriculture. Differences are due largely to the extent and intensity of various farming practices and their improvements used within different forms of agriculture. Efficient and direct recycling of manure and slurry is the best option to reduce GHG emissions as this practices avoids long distance transport (ITC, 2007). In organic farming systems, cropping depends on nutrient supply from livestock and the combination of cropping and livestock provides an efficient means of mitigating GHG emissions especially CH_4. High energy products fed to animals produced manure with more volatile solids emitting more CH_4 (Greenpeace, 2008). However, CH_4 emissions per kg-feed intake and per kg product are invariable reduced by feeding more concentrates and replacing forges.

Effects of major organic farming practices which reduce GHG emissions and enhance soil carbon sequestration are related to the following.

1. Less fossil fuel consumption and energy inputs.
2. Using organic biomass ass substitute for fossil fuel
3. Enhancement of soil carbon sequestration in organic farms compared with conventional no-till or minimum tillage cropping systems.
4. Less carbon losses due to soil erosion
5. Enforcing certification and monitoring of organic farming practices.

Increases in soil carbon sequestration

Soil carbon sequestration refers to the storage of carbon in the tessestrial soil in the medium to long term (15 to 50 years) Goh(2004). Mechanisms of soil carbon sequestration have been presented by Goh (2004). Soils contain about 1500 Gt of organic carbon which is about three times that in the vegetation and twice that in the atmosphere (IPCC, 2007). This a small change per unit area in the soil carbon pool can have important implication in the global carbon balance and climate change. Organic farming practices such as the use of green manure, animal manure, composts and rotation with inter cropping and cover crops enhance soil carbon sequestration and reduced soil carbon losses by soil erosion in addition to increasing soil fertility and physical conditions for plant growth (Goh, 2004). Although soil carbon sequestration varies considerable, results from long term farm comparison and field trials showed that organically managed soil have higher soil organic matter content that those of conventional systems.

There is skepticism as the whether organic farming system can improve soil carbon sequestration compared with conventional minimum tillage or no-till systems because tillage is required in organic farming to control weeds since herbicides are not permitted. In conventional agriculture, the conversion of till to no till has been reported to enhance soil carbon sequestration in the top soil althrough this may not occur below 7.5 cm soil depth as higher carbon below the top soil in tilled areas has been reported depending on soil texture due to residue incorporation at greater soil depths.

Reduction of fossil fuel consumption and energy inputs

Both conventional and organic agriculture relies on solar and fossil energy for food production. The use of fossil fuels in agriculture produces globally the second major sources of GHG emissions and thus any reduction in fossil fuel use mitigates climate change. According to Pimentel (2006) the conversion to organic farming system can reduce the dependence of farmers on energy and increase the efficiency of energy use per unit production. Results from Rodale Institute Farming Systems Trials (21 years, 1981 to 2002) showed the fusel fuel energy inputs for organic corn production were about 30 % lower than that for conventionally produced corn energy inputs per unit area required for organic grown crops are typically 50% of those in conventional crops due to the lower or no fertilizer and pesticide input in organic agriculture, althrough this is partially offset by mechanical cultivation in organic farms.

The use of plant biomass as a substitute for fossil fuel provides a high potential for the avoidance of GHG emission. According to Lal (2002), a real mitigation using this technique is only achievable if the biomass production does not generate additional GHG emission due to the need of fertilizers inputs and the removal of large quantities of nutrients from the soil by biofuel plants. Organic agriculture is well positioned for this techniques as N fertilizers are not applied (Kotschi and Muller Samann, 2004). However, the organic bio-fuel production system also needs to be not on the same land used for organic food production so as to avoid competition for land.

Reduction of soil carbon losses due to soil erosion

Soil erosion is the major cause of soil organic carbon loss, affecting climate change. It has been estimated that is the United State alone, water and wind erosion remove about 1.5 to 2.5 billion tonnes of soil annually (Wojick, 1999). The application of improved agricultural techniques in organic agriculture such as the addition of crop, residues, green and animal manures and composts together with the use of rotation, intercropping and cover crops converts soil carbon losses into gains (Gog, 2001 and 2004). In addition, this leads to improved soil structure, increase in soil water infiltration and storage (Goh, 2001) and reduces soil erosion and carbon loss. Under organic farming, the soil organic matter captures and stores more water in the crop root zone and can be 100% higher in organic than in conventional fields.

Provides an assurance strategy for mitigating climate change

Unlike conventional agricultural, organic agriculture follows detailed standards of production and processing, which are enforced by inspection and certification (IFOAM, 1998). Thus, organic agricultural provides a strategy to ensure that farming practices which results in mitigating climate change are favoured and enforced. This also allows organic agriculture to be extended to meet the standards of the clean development Mechanism (CDM) of the kyoyo protocol (IPCC, 2000). The CDM is a compensation scheme, which allows industrial countries obtain carbon emission reduction credits with emission reduction projects in developing countries (IPCC, 2000).

Although organic agricultural has been in the forefront of biogas production for many decades, this option is not restricted to organic agriculture only. In addition, in the context of climate change, the benefits of aerobic fermentation of manure by composting are ambiguous because a shift from anaerobic storage of manure can reduce CH_4 emission but will increase N_2O emissions by a factor of 10 (Kotschi and Muller-samann, 2004), thus resulting in no beneficial mitigation in climate change.

Future strategies for improving the effectiveness of organic agriculture in mitigating climate change

Most of the present global research in agriculture is mainly confined to conventional agriculture and vert little research is conducted on organic agriculture. A number of strategies are needed to improve the effectiveness of organic agriculture in mitigating climate changes. These include

1. Greater recognition and acceptance by IPCC and the public
2. Better accounting measure of climate change mitigation potential related to carbon footpaint and resource use
3. Better technology transfer to improve organic yields
4. Adopting the application of biochars as a farming for improving climate change mitigation potential
5. More research in improving organic yields and climate change mitigation potential.

Carbon sequestration in soils and plants is the only strategy that can remove carbon from atmosphere and over time, reduce atmospheric concentration of CO_2. Initiative to support reduced emissions from deforestation (REDD) are well underway. Funds for soil carbon mitigation should also be made available. Support should provide for.

1. Crop mixes to include more plants that are perennial or have deep root systems in order to increase the amount of carbon stored in the soil.
2. Cultivation systems that leave residues and reduce tillage, especially deep tillage, in order to encourage the build up of soil carbon.
3. Shifting land use from annual crops to perennial crops, pasture and agroforestry in order to increase both above and below ground carbon stocks and
4. Activates that restore degraded and desertified soils and ecosystems, especially those affected by accelerated erosion, salinization and nutrient depletion.

Conclusions

The solutions to global warming and present day climate change problems caused by agriculture lies in changing farming practices in agriculture, and adopting the best form of agriculture to provide cost effective high yielding agricultural production with minimum adverse effects on the environments and climate. The world wide acceptance and adoption of organic agriculture for agricultural production and mitigating climate change at present depends on its ability to feed the wolds. It has been shown that the negative impact of climate on agricultural production is region specific and is more severe in developing countries. Thus, organic agriculture could be a good option for agricultural production in developing countries, and at the same time, provides mitigation for climate change. In both developed and developing countries, organic agriculture has considerable potential in mitigating climate change due largely to its ability to reduce GHG emission and in enhancing carbon sequestration in soils. This approach allows the enforcement of adopting new and improved farming practices aim at mitigating climate change. In addition, organic agriculture is highly adaptable to climate change and is also provides a high degree of diversity in the ecosystem. More research is needed for improving this potential and in increasing organic yields especially in developed countries.

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Theme 7
Livestock & Fisheries

T7 A039

Climate changes warrant the conservation and development of Indigenous cattle

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In general, livestock's role in contributing to food security is very well acknowledged but in developing countries,this sector of agricultureisstrongly affected by the thermal and humidity stress conditions and it depend on pasture and other natural forage for nutrition. Facing the effect and threats of climate changes on milk production requires an integrative and multidisciplinary approach. In present scenario, the ever-increasing demand of protein food has put stress on the agricultural produce and hence there is need to a shift towards animal products mainly milk. Climate change may have serious implications to the dairy sector especially to cross breed cattle and buffaloes that is manifested in the form of decline in milk production, reproductive efficiency and changes in epidemiological pattern of emerging and re-emerging disease. Reproductive behavior of cattle and buffalo is synchronized with their own biological clock as per favorable environmental conditions especially for rising their young ones and for milk production. Decline in feed intake, improper reproductive cycles and decrease milk potential owing to the increased temperature and humidity in environment is observed mainly in cross breed cattle and buffaloes that are known to have a poor capacity to dissipate heat from the skin. One possible adaptation strategies to maintain the viability of dairy sector in climate changes is to promote the indigenous cattle breed in India. Better adaptation of Indigenous cattle breeds to tropical climates ensures their place in the future of milk production which facing the challenge of climate changes. Due to their unique characteristics of heat tolerance, tick and pest resistance, resistance to diseases and the ability to thrive under extreme climatic conditions, these breeds have been imported decades back from India by progressive countries for development of heat tolerant disease resistant stock. This paper will focus specifically on the role of Indigenous cattle with respect to the anticipated changes in theclimate.

Key words: Livestock, Milk, Dairy, Indigenous, Reproductive cycle.

T7 A113

Effect of Nutritional Restriction on Physiological Responses of AvishanSheep in comparison to Native Malpura Sheep under Hot Semi-Arid Tropical Environment

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Abstract

In hot semi-arid tropicsamajor problem in sheep rearing is scarcity of feed and fodder during the summer and winter. In this region, a new prolific triple cross sheep breed Avishan (carrier of Fec B gene) has been developed by crossing of a native Malpura sheep breed with a breed of hot humid coastal region Garole and Patanwadi Sheep.The purpose of developing this breed is to propagate fecundity gene without hindering body weight and adaptive capability of native breed to increase sheep production of this region. But it is completely unexplored that whether this newly developed sheep is able to withstand the nutritional scarcity of this region or not. Therefore, the present study was carried out for eight weeks on sixteen Avishan and sixteen Malpura rams to assess and compare the effect of nutritional restriction on physiological responses of these sheep breeds. Eight Avishan and eight Malpura rams were kept on their maintenance requirement as per their body weight as suggested by ICAR 2013, served as control. Another eight Avishan ram and eight Malpura rams kept under nutritional stress by providing 30% less than their maintenance requirement. The feed intake was significantly lower ($P<0.01$) in nutritional stress group of both the breeds. Under nutritional stress, Avishan rams significantly ($P<0.05$) reduced their body weight in comparison to their initial weight. At afternoon, the respiration rate of Avishan rams under nutritional stress increased significantly ($P<0.05$) as compared to Avishan control rams, whereas no changes was found in afternoon respiration rate among both groups of Malpura rams. The pulse rate at afternoon significantly ($P<0.05$) decreased in Malpura nutritional stress

group as compared to its control group but no decrease was found in pulse rate among both groups of Avishan rams. Rectal temperature at morning significantly ($P<0.05$) reduced under nutritional restriction in Malpura rams; whereas in Avishan rams no change was found. At afternoon, the rectal temperature significantly ($P<0.05$) increased in Avishan sheep under nutritional stress as compared to Avishan control rams, whereas, no difference was found in rectal temperature in Malpura rams under nutritional stress. Therefore, we can conclude that the Avishan rams are slightly different from Malpura rams in metabolism under nutritional scarcity. Therefore,under nutritional scarcity proper managemental practices should be undertakenfor optimal performance of this breed.

T7 A183
IMPACT OF CLIMATE CHANGE ON FRESHWATER AQUACULTURE SECTOR – A CASE STUDY FROM WESTERN INDIA

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Abstract
Production trend of Carp Seed and carp grow out in Anand and Kheda districts of Gujarat in western India in response to climatic variations was studied through survey amongst farmers. Results revealed bad water quality, disease prevalence, insufficient water in ponds, reduced feeding and lower growth and survival in fish farming, fish seed production etc. due to climatic changes.
Keywords: Climate Change, Freshwater aquaculture, Anand, Kheda, Gujarat, Western India

Introduction
Increasing concentrations of greenhouse gases in the atmosphere due to human activities are driving changes in global climate at a magnitude and rate greater than at any other time in human civilization (IPCC 2007). Aquaculture is one of the fastest growing primary production sectors in the world, providing significant social and economic benefits globally and accounting for approximately 45% of aquatic animal food produced for human consumption (De Silva & Soto 2009). As the human population grows aquaculture production is expected to increase further to meet escalating demands for high-quality protein and to ensure food security (De Silva & Soto 2009). India's aquaculture production basically can be classified into freshwater and brackish water production. Freshwater aquaculture contributes to 95% of total aquaculture production in India (FAO, 2016). Climate change is predicted to critically impact many aquaculture systems around the world through its effects on species' physiology (e.g. changes in growth rate, reproductive output and disease susceptibility) and farming practices (e.g. changes to farm locations, infrastructure and husbandry) (De Silva 2012).

The state of Gujarat in western part of India is a leading producer of marine fish and is contributing poorly to inland fish production through freshwater aquaculture. The districts of Anand and Kheda located in central part of Gujarat are having great potentialities for aquaculture development. Therefore, increasing efforts are undertaken for promoting aquaculture productivity in this region against uncertain climatic changes. But, little research is reported on climate change and its impact on production of fish seed and grow out aquaculture operations. Therefore, it is imperative to undertake investigation on impacts of climate change on fish breeding, seed rearing and growout aquaculture which would be greatly helpful in planning and setting up of strategies for further development of aquaculture production for ever increasing population. Hence, the study intends to perceive the impacts of climate change on fish hatchery operations, fish seed growing and fish farming operations in western India. The present study was undertaken with following objectives.

1) To understand different climatic variables those have adverse effects on freshwater aquaculture;
2) To identify possible impacts of climate change on freshwater aquaculture; and

Material and Methods
The study was based on field survey during January to June 2016 where primary data were collected from the respondents in the two selected districts in Central Part of Gujarat. The districts of Anand and Kheda in Central Gujarat, being the top producers of freshwater fish in the region were selected purposefully, because of existence of more numbers of fish seed farms and fish farms. Data on impact of climate change on freshwater aquaculture practices were collected from randomly selected fish farmers (16 from each district), fish seed producers (6 from each District) and key informant (3 from each district) by

pre-tested questionnaire interviews, Participatory Rapid Appraisal (PRA) tool such as Focus Group Discussion (FGD) and cross-check interviews with key informants, such as District Fisheries Officials, local leaders etc were also carried out. Before going to make an actual interview, a brief introduction about the objectives of the study was given to each of the selected fish farmers, fish seed producers and key informant and assured them that all information would be kept confidential. At the time of interview each question was explained clearly and asked systematically as for their sound understanding.

The primary data collected through survey were supported by collecting secondary information on freshwater fish production, fish seed production and climatic data from various sources. Data on climatic parameters such as temperature and rainfall were collected from the meteorological stations of Anand Agricultural University located in the selected districts. Aquaculture production data were also collected from the fisheries offices located in the selected districts.

The collected data were summarized and scrutinized carefully. These data were tabulated and showed in diagram and graph. According to this data climatic variables were ranked. Majority of data were used as percentage (%) The data were analyzed with suitable statistical tools..

Results

There are several climatic variables which influence the climate change. According to field survey, heavy variations in rainfall and fluctuation of temperature were common climatic variables frequently occurring during freshwater aquaculture in Gujarat. According to fish farmers, heavy rainfall was ranked first climatic variable affecting freshwater aquaculture followed by least rainfall, rainfall variation and fluctuation of temperature. Most of the respondent farmers (83 %) encountered some sorts of natural problems due to climatic changes such as less rainfall and high temperature, whereas, only 2 % faced man made problems and 15% encountered both. Majority (54 %) of the fish farmers and fish seed producers mentioned that various problems occurred due to climate change such as over heat of pond water, bad water quality, disease prevalence, increase mortality, late maturation, reduce survival rate, reduce feeding activity and lower growth rate hampered the fish growth and survival in culture, nursery and hatchery level. The fish seed producers mentioned that survival rate of fish seed was sharply declined with slight change of temperature. About 90% of fish seed producers claimed temperature change for low survival rate of fish seed. Most of the fish farmers in the study area mentioned that insufficient rainfall during the peak culture period. Moreover, 65% and 35% respondents claimed that insufficient and fluctuating of rainfall hampered their aquaculture operations. However, not a single case was found with excess rainfall in the area during last 16 years. No rain or less rain due to climate change created various problems like less water availability, reduce feeding activity, disease prevalence and mass mortality of fishes. Deformed fry, fingerlings and adult fish were produced under the effect of climatic changes including floctuations of temperature and rainfall. The majority of the respondents (43%) mentioned that lack of rainfall has made fish farm and fish seed farm management difficult. About 23% fish farmers and fish seed producers mentioned late rain and increased sun light intensity increased. On the other hand, 5.33% fish farmers and fish seed producers encountered two seasons in a year and 6.66% fish farmers and fish seed producers mentioned that the weather do not match with the season now days.

Discussion

The result showed that there are several climatic variables such as heavy rainfall variation and fluctuation of temperature which frequently occur during freshwater aquaculture in Gujarat. Similar type of study was also reported by Faisal IM and Parveen (2004). The study found that heavy rainfall and least rainfall are most important climatic variables that cause serious damage during aquaculture practices. These cause outbreak of different pathogenic diseases in fish. Climatic change has great impact on fish seed farms in Gujarat. The survey found that in last few years climate variables had different affects on growth and survival rate of fishes. Increased temperature increases the metabolic activity of fishes. Thus increase fish mobility and eventually cause stress of fish. Increasing temperature increases the evaporation of water, which reduces the surface and volume of water in the fish pond. So, in pond culture system, critically low oxygen concentrations are occurred in the overnight when all aquatic organisms use the dissolved oxygen for respiration and the peak of low dissolved oxygen concentration in the pond reaches before sunrise. As a consequence, fishes face hypoxic condition, frequent occurrence of which will cause the reduction of the fish feeding. More or less similar findings were noted by Alam, M.S. and M.A. Salam (2009). They described as majority (44.44%) of the fish farm operators, hatchery and nursery owners had various problems due to climate change such as over heat of pond water, bad water quality, disease prevalence, insufficient water in the ponds, reduce feeding activity, hampered the fish growth and survival in culture and nursery farms.

According to the survey, it was found that climate changes could affect productivity of aquaculture systems and increase the vulnerability of cultured fish to diseases. Relatively small temperature changes alter fish metabolism and physiology, with consequences for growth, feeding behavior and survival. The general effects of increased temperature on parasites include rapid growth and maturation, earlier onset of spring maturation, increased number of generations per year, increased rates of parasitism and disease, earlier and prolonged transmission, the possibility of continuous, year-round transmission. More or less similar findings were noted by De Silva and Sato (2009). They described that increased temperature may cause thermal stress in aquatic animals, leading to reduced growth, sub-optimal behaviors and reduced immunocompetence resulting in changes in the distribution and abundance of their hosts. Climate changes could affect productivity of aquaculture systems and increase the vulnerability of cultured fish to diseases. All aquatic ecosystems, including freshwaterbodies are influenced by climate change. Similar type of study was also reported by Marcogliese (2001). The study found that the general effects of increased temperature on parasites include, rapid growth and maturation, earlier onset of spring maturation, increased parasite mortality, increased number of generations per year, increased rates of parasitism and disease, earlier and prolonged transmission, the possibility of continuous, year round transmission.

Conclusion

Considering the likelihood impact of Climate Change on freshwater aquaculture, the present study was undertaken during January to June 2016 in two selected districts of Gujarat in Western India such as Anand and Kheda. The study was based on direct observation and questionnaire interviews with fish farmers, fish seed producers and key informants using a well defined pre-tested questionnaire, focus group discussion and secondary data were collected from the relevant organizations. Most of the fish farmers and fish seed producers in the study area mentioned that rainfall variation and temperature fluctuation had hampered freshwater aquaculture adversely. It was recorded that no rain or less rain created various problems like less water availability, reduce feeding activity, disease prevalence, and mass mortality of fishes happened in the area. Climatic variables have a profound impact on freshwater aquaculture, fish feeding behaviour, fish diseases, parasites and water quality. These variables affect on growth and survival of fingerlings in fish seed farms. Besides this climatic variables introduce freshwater aquaculture with many unwanted pathogenic micro-organisms and cause serious disease outbreak. The changing environment put the fish farmers and fish seed producers in great challenge as they have to shift their traditional activities to alternative modern opportunities on which they are not adopted. The adverse consequences of climate change will also have an effect on fish farming community health, livelihoods, and food supply.

Climate change is now inevitably a challenge for aquaculture in the region. The aquaculture production in the study area greatly hampered due to uncertain climate change. It is needed training poor farmers to understand of climate change trend consequences to enhance aquaculture production.

Acknowledgements

The authors acknowledge thankfulness to all the participants who provided necessary primary informations to survey questionnaire. The authors also express their thankfulness to the Head of Meteorological Department of Anand Agricultural University and Fisheries officials of the Districts of Anand and Kheda of Gujarat in western India.

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T7 A205
FISHERY BASED FARMERS' PERCEPTION OF CLIMATE CHANGE IN COASTAL KARNATAKA (INDIA)

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Abstract
Fishery based Farmers in a coastal Karnataka, priorities climate variability as their primary agricultural and fishery productivity-reducing factor. This paper focuses the importance of considering local farmers' perceptions of climate hazard, as this significantly persuade on-farm investments and decision-making. The study is evidence for farmers perceived climatic and weather patterns to have changed over the past decades, as indicated by erratic rainfall patterns, a shift in season's decreased rainfall and increased temperature, leading to declined crop and fish productivity, increased drought and flood incidents and increased livestock and human morbidity and mortality. The majority of respondents had average to better perception on changing climate. The climatic data show evidence that corroborates the farmers' perceptions.
Key words: Climate change, Crisis, Farmer, Perception

T7 A211
CLIMATE CHANGE IMPACT ON AGRICULTURE, LIVESTOCK AND HEALTH & EDUCATION IN SAHARIYA TRIBAL COMMUNITY LIVING IN BARAN, RAJASTHAN

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Abstract
In India drastic effects and trends of the climate change are seen in the last few years in the form of natural disaster, increased in pollution and raised sea level and change in the monsoon pattern etc. In Rajasthan around two third of its population (56.5 million) is still dependent on agricultural activities for their livelihood. Only 34.5 per cent of the net sown area is irrigated. Climate change is one of the greatest challenges of our time. Fossil fuel burning and deforestation have emerged as principal anthropogenic sources of rising atmospheric carbon dioxide (CO2) and other green-house gases and consequential global warming. Proxy records of variability in temperature, precipitation, sea level and extreme weather events provide collateral evidence of global climate change.
Key words: Climate change, Impact on Agriculture, Health & Education in Tribal Community

Introduction
In the present scenario climate change is a burning and debatable issue for every country of common concern. The scientists, scientific and environmental organizations and government of every country having prudent conscience, that the changing climate is a result of the human activities. And India is not left behind from getting the effects of climate change, although India is food self-sufficient country where agriculture is an important component of the economy.

Methodology
The aim of the present study was to understand the impact of climate change on tribal community in Shahabad, Rajasthan. A qualitative research approach was adapted for the present study. The researcher visited 15 different village of Shahbad and conducted Focussed Group Discussion with the Sahariya tribal community residents of these villages. The impact of climate change was evaluated with the help of thematic analysis on different themes of life related to Agriculture, livestock, livelihood, education and health etc. Due to change in climate their crop yield of wheat, mustard, gram, maize and soyabeans has decreased. So to cope with crop failure they have changed their crops and even some of them stopped farming like Fenugreek, Groundnut crop yield is very much affected. Scanty of rainfall and increase in the days of summer, no fodder and grasses are left on the bank of the river and in the posture land for animals to feed due to which milk production is decreased.

Buffaloes are yielding from 1 to 2 kg and cows are 500 gm to 1 kg. A greater impact is seen on the education on tribal community.

Results

The tribal people consider education as useless, as they are trained in hunting and gathering the food. During the past six decades as deforestation has been occurring, in the name of development many tribals were displaced and consequently forced migration occurred. Overwhelming evidence shows that climate change presents growing threats to public health security - from extreme weather related disasters to wider spread of such vector-borne diseases as malaria and dengue. The impacts of climate on human health will not be evenly distributed around the world. The Third Assessment Report (Intergovernmental Panel on Climate Change-2001) concluded that vulnerability to climate change is a function of exposure, sensitivity, and adaptive capacity.

Conclusion

In light of the above information and discussion it is suggested that proper facilities for living must be provided by the government. The contractors who engage these people in labour works should provide proper shelter, health accessibility, and education for children and many other facilities under their CSR practices. The Govt. of Rajasthan should have a wider role in preparing policy for protection and help of these people.

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T7 A302
LIVESTOCK MANAGEMENT STRATEGIES UNDER ARENA OF CLIMATE CHANGE

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Stress is a complex phenomenon, which alters physiological, psychological and behavioral responses of animals. It involves areas of brain and endocrine system thus causing threat to homeostasis (Sharma, 2001). Stress is one of the major factors, which affects the physiological functions of the body and production as well as reproduction of the livestock. Stress represents an integral part of every day's life and a number of adaptive processes are activated in order to maintain homeostasis in the face of challenging external and/or internal milieu (Walker *et al*., 1997). Stress is commonly defined as a stimulus that disturbs or interferes with normal physiological equilibrium of an organism or stress refers to situations that release emergency signals necessary for survival or stress is any environmental changes that are severe enough to elicit the behavioral response from an animal.

Types of Stress- Animal may be exposed to different types of stress, according to involvement of stressors. The stress can be classified into –

1 Environmental stress: - Environmental stress plays a significant role in deterioration of animal health and weakened the defensive mechanism of body. Environmental stress includes all external factors (temperature, humidity, solar radiation, wind velocity, rain fall). Extreme temperature i.e. excess heat or cold, sudden wind and rain and/or humidity affects the comfort of the animals, especially that of pastured animals. The climatic changes are likely to precipitate metabolic diseases. For example, hypocalcaemia in sheep and hypomagnesaemia in cattle are predisposed during cold weather and heat stress.

2 Nutritional stress: - Lack of energy, bulk, fluid and deficiency of certain micronutrients and vitamins causes stress in animals. Vitamins, particularly vitamin C and E, and minerals such as zinc and selenium have been used extensively as

anti stress treatment in livestock and poultry production.

3 Social stress: - This may be due to the faulty management and inconvenient ways of different operation. These includes, holding a low rank in peck order, overcrowding, fear, predators, physical & emotional trauma to animal.
4 Internal stress: - This type of stress is due to the internal factors like growth of pathogens, productions of toxins.
5 Oxidative stress: - This type of stress is due to free radicals and reactive oxygen formation.
6 Transformational stress
7 Surgical stress
8 Starvation stress
9 Physical stress
10 Psychological and Physiological stress

Among all these stresses environmental stress especially heat stress plays a significant role in dairy milk production as well as animal health. The term heat stress refers to stress of hot weather and not the estrous or heat cycle (Varner, 2005). Heat stress in dairy cattle and buffalo is one of the leading causes of decreased production and fertility in dairy in dairy animal during summer months (Sharma *et al*., 2005). The primary factors that causes heat stress in dairy are high environmental temperature and high relative humidity (West,2002). As the environmental temperature increases, the difference between the temperature of the cow's surroundings and her body reliance on evaporative cooling (sweating and panting) to dissipate body heat increases. Heat stress results from the animal's inability to dissipate sufficient heat to maintain homeothermy, which is caused primarily by high air temperature but can be intensified by high humidity, thermal radiation, and low air movement and by metabolic heat production (Varshney, 2001). Cattle are more susceptible for heat stress because cattle sweat's at only 10% of human rate where as buffalo sweat's only 1/6th of cattle rate (Kseown *et al*., 2005). Severe weather conditions especially during summer drastically reduce milk production by affecting the hypothalamic centers, which then causes a decrease in feed consumption. During hot weather conditions, the high milk producers cannot maintain high levels of milk production because heat produced has to be dissipated in addition to the heat imposed by external environment.

Comfort zone:

Comfort zone is the term used to denote a type of mental conditioning resulting in artificially created mental boundaries with in which an individual desires a sense of security (www.en.wikipedia.org). It is the range of temperature, humidity and air velocity at which the greatest percentage of individual feel comfort (www.hobsonac.com). Comfort zone of cattle as temperature zone with in which no energy demands are made on temperature regulating mechanism. The range of comfort zone for tropical cattle is 50-60°F where as for temperate cattle it is about 30-60 °F(Broody *et al.,* 1956).

Thermal neutral zone:

The range of ambient temperature within which the animal doesn't need to expend any additional energy in order to regulate body temperature is known as thermal neutral zone.

Temperature humidity index (THI):

Heat stress is commonly assessed by the temperature humidity index, is the sum of dry and wet bulb temperature (Berman, 1993). The THI can be used to estimate the effect of heat stress on production (Ravagnolo *et al.,* 2000). The Temperature humidity index is also known as discomfort index because when the temperature and humidity both are high then it causes discomfort to the animals (Mahapatra *et al.,* 2002).

THI= DBT + 0.36 DPT + 41.2 (Johnson, 1987)

Where, DBT; Dry bulb temperature (°C)

DPT; Dew point temperature (°C)

THI=0.72 (C_{db} + C_{wb}) + 40.6

Where, C_{db}; Dry bulb temperature (°C);

Cwb ; Wet bulb temperature (°C)

Now in a recent days, an advance technology developed known as THI logger system, which automatically converts temperature/Humidity data into dairy THI numbers and summarizes them in a color-coded (metermall.com).

The heart of the THI logger system is a small battery operated HOBO data logger that records air temperature and humidity every 10 minutes around the clock for up to 28th days. When it connects with PC then we get a much more accurate picture of when, how long and to what degrees the animals are heat stressed.

Fig 1: THI logger system

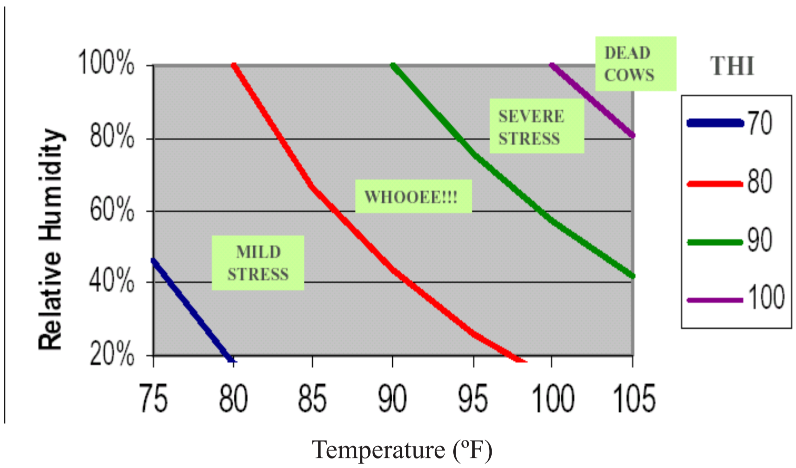
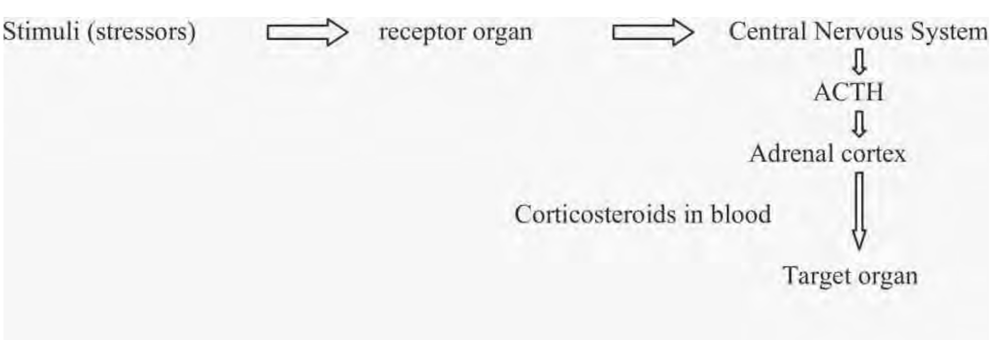


Fig 2: Heat stress index/ THI index for exotic cattle

Genesis of heat stress:

Any alterations in any environmental parameters like air temperature and environmental humidity leads to genesis of heat stress condition. Animal must maintain a stable body weight at normal range of body temperature. Thus animal must maintain a balance between heat gain and heat loss mechanism.

Physiological mechanism causing stress to the animals:



Mechanism of heat loss:

There are mainly four mechanisms are involved in heat loss.

1. Conduction
2. Convection
3. Radiation
4. Evaporation

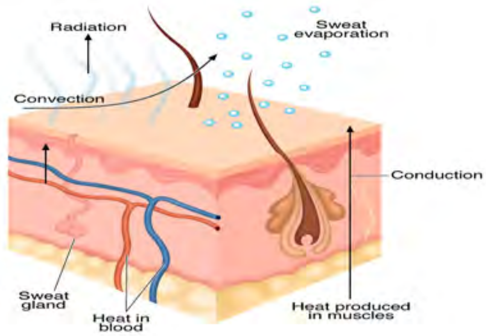


Fig 4: Heat loss mechanism

1. **Conduction:** Where the dairy animal conducts heat to a cooler surface. Conduction losses will depend on
- The mean temperature of the external surface of the body
- The mean temperature of the surface in contact of the body, the area of contact and the thermal conductivity of animal coat and skin.

2. **Convection:** Heat exchange by convection is of two types – Respiratory and Cutaneous
Convective heat losses depend upon (i) Mean temperature of the skin and evaporating surface (ii) The area of surface exposed to convective air (iii) The mean temperature of the ambient air (iv) The type of coat (v) The air movements.

3. **Radiation:** The heat exchange by radiation depends upon –
- The mean radiant temperature and intensity of radiant source.
- The mean temperature of external surface of the animal.
- The surface area of the body effective in radiation interchange.
- The radiation absorption characteristics of the animal skin and coat surface.

4. **Evaporation**: where moisture is evaporated from the surface of her body (sweating) and from her lungs (panting).

Conduction, convection and radiation depend on the large difference between the cow's body temperature and environmental temperature. Evaporation work best at low humidity. When the environmental temperature is near cow's body temperature, coupled with high relative humidity, the cow's body temperature rises and cows exhibits physiological response to hot weather. The cow also eats less feed to produce less metabolic eat, which is a protective mechanism.

Factors affecting severity of heat stress: There are several factors, which influence the severity of heat stress.
- Environmental condition
- Level of production and feed consumed
- Stage of lactation
- Exercise requirements
- Breeds and color

All these factors influence heat production, degree of stress she is subjected to, and how effectively the cow dissipates heat.

Clinical signs of heat stress

Signs of heat stress in lactating animals are obvious, especially the reduced milk production and the lethargic behavior of the cows. Higher producing cows exhibit more signs of heat stress than lower producing cows because higher producing cows generate more heat as they eat more feed for higher production.

Moderate Heat Stress- (80-90 ºF ET, 50-90%RH

- Rapid shallow breathing.
- Profuse sweating.
- Decrease in milk production &feed intake by10%.
- Increased rectal temperature more than 103 ºF

Severe heat stress- (90-100°F ET, 90%RH)
- Severe depression in milk yields & feed intake
- Open mouth breathing with panting.
- Abnormal increase in rectal temperature

*Lethal temperature range for cattle is >100ºF ET & >80%RH

The physiological and behavioral changes include during heat stress are-

(i) Vasodilatation of peripheral or cutaneous blood vessels.
(ii) Increase respiration rates, panting (evaporation)
(iii) Sweating activity increases
(iv) Seek wind currents
(v) Seeking shade
(vi) Extra drinking of waters
(vii) Decreasing locomotors activity
(viii) Licking body surface
(ix) Eating succulent feeds

Effect of production level on animal performance in hot environments

Physiological responses

Hagiwara et al. (2002) reported that the ET at which the respiration rate started to increase was lower (17°C) for high-producing cows (>35 kg milk/day) than that (22°C) of low-producing cows. The body temperature of high-producing cows rose to a higher level than that of low-producing cows, because of the higher metabolic rate and heat production of the more productive cows.

Dry matter (DM) intake and milk production

Sinde *et al.* (1994) reported that the food intake (dry matter (DM) basis) of cows which ate more than 20 kg of feed (DM basis) per day started to decrease at 25°C of ET. The ratio of forage to concentrates also decreased. However, the feed intake of cows with a feed intake of less than 20 kg/day (DM basis) was relatively constant. These cows were fed a high-quality diet of corn silage, timothy hay and concentrates, in which the level of total digestible nutrients (TDN) was 75 - 77%. NDF, the level of neutral detergent fiber (NDF) supplied by roughage, was less than 35%.

The milk production of cows which consumed more than 20 kg of feed per day (DM basis) decreased with a rise in ET. Milk production also fell, especially when the ET rose to 25°C. On the other hand, no significant differences were seen with a higher ET in the milk production of cows which consumed less than 20 kg of feed (DM) per day.

Milk yields in summer in Japan show a more marked fall in more productive dairy cows (Toda et al. 2002). In other words, the decline in milk yield at higher temperatives is more marked in cows that produce more milk. A significant relationship exists between the level of milk yield (X, kg/day) and the decline in milk yield with each increase in daily mean ET (Y, kg/day/°C) as follows:

$Y = -0.04*X + 0.18$ ($r = -0.53$, $P = 0.03$).

This equation shows that the decline in milk yield seen in lactating Holstein cows with each increase in ET of one degree C was 0.6 kg/day in cows producing 20 kg milk/day, 1.0 kg/day in cows producing 30 kg/day, and 1.4 kg/day in cows producing 40 kg/milk/day.

Milk composition

Due to prolong heat stress the milk composition of cattle and buffaloes are also changed. Some of the milk constituents of cattle and buffaloes when exposed to high environmental temprature with different levels of relative humidity increase, e.g., non-protein nitrogen, palmitic and stearic acids; other constituents decrease, e.g., butter fat, total solids, solid not fat, total nitrogen, lactose, short chain fatty acids (C0-C12) and oleic acid. The percentage of fat. The percentage fat diminishes between the environmental tempratures 21ºC to 27ºC, but beyond 27ºC the percentage increases , where as solids not fat usually decrease. High temperatures also depress the amount of citric acid and calcium during eaely lactation in dairy cattle and buffaloes. Heat also causessa decrease in potassium, but no marked changes in sodium (Kamal et al., 1961). These temprature dependent ion fluctuations are of practical significance to the dairy products industry. For, example, if citrate and phosphate ions are low in proportions ions are low in proportion to calcium and magnesium, coagulation will occur during sterilization and pasturization procedures.

Low ambient temperatures causes an increase in butter fat percentage, the degree varying with the breed. For example, under simila low temperature conditions there is a 10 to 35% increase in thes milk of Jersey cattle, where as Holsteins shows a much smaller change. The total solids, total nitrogen and the solid not fat, also are greater at tempratures below freezing than at 10ºC.

Reproductive physiology

Heat stress has been shown to alter the duration of estrus, colostrum quality, conception rate, uterine function, endocrine status, follicular growth and development, luteolytic mechanisms, early embryonic development, and fetal growth. Although season alters endocrine profiles and fertility in males, this discussion will focus on the female because most of the impacts on male fertility can be circumvented with AI.Climatic factors that may influence the degree of heat stress include: temperature, humidity, radiation, and wind. In an Israeli study, evaluating the relationship between ambient temperature and body temperature, the upper critical temperature for heat stress to begin was between 25 and 26°C. Furthermore, cattle & buffaloes with rectal temperatures of 40°C as a result of exposure to 32.2°C ambient temperatures for 72 h after insemination had conception rates of 0% compared with a conception rate of 48% when rectal temperature was 38.5°C for cows in an ambient temperature of 21.1°C (Ulberg and Burfening, 1967).Therefore effect of heat stress more pronounced when THI becomes more than 72.

The overall effect is almost same in cattle& buffaloes, but the reproductive performance is poor in buffaloes compared to cattle. Research on buffalo reproduction showed less number of primordial follicle reserve in a pair of buffalo ovaries (10,000-19000) as compared to cattle (150,000) and comparatively less antral follicle during the estrous cycle unlike cattle (Kumar et al).

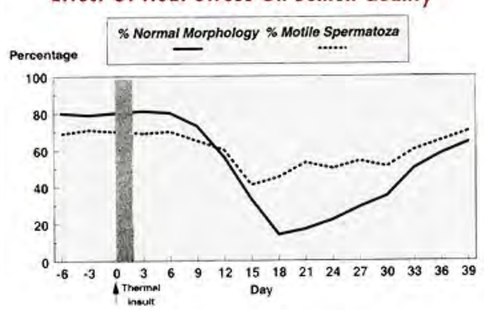
The buffalo are more sensitive to heat stress than cattle due to its coat colour and only 1/6 sweat gland are present in body surface than cattle. Hot weather lowers reproductive efficiency in two ways. First, cows& buffaloes are harder to detect in estrus and are some times classified as anoestrus. Second cows& buffaloes that are bred by artificial insemination have a hard time becoming or staying pregnant. The second problem shows up as a low conception rate or high services per conception.

The male reproductive physiology of cattle & buffaloes altered greatly with the extent of heat stress .The spermatogenesis is based on the thermoregulatory mechanism of testes. In all domestic mammals spermatogenesis is depressed at body temperature. Artificial insulation of the testes results in testicular epithelium degeneration, the primary spermatocytes being the most sensitive. Degeneration may be due to hyperemia, resulting from vasodilatation or to vascular stagnation and ataxia. Extremely high temperatures have an immediate effect on spermatogenesis in contrast to moderately high temperatures extending over several months, which show a delayed effect.

The scrotum behaves much like a thermostat holding the testes close to the body when air temperature is below 6ºC, allowing the testes to drop a maximum distance from the when the air temperature is above 24ºC, and adjusting the distance appropriately at intermediate temperatures. When there is even slight variation between abdominal temperature and testicular temperature than normal (2ºC) range the semen quality and quantity both are greatly affected. The percentage normal morphology and percentage motility of spermatozoa are decreases greatly, it depend upon duration intensity of heat stress.

FIGURE 1

Effect Of Heat Stress On Semen Quality



Initially the semen quality curve is relatively constant, but when duration of heat stress increases it decline rapidly, then the spermatozoa acclimatized to heat stress condition, so the semen quality gradually increases, but can’t achieve the optimum level (as shown in figure).

Effect on climate change on female reproductive physiology

1. Effect on follicular development:

Discrepancies exist regarding the effect of heat stress on emergence of small follicle. Some workers reported a reduction in small follicles while others reported increased number of small follicles in heat stress affected cows and buffaloes. In normal animals, a follicle attains dominance in a cohort and it suppresses the development of sub ordinate follicles. This suppression is mediated through inhibin. Hence the number of medium sized follicles is less during the period of dominance. But lack of decline in medium sized follicles was observed in heat stress cows and buffaloes. It suggests that, even though heat stress does not suppress the overall pattern of folliculogenesis, it does affect the follicular dominance. This suppression in the dominance of the large follicle permits the growth of additional large follicles and increase tendency towards twinning in summer month. The mechanism by which heat stress affects dominance of larger follicles has not been studied in detail. However, it has been reported that in heat stressed cows & buffaloes the level of circulating inhibin were less and consequently the plasma FSH concentrations remained elevated. This may result in to development of more than one large follicles in heat stressed cows & buffaloes.

2. Effect on gonadal hormone:

Heat stress severely affects gonadal hormone synthesis by impairing both the FSH stimulated differentiation of granulosa cells and LH receptor expression in thecal cells. With in a follicle, theca cells produce androgen under the influence of LH. These androgens are aromatized to estradiol in the granulose cells under the influence of FSH.A significant decrease, in estrogen production, in the follicles of heat stress cows & buffaloes occurs due to decline in androgen production by the theca cells and the conversion enzyme (aromatase). Low levels of plasma estradiol in such animals were also associated low amplitude of tonic LH release and reduced peak concentrations of preovulatory LH surge. Heat stress affects the steroidogenic capacity of corpus luteum so less progesterone are produced. This decrease in progesterone production by CL may cause embryonic mortality and reduced pregnancy rates in heat stressed cows & buffaloes.

3. Effect on gonadotropin secretion:

Despite the important role FSH & LH in reproduction the effects of heat stress on their secretion has not been hypothesized that activation of hypothelemo- pituitary axis by stressors reduce the pulsatility of GNRH /LH by acting at both hypothalamus &pituitary gland. Chronic heat stress decreases both, the mean basal as well as preovulatoryLH surge concentrations. The effect of these inhibitions is of two fold. Firstly, the GNRH/LH frequently may be so slow that initial follicular growth occurs but unable to continue in latter stages.

Thus the animal fails to maintain estrous cycle and the consequent anoestrous is easily recognized. Secondly, the LH pulse frequency may be sufficient to get a follicle into latter stages of development but may not be sufficient enough to provide correct GNRH priming of pituitary and/or adequate estradiol production. Hence, an abnormal LH surge is generated which may cause failure of ovulation and lead to ovarian syndrome. Heat stress induced depression of dominance was also found to be associated with early appearance of a wider FSH surge and pronounced decrease in plasma concentration of immuno-reactive inhibin.

4. Effect on fertilization and embryo development:

Exposure of spermatozoa to elevated temperature while in the uterus or oviducts of hyperthermic female could compromise the sperm survival or their fertilizing potential has been demonstrated. The mechanism by which heat stress affects embryonic development is multifactorial. Heat stress is highly harmful to cleaving embryos. Also the embryonic signal to mother (maternal recognition of pregnancy) in heat stress cows is so week that it may not be sufficient to block PGF2α production by the uterine endometrium, which in turns causes luteolysis and termination of pregnancy. Though the embryo becomes more resistant to maternal heat stress as pregnancy advances, severe heat stress can inhibit embryonic development in late pregnancy also. Heat stress also reduces the metabolism and blood flow to the fetus and results in retarded fetal growth.

5. Effect on fertility:

Heat stress lowers the fertility in dairy cows & buffaloes. Conception rate drops considerably in summer than cooler months. Increased cortisol synthesis during heat stress delays the action of estrogen and hence the animal experiences silent estrous. Because of the covert estrous signs, there is very possibility to miss the estrous or the animal may be inseminated at wrong time leading to conception failure. Other means of conception rate reduction in heat stress cows are delayed/anovulation, luteal insuffiency and/or embryonic mortality.

So, during heat stress the reproductive physiology of cows &buffaloes changed mainly because of the elevating body temperature and the blood flow may be diverted from internal circulation to peripheral circulation in an attempt to reduce body temperature. The reduction in blood flow to internal organs including the uterus, oviducts and ovaries may reduce available nutrients and increase biochemical waste products at the tissue level.

How to reduce heat stress:

The most practical methods to reduce heat stress can be grouped into Managemental practices and nutritional correction.

1. Managemental practices: Careful management, which can alleviate heat stress, is the best way to maintain high production levels in lactating cows in a hot environment. Under management practices, emphasis should be given on proper water supply, shading and cooling system to reduce or manage heat stress.

A. Water: Dairy animals need to increase water intake during times of heat stress to dissipate heat through the respiration and sweating activity. Water is the primary nutrient needed to make milk accounting of over 85% of the content of milk. Water consumption will increase by as much 50% as the environmental temperature rises. Following points encourages the water consumption:-

- Water should always be fresh, clean and approximately at 70-86F temperatures.
- Provided cool water during periods of high temperature.
- Put water close to shade, since cattle will not travel great distance for water.

B. Shading: - shading from direct sun light is also very important, as this allows cattle to rest in a more comfortable environment. The most effective sources of shade are trees and other plants. They provide not only protection from sunlight, but also create a cooling effect through the evaporation of moisture from their leaves (Hahn, 1985). When not enough natural shade is available, artificial shades can provide to check the soar radiation during peak hours.

Shade has a beneficial effect on the physiological response of dairy cattle to heat. The body temperature, heart rate, and respiration rate all decreased when shade was provided during the summer.

C. Cooling: Each area of the dairy facility must be considered when looking at cow cooling options. The holding pen is the most stressful location for milking cattle during periods of heat stress. First, cool the holding pen area with a combination of shade, air movement and water. If cooling is done effectively with fans and water in the holding pens, less cooling is required between milking. Fans and sprinkler can reduce ambient temperature by 15F and cooled cattle produced more milk than non cooled cattle. Some important methods of cooling are –

- Evaporative cooling pads and fan system: This method is effective in areas of low or high humidity and cool the air while raising the relative humidity. This system requires fans, evaporative cooling pads, and pumps to circulate water to the pads. Fans are used by most dairy farms with an average of 5 (2-8) cows per fan. The cooler are positioned every 20 feet in the roof and air is pulled through the cooler at very high rates.
- Fog system: A fog system sprays small water droplets into the air and cools the air as the droplets evaporate. When an animal inhales the cooled air it can exchange heat with the air and remove heat from its body. High-pressure foggers disperse a very fine water droplet, which quickly evaporates and cools air while raising the relative humidity. As fog droplets are emitted they are immediately dispersed into the fan's air stream where they soon evaporate. Foggers should operate during day light hours only; humidity is too high at night but fans should operate continuously. Fog systems are very efficient methods of cooling air but also are more expansive than mist system and require more maintenance.
- Mist System: A mist droplet is larger than a fog droplet and animals are cooled primarily by inspiration of cooled air. Mist systems are difficult to use under windy conditions or in combination with fans.
- Mist and fan system: Ali *et al.,* 1998 have described an evaporative system, which water mist and a fan. Mist particles are sprayed onto the cow's body to wet the hair. A fan is then used to evaporate the moisture as a way for cooling of cows. The results showed an increase in milk production of 0.66-1.90 kg/day for cows producing 20-25 kg/day.
- Sprinkling System: this system works very effectively is to sprinkle the cattle for a short period of time (0.5to3.0 min) and apply 0.05 inches of water per cycle, just enough time to soak the cattle skin. It is an alternative to fog and mist system.
- Cooling ponds: The cooling ponds have been found to effectively reduce body temperature with no apparent adverse effect on udder health or other disease.

2. Nutritional correction: It is important to predict dry matter intake (DMI), in orders to formulate an adequate diets for cattle in a hot environment. Although there are some reliable equations regarding DMI in regard to thermo neutral zone.

$DMI = 0.0198\ LW + 0.231FCM + 0.179\ T_{max} - 0.187\ TDN$

Where LW, live weight (kg); FCM, 4% fat corrected milk (kg); Tmax, Maximum air temperature (°C); TDN, Total Digestible Nutrients.

From this equation, with the goal of maintaining the live weight and milk production of Holstein cows in hot environments. We must increase the DMI by 0.179 kg for each 1°C rise in Tmax. This value (0.179 kg –DM) is 1.05% of the mean DM intake used for this analysis. This means that the energy needs of cattle for maintenance and production should increase in a hot environment, while the gross energy efficiency should fall. Ration modification can help minimize the drop in milk production during hot weather. Decreasing the forage to concentrate ratio (feeding more concentrate) can result in more digestible rations that may be consumed in greater amounts. The primary reason that cattle decrease in milk production during hot weather is that cattle eat less. Diets high in grain and low in fiber causes less heat stress for lactating cattle because of lower heat of digestion. Energy is a critical nutrient because of the decline in feed intake during hot weather. Grain and fiber recommendations are as follows:

- Do not exceed 55-60% concentrates in rations.
- Non-structural carbohydrates should be in the range of 35-40% of DM.
- Neutral detergent fiber 28-34% of DM.

Feeding buffers such as sodium bicarbonate and magnesium oxide allow higher concentrate rations to be fed and can help in alleviating the low-fat milk syndrome. Minerals are also more easily depleted during the hot summer months. The increase in respiration and perspiration will cause an excessive loss of water, there by reducing mineral levels. Hot weather increases the need for certain minerals (Harris, 1992). Potassium should be increased from 1.3 to 1.5%, sodium to 0.5 to 0.6% and magnesium to 0.3 to 0.4% of dry matter intake, may result in less heat stress heat stress by allowing the animals to dissipate sufficient heat. Chlorine is usually at least 0.25% of the diet, which is recommended throughout the year. Do not over feed highly degradable protein during hot weather because it takes energy to excrete excess nitrogen. Rations usually should be 18% protein or less on a day basis. Proper supplementation of more non-degradable protein appears to be effective in reducing the heat of digestion. Supplemental fat can be added to rations to increase energy intake. This supplemental fat can come from whole seed such as cottonseeds or soybean, tallow, rumen inert sources, or combinations. Most diets will contain about 3% fat (dry basis) without any high fat feeds. The next 2-3 % fat can come from whole seeds. Always avoid over feeding of fat especially in hotter weather because it is associated with problems of rumen function and can reduce dry matter intake. Supplementation of vitamins in diet of heat stressed animals can help in reducing the heat stress effect on dairy animals.

Conclusions:

- The respiration rate increased by 60-80% under heat stress condition as compared to animal in comfort zone, but rectal temperature and heart rate did not affect significantly.
- DMI and milk production declined by 20% and 5-17% respectively when animals are exposed to heat stress.
- The reduction in blood flow to internal organs including mammary gland, uterus, oviducts and ovary reduces availability of nutrients and there by reduce the productivity and reproductively.
- Animal under heat stress condition must be provided protein with high biological value & 5-6% dietary fat which consists 1/3 natural ingredients, I/3 oil seed and 1/3 bypass fat.
- Environmental modification through provision of shade, splashing of water, misting, fogging significantly reduced respiration. rate and increasing feed intake, milk production, growth rate & feed efficiency, but milk composition did not show any significant improvement.

Theme 8
Global Situation and Market

T8 A086
EFFECTS OF CLIMATE CHANGE ON FOOD SECURITY IN SOUTH ASIA

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Abstract
The dynamic climatic conditions of the densely populated South Asia have been increasingly proving to be detrimental to the already impoverished and food insecure inhabitants. This paper links the challenges of climate change as directly impacting the food security and socio-economic conditions of the people in the region.
Key words: Climate Change, Food Security, South Asia.

South Asia, home to around one-fourth of the world's population, has a unique geographical location on the world map, located entirely in the Northern and Eastern hemispheres. The constituent eight countries have a mix of climates- from equatorial to tropical savannah, and the coexistence of hot humid summers and mild to cold winters, with temperatures below the freezing points in some places. These climatic conditions lend to varieties of agricultural activities and vegetation practices.

Judged by the criteria of food insecurity and poverty, SA has the dubious distinction of being the worst affected region in the world (World Bank, 2015). In this region, where the incidence of malnutrition is serious, with 78 million stunted children under the age of 5 years (UNICEF, 2014; Hatlebakk, 2012). The effects of climate change will be strong in South Asia, particularly because these are either low- or lower-middle income countries in which the rapidly growing populations continue to struggle with their daily needs. The poorer households spend a majority of their budgets on food, and are the most sensitive to the weather-related shocks that threaten to make daily staples unaffordable (IPCC, 2014; Bhatiya, 2014).

Furthermore, large areas in several of these countries are disaster-prone; for instance, Bangladesh and coastal parts of India, Sri Lanka and Maldives are threatened quite frequently by cyclones and floods. As a result of climate change, recurring droughts are a common feature in the arid and semi-arid parts of India and Pakistan. Low-lying Bangladesh and the whole of the Maldives are vulnerable to flooding and cyclones in the Indian Ocean, and scientific literature suggests that these uncertainties will become more intensive in coming decades (Bhatiya, 2014; IPCC,2014). The incidence of natural calamities is more severe on food-insecure households. Extreme heat has begun disrupting the growing season for regions in Afghanistan, Pakistan, India, and Bangladesh. Wheat production in the fertile Indo-Gangetic Plains, is predicted to decrease by up to 50% by 2100, which would have disastrous effects on the hundreds of millions of people who rely on it for their sustenance and livelihood (Aggarwal, 2008). The respective governments thus must devote large resources to cope with frequent natural disasters (FAO, 1999).

Status of Food Security in South Asia

On January 13, 1996, the Rome Declaration on World Food Security and the World Food Summit Plan of Action laid out the various dimensions of food security. Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). The Food and Agricultural Organization of the United Nations (FAO) identified the four main elements of food security, namely, the physical availability of food, through sufficient supply; the economic and physical access to food and hence greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives; utilization of the various nutrients of the food that determine the nutritional status of individuals; and stability of the first three elements, that is, ensuring food access is not at risk, the political and economic factors do not impact the food security and there is no deterioration of nutritional status (FAO, 2008a; FAO, 2003).

Hunger is direct evidence of lack of inclusive development in the region, and hence ensuring food security and eradicating hunger are development challenges. The 2015 Global Hunger Index (GHI) developed by the International Food Policy Research Institute (IFPRI) reflects the multi-dimensional nature of hunger by studying the percentage of the population that is undernourished; the percentage of children under the age of five who suffer from wasting (low weight for height); the percentage of children under the age of five who suffer from stunting (low height for age); and the percentage of children who die before the age of five (child mortality). Scores of 9.9 or lower denote low hunger; scores between 35.0 and 49.9 denote alarming hunger. While the overall situation of the region has been characterized as being 'serious' (29.4), the state of hunger in Afghanistan is 'alarming' (35.4).

The Figure 1 shows temporal changes in the GHI score of South Asian region as a whole, from 1990 to 2015. While there has been a decline in the score from an alarming 47.7% in 1990, the problem of hunger and food security in 2015 still remains serious.

Figure 1: Temporal changes in the Global Hunger Index of South Asia between 1990 and 2015.
(Source: Redrawn from the data of Global Hunger Index, IFPRI 2015)

The data in Figure 2 shows the GHI for all South Asian countries, except for Bhutan and Maldives, for which data were not available, and in the case of Afghanistan, 2015 is the first year for which the GHI could be calculated.

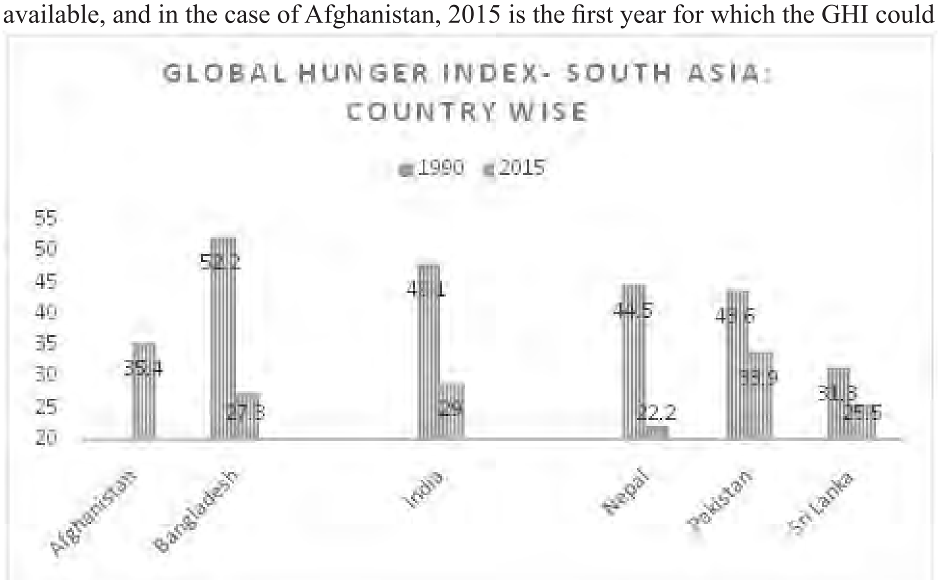

Figure 2. Country-Wise Differences in the Global Hunger Index in SA between 1991 and 2015
(Source: Redrawn from the data of Global Hunger Index, IFPRI 2015)

The above illustrations reveal that SA's GHI score is closely tied to that of India, where three-quarters of the South Asian population lives. Hunger has been dropping at a moderate rate both in India and in the region since 1990, with just a short stall between 2000 and 2005. Over the past decade, India has made some progress in fighting malnutrition[2]. Between 2005-2006 and 2013-2014, child wasting decreased from 20 to 15 percent, and stunting from 48 to 39 percent. The Indian government has scaled up nutrition-specific interventions over the past decade. Progress in reducing child malnutrition is uneven in India's states. One key factor that makes it more likely that babies are born underweight is the low social status of women, which affects women's health and nutrition (von Grebmer, et al: 2015; United Nations: 2012).

Climate Change (CC) in SA

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate

2 Malnutrition can be caused by eating too little, too much or an unbalanced diet that does not contain the right quantity and quality of nutrients necessary for adequate nutrition. Inadequate dietary intake and disease/infections which alter dietary requirements and the body's ability to, absorb and utilize nutrients effectively, are immediate causes of malnutrition (FAO, 2016).

which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1992).

Whatever cause to which climate change is attributed, the fact is that it is real and tangible. Its impact is of particular significance to SA because being composed of primarily agrarian economies, with a variety of climatic zones and in the stages of 'underdevelopment' or 'developing', even a mere increase in temperature of 1 degree Celsius has the potential of damaging the coastal and low-lying areas of the region. Bangladesh and the Maldives face the threat of complete inundation. In such a scenario, and amid high rates of poverty, with around 399 million people of the region living under $1.25 per day, (World Bank, 2015), ensuring food security for all becomes a challenge for each country. One major impact will arise from the melting of the Himalayan glaciers. In fact, it has been suggested that the food security implications of changes in the severity, frequency and extent of drought events will affect people in the future more than any other climate-related impact (Sheffield and Wood: 2008; Romm: 2011). These present disasters to human communities and cause substantial damage to economies and livelihoods, especially those related to agriculture.

SA has witnessed climate change trends that offer a perspective on the predictability of future trends. According to the Purdue University's Climate Change Research Center Report, the start of the summer monsoon in SA could be delayed by 15 days with the end of the century, which would significantly disturb the quantity and distribution of rainfall in most parts of the region, for instance more rainfall will occur in Indian Ocean, Myanmar and Bangladesh but India, Pakistan and Nepal will experience decreased and scattered rainfall (Mittal and Sethi: 2009).

Climate Change Impacts on Food System of SA

Climate change has become highly heterogeneous in terms of severity and occurrence. 'The Fourth Assessment Report: Climate Change' (IPCC, 2007a) showed the trends and variability in climate in SA and the Fifth Assessment Report (IPCC, 2014) has elaborately discussed the impacts, adaptation, and vulnerability to climate change. The upstream glaciers are melting at a faster rate in monsoon seasons than in dry seasons, when water is needed more, thus substantially reducing the aggregate food production and yield, especially of wheat rather than rice (ADB, 2013).

One of the greatest impacts of climate change that threatens food security and lives is the vulnerability to natural disasters, including flooding, droughts (OXFAM, 2007), fires, mudslides, tidal storms, cyclones and landslides, which threaten lives, leaving the population in food and water crisis. This adds to the huge economic burden upon the governments of the countries and stresses the food production and distribution systems (United Nations, 2012b; Earley, 2009). Evidence indicates that more frequent and more intense extreme weather events, rising sea levels, and increasing irregularities in seasonal rainfall patterns (including flooding) are already having immediate impacts on not only food production, but also food distribution infrastructure, incidence of food emergencies, livelihood assets and human health in both rural and urban areas. In addition, less immediate impacts are expected to result from gradual changes in mean temperatures and rainfall. These will affect the suitability of land for different types of crops and pasture; the health and productivity of forests; the distribution, productivity and community composition of marine resources; the incidence of different types of pests and diseases; the biodiversity and ecosystem functioning of natural habitats; and the availability of good-quality water for crop, livestock and inland fish production. Climate change will have multiple impacts on livestock, for instance heat stress would affect animal performance and productivity of dairy cows in all phases of production; livestock diseases will lead to a lowering of feed efficiency, milk production, and reproduction rates; and impact upon feed quality and availability. Further, environmental stress will reduce the productivity and health of livestock, resulting in significant economic losses (Thornton et al., 2009; Sejian et al., 2015).

Recommendations for Combating Climate Change and Food Insecurity

i. Resolving the problem of food insecurity through committed governance and political leadership
ii. Need for sustainable agriculture and strengthening resilience
iii. Need for climate risk management as a key to sustainable food security
iv. Need for increased investment in agricultural education, research and extension
v. Investment in best practices
vi. Call for re-invigoration of South Asian Association for Regional Cooperation (SAARC)

Conclusions

Global warming is the immediate consequence of increased GHG emissions with no offsetting increases in carbon storage. The current episode of human-induced global warming on the climate system will both cause additional stresses and create new opportunities for food systems, with consequent implications for food security.

There are various avenues through which countries can pursue cooperation not only for food security, but also for the improvement of mechanisms to increase food production, reduce excess demand and insulate against food price shocks. Regional cooperation would also help in accelerating the development gains in complementary areas like energy, related to the food demand-supply nexus and market management (United Nations, 2012b), as well as in positively harnessing women's capabilities in garnering attention toward mitigating the impacts of climate change. Since the adaptation and mitigation strategies of climate change in agriculture go hand in hand, adopting an integrated strategic approach represents the best way forward. This would go a long way in achieving food security for all and contribute towards the fulfillment of the SDGs of the UN by 2030, both in letter and in spirit.

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T8 A185

DISCOVERY OF HIGH RICE NITROUS OXIDE EMISSIONS CALLS FOR INTEGRATED MANAGEMENT OF WATER, NITROGEN AND ORGANIC MATTER FOR REDUCING NET GREENHOUSE GAS EMISSIONS DUE TO RICE CULTIVATION

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Climate impacts of nitrous oxide (N2O)emissions from cultivating riceare considered limited, and much less important than rice methane (CH4). Rice N2O emissionsarenot currently included in national greenhouse-gas emissions inventories submitted to United Nations. We hypothesized that high resolution measurements (sampling intensity = 35-65% days in a season) at farmer-managed irrigated Indian rice paddies, which are conventionally not under constantly flooded conditions, will reveal much higher N2O emissions than previously reported and that climate smart(sustainable) farming practices involving N, water and/or organic matter management will reveal a high net climate mitigation potential. Our measurements for conventional (business as usual) and climate-smart rice farming practices at five sites in peninsular India between 2012-2014suggest that the climate impact of rice N2O can be similar to that of rice CH4 (~10 tCO2e ha¬-1)over 100 years. The maximum N2O fluxes at different sites varied from 0-32.8 N2O Kg ha-1season-1 and 940-15,000 µg N2O m-2 h-1 which are ~350-550% higher than the maximum reported rice N2O flux both in the global literature (<2.9 tCO2e ha-1 season-1 and 3000 µg m-2 h-1, respectively)18 and in studies from Indo-gangetic plain and eastern India (0.10-0.54 tCO2e ha-1 season-1where sampling intensity was between 3-19% days in a season).While alternatepracticesproduced lower yields than the baselinepractices in most cases, they provided net greenhouse gas reductions ranging from 0.4 to 6 tCO2e100 ha-1 season-1at five out of six seasons with evidence oftrade-offs (increase in N2O when CH4 flux decreased or vice versa). We also found a positive correlation of rice N2O with nitrogen. Crucially, there is an inverse relationship (R ~0.6) between CH4 and N2O fluxes; and there is statistically significant negative correlation of N2O flux with cumulative water and organic matter use both of which are usually correlated positively with rice CH4 emissions. These results suggest that alternate wetting and drying during rice cultivation, which is usually recommended as a water saving or CH4 reduction practice could cause long term climate harm in the absence of simultaneous nitrogen and organic matter management.It is important to conduct high resolution regional studies that consider CH4, N2O as well as changes in soil carbon to confirm the baseline and alternate trajectories of net cumulative climate impact of global rice cultivation.

T8 A226

FOOD SECURITY IN INDIA: AN ANALYSIS THROUGHFOOD PRODUCTION

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Abstract

India's population is growing fast and so are the gaps between richness and poverty, inequality in distribution of income and food entitlement. Policy measures have been taken by the government to reduce these gaps but how far is our government able to achieve in reducing these gaps is the question of every individual of this country. The researcher would like to study the macro picture of food entitlement as it is an important aspect and the need of an hour for proper and healthy picture of the country. Proper consumption of food will give proper health, appropriate health condition will help to work and increase the production and improve the per capita income of the country. Increased per capita income and production will enable the individuals to have purchasing power and availability of food supply to all parts of the country and the world. Keeping these vicious circle into the account, the researchers would like to analyse the root base of the circle i.e. changes in the production of food grains and its impact on entitlement of the food to the deprived people of the society.The paper will study on the effect of availability of agricultural lands on production.Also, the paper will understand whether production of food grains is self-sufficient for the fast growing population in India; either import is required for meeting the consumption needs or export can be curtailed to meet the needs of the country. The paper also aims at understanding the impact of production on the distribution of food grains through various schemes such as Public Distribution System (PDS), Noon-Meal Schemes, and ICDS which has direct impact on improving the health condition of the poor.The data were extracted from the reliable secondary sources of information such as reports published by NSSO, World Bank, FAO Reports and Union Budget reports.The researcher has used step by step regression method as a statistical tools for analysing the variables. Other statistical tools such as percentage method, ratio and correlation co-efficient methodswere also used. The results suggests that if policies are framed appropriately, the problem of distribution of foods can be easily solved.The government needs to improve the production of food grains by improving the technologies so that larger production are available with limited agricultural lands.

Key Words: Food Entitlement, Policy, Purchasing Power, Per Capita Availability, Food
Production

T8 A230

CLIMATE CHANGE – IMPACT ON DEVELOPING COUNTRIES – A SOCIO-LEGAL STUDY

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Introduction

Climate change is a change of climate which is attributed directly or indirectly to the human activity that alters the composition of global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The earth's climate is determined in large part by the presence of naturally occurring greenhouse gases including in particular water vapour, Carbon Dioxide (CO_2), Methane (CH_4), CFC, Nitrous Oxide (N_2O) Troposphere Ozone (O_3). The scientific evidence suggests that the continued increase in the atmospheric concentrations of these selected greenhouse gases due to human activities lead to an enhanced greenhouse effect and global climate change. The First IPCC Report 1990, the Second IPCC Report 1992, and the latest IPCC Reports predicted that on a 'business-as usual" emissions scenario would raise temperature of about 2°C to 4°C by 2100 and consequent increase of global rainfall and raise in global mean sea level. It also predicted that anthropogenic warming lead to the increased precipitation and greater risk of extreme weather conditions such as floods and droughts. The most affected countries of the climate change are the third world countries. Although the effects of climate change are seen through out the world, it is the developing countries who will suffer the most. All developing countries are more vulnerable because their economic activity heavily relies on natural resources. The developing countries are lacking in scientific and technological knowledge and also suffering from inadequate infrastructure and economic resource. It is also a fact the richer and developed world has predominantly contributed to emissions of greenhouse gases. Strangely, the Industrialized Nations that contribute 20% of the world population are responsible for nearly 80% of the world total emission. This paper will discuss the global scenario of climate change and its impacts on developing countries and also analyse the legal controls at International level.

Impact of climate change on agriculture in developing countries

The effect of climate change on Agriculture in developing countries is predominantly dangerous. The Natural and organic farming is diminishing in the irrigation and the cultivation of agriculture in developing countries. The climate could trigger drastic changes in Monsoons, Rainfall, Summer and Temperature, consequently, there would be major decline in global agriculture production and food grains. East Africa can expect to experience increased short rains, while West Africa should expect heavier monsoons. Burma, Bangladesh and India can expect stronger cyclones. Indonesia may receive less rain fall but the coastal regions around South China Sea and Gulf of Thailand can expect increased rain fall.

Unlike people of wealthier developed countries, the people of the developing world do not have the means to fight global climate change. The people of developing countries are the first and the worst to be hit. People are migrating from rural areas to urban areas, in some countries due to decreased yield in agriculture. Over the last few years in Kenya, the weather patterns have been changing and becoming more unpredictable. The Agriculture is the back bone of Kenya's economic growth and 70% of Kenyan GDP is from agriculture and agricultural related industries. The effects of climate change in weather pattern on the agriculture in Kenya are becoming more devastating year by year and people are getting migrated to urban areas leaving agriculture and becoming unemployed. The young people are either idle in the city or taking part in organized crimes which Nairobi is notorious for it.

The change in the pattern of agriculture has induced the international trade in the adjustment of world food system and crop models for individual countries and the geographical regions. The yield in different crop models would vary in different climate change Scenarios. Therefore, the World Food Trade models would reflect on the World Food Prices and in the number of people at risk of hanger, which generally depends on income and food price level in developing countries. This would result a significant implications for potential future distributional aspects of world food system. The changes would take place in the adaptations of planting dates, variety and crop and application of irrigations and fertilizer, water use and water supply.

Climate change and impact on biodiversisity in developing countries:

The climate change would cause a lot of harm to the biodiversity in the developing countries. The prediction says that there would be enormous extinction of spices in the world particularly in the developing countries. The reason is that the developing countries has no such type of Technology to reduce emissions. The Climate change could surpass habitat destruction on the greatest global threat to the biodiversity. The indiscriminate mining and quarrying in the forest areas is causing lot of deforestation. The climate change has led to phonological shifts in flowering plants and insect pollinators, causing mismatch between plant and pollinator population that led to the extinctions of both plants and pollinators. A large portions of Amazonian rain forest could be replaced by Tropical savannahs increased temperature and decreased rain fall mean that some lakes especially on Africa might dry out. Oceans are predicted to warm and became more acid resulting in wide spread degradation of Tropical coral reef.

International legal controls

Climate change is the ultimate international problem because of its gravity and of geographical reach of causes and effects. In order to reduce the effects of climate change the primary agreements adopted at international level are United Nations Framework Convention on Climate Change (UNFCCC) signed at Reo de Janerio Earth Summit in 1992 and the Kyoto Protocol to the UNFCCC, signed at Kyoto, Japan in 1997. However, the implementation and ratification and acceptance of the treatise by the world community are not satisfactory. The climate law must explore the rich diversity of international, regional, national, sub-national and trans-national responses to climate change. But as the treatise is silent, the effects of climate change are progressive. The UN Framework Convention on Climate Change is the First International Environmental Agreement for the protection of global climate. The UNFCCC consists of 26 Articles and 2 Annex

Objectives and principles of the unfccc

The preamble of the Convention deals with wide range of interests. The preamble refers the concept of "per capita emissions" and 'energy efficacy' matters which did not receive sufficient support in the operational part of the Convention. The objective of the convention is to stabilize greenhouse concentrations in the atmosphere, but convention itself recognizes that climate change is inevitable and in time frame it would be possible to stabilize. Article 3 of the convention set out the principles to guide the parties in achieving the objectives and implementing the provisions. All these principles are based on the "Equity" and in accordance with their common but differentiated responsibility. Therefore the developed countries have to take lead but practically a few are taking lead.

General commitments

Art.4 of the Convention deals with the commitments. To achieve the objectives of the convention, all parties are committed to take certain measures, taking into account their common but differentiated responsibilities and priorities, objectives and circumstances. Another commitment under Art. of the convention is that all parties are required to promote, co-operate in the diffusion of technologies, practices and process that control, prevent and reduce anthropogenic emissions of greenhouse gases. How far this commitment is being followed by the developed nations is a big question. As the economically poor with large population, whether the developing countries can afford to pay the cost of the technology transfer to the Developed nation? As per the commitment whether they are giving on free of cost is also a doubtful one.

Communication Of Information Related To Implementation – Reporting

All parties are required to communicate to the conference of parties (COP), information on implementation, a National inventory of anthropogenic emission by source and removal by sinks of all greenhouse gases and other relevant information including that relevant for calculating global emission Trends. But no countries are furnishing the information. The developed countries are not interested in furnishing the information about emission of their country. For other countries the reports were to be made within three years of entry into force. This commitment is also not followed properly

Financial resources and technology transfer

As per UNFCCC, Annex II parties have to undertake the specific financial commitments. The developed countries agreed to provide new and additional financial resources to meet the "agreed full cost" incurred by developing countries in fulfilling their commitment to communicate information relating to implementation. Annex II parties also undertake to assist developing countries that are "particularly vulnerable to adverse effects" of climate change in meeting the cost of adaptation to those adverse effects. The amount of financial resources, effective assistance is not mentioned in the convention. However Art.4 of the Convention specifies that full consideration must be given for every adverse effects of climate change. Annex II parties are also required to take all practicable steps for transfer of environmentally sound technology and know-how and support the development of indigenous capacity and technologies of developing countries.

The climate change convention establishes a conference of the parties, a secretariat, two subsidiary bodies and financial mechanism. The conference of the parties is the supreme body of the convention, entrusted with keeping the implementation of the convention under regular review and making decisions to promote its effective implementation. The convention provides dispute settlement mechanism with compulsory recourse to arbitration or the International Court of Justice with consent of relevant parties.

The 1997 Kyoto Protocol

Kyoto Protocol is another International Legal Instrument to combat the effect of climate change. The Kyoto Protocol to UN Framework Convention on Climate Change was adopted by the Third Conference of the parties in December 1997. The First Conference of the parties at Berlin in 1995 determined the commitments provided in Art. 4 of the convention and decided to launch a process to strengthen the commitments. The Second Conference of the parties at Geneva in 1996 clarified the scope of the Berlin mandate. In Third Conference of the parties, the Kyoto Protocol in 1997 was adopted and opened for signature on 16th March 1998. The provisions of Kyoto Protocol are so difficult and complex and divisions between parties emerged in relation to a range of key issues such as emissions reduction targets, sinks, emission trading, joint implementation and treatment of developing countries. In 2001, the future of the protocol was thrown into a doubt with the announcement by president George W. Bush that United States would not ratify the protocol. Nevertheless, the conference of the parties held in Bonn in July 2001, the remaining States agreed on mechanisms for implementing for commitments under the protocol. Subsequently, the Bonn converted into the legal text of the Marrakesh Accords.

Kyoto Protocol – Emissions Reduction Target And Timetable

The major achievement of the Kyoto Protocol was the commitment of Annex I parties to quantified emissions reduction Targets and a time table for their achievement. As per Art.3(1) of Kyoto Protocol the Annex I parties must implement 30% emission reduction target during the period 2008 to 2012. The determination of emission target for Annex I parties was a difficult issue. Therefore Annex B lists differentiated targets for individual countries and regional economic organizations. There was a controversy with regard to the number of gases covered by the Kyoto Protocol. Originally upto 1995, there were three gases and six gases are covered by the emission reduction commitments of Annex I parties such as carbon dioxide, methane, nitrous oxide, hydro fluro carbons, per-fluro carbons and sulphur hexafluoride.

Kyoto Protocol – Reporting And Compliance

Art.5, 7 and 8 of the Kyoto Protocol deal with the detailed reporting obligation for Annex I parties. Under these provisions the parties are required to furnish annual inventory of anthropogenic emissions by source and removal by sinks and necessary information for the purpose of ensuring compliance with commitment under the protocol. The reports will be reviewed by 'Expert Review Teams' and identify the problems and factors and take decisions on the matters required for the implementation of the protocol. Amendment to the protocol can be adopted by three-fourth majority vote of the parties present. Forest management, crop land management, grazing land management and revegitation were designed as additional eligible LULUCF activities under Art.3 (4) of the Protocol.

In addition to the UN Framework Convention on Climate Change and Kyoto Protocol there are number of legal instrument which deal with the reduction of emission of green house gases at regional and inter-national levels. They are CBD, 1978 Brand Report which deals with the greenhouse effects in energy section, 1979, World Climate Conference, 1987 Montreal Protocol, Inter-governmental panel on climate change, and 2006 climate action board. These protocols, documents and guidelines would also deal directly or indirectly with the climate change.

Conclusion

Climate change is the greatest and most urgent Environmental challenge facing mankind today. For the sake of present and future generation and the future of the planet, let us rise to the challenge and take serious action to takle it. The global warming theory needs to be taken very seriously and act upon as quickly as possible. The USA has been in the forefront in spreading awareness about climate change, now the time has come when the mighty nations should actively participate in the forthcoming conferences of implementation of Kyoto Protocol to reach the practical solution to the problem. All countries specially the developed need to co-operate with each other and solve this problem. For the few years the big companies like Ford, Tata and Birla and oil companies like B.P and shall have began to pour billions into research in finding new technologies to reduce carbon emission. Climate change mitigation, along with legal frame work methods, is also an important technique to reduce the emission of greenhouse gases. The government and non-governmental organizations at National and international levels have to adopt new techniques and Methods to mitigate the climate change. The mitigation can be achieved by increasing the capacity of carbon sinks through reforestation, and also by low carbon energy resource such as renewable and nuclear energy. Energy efficiency and geoengineering may also play an important role in climate change mitigation.

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CHANGES OBSERVED IN DIETARY PATTERN IN INDIA

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Abstract
The economic growth in our country has been accompanied by growth in food supply. The increase in food supply has not resulted in increase in nutritional status of majority of the people.Due to increase in income, change in lifestyle, increasing urbanization and globalization,there have been considerable changesin thefood habits and dietary pattern of Indian households. The objectives of the paper are, to bring out the changes in demand for food in our country and to depict its implications on the nutritional and health status of the people. The study is based on secondary data sourced from different rounds of NSSO Reports and FAOSTAT(Food and Agriculture Organization of the United Nations Statistics Division). The changesobserved from the NSSO reports include,decline in proportion of food expenditureto the total Monthly Per Capita Consumer Expenditure (MPCE) from 72.9 percent in 1973 to 48.6 percent in 2012 in rural areas and 64.5 percent to 38.5 percent in urban areas during the same period. The share of cereals in total consumption expenditure reduced from 40.6 percent to 12 percent in rural India and from 23.3 percent to 7.3 percent in urban India during the period in between 1973 and 2012. It implies thatpeople have diversified their diet with more vegetables, fruits, milk, meat, fish, eggs with fewer cereals in respect to their income level (NSSO,GoI). In recent years, there have been inclusion of western foods like pizza, burger and soft drinks/beverages in people's food habits and reduction of traditional food items which can be attributed to Globalization. In urban areas these changes are more witnessed with increased use of fast food and street food mainly due to changes in their lifestyle.Increase in availability of variety of foods and demonstration effect have been the major cause for shift in the food habits. These changes in turn have influenced the nutritional and health status of the people in the country. While the increase in consumption of cereals and other healthy food like milk, fruits and vegetables has resulted in improved nutritional status, the increased consumption of highly-calorific,high-sugar and fatty food,has led to rise in incidence of obesity and other diet-related diseases, like Type-2 diabetes, cardiovascular disease, cancer and osteoporosis. The results indicate substantial shifts in food habits and dietary patterns of people at levels.
Keywords: Diet, Health, Western Food, Consumption Pattern, Demonstration Effect.

T8 A289
STUDIES OF MAJOR CROP YIELDS OF INDIA AND THEIR RESPONSE TO INCREASED POPULATION'S FOOD DEMANDS

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Abstract
In the present study, we have chosen Rice, Wheat, Maize, Jower and Bazra as five major crops of India and studied their trends in relation to irrigation statistics for the period 1951 to 2012. The yields were correlated with Normalized Difference Vegetation

Index (NDVI) of Advanced Very High Resolution Radiometer (AVHRR) and Moderate Imaging Spectroradiometer (MODIS) Terra to perceive the linear association with crop yields. Further, the crop products data supplied by FAO have been used to understand the relation of irrigation, percentage of food inadequacy and average food production rate over India. Decadal variability of crop yields with the increasing population of India has been studied. The present study also dwells in estimating the return values for different return period of crop yields using Gumbell Extreme Value Theory. This study has been carried out majorly to comprehend the future needs of food demands with the increasing population over India as it is reported that globally the crop yields should be doubled by 2050 to meet the increasing food demands. We have found that all the five crops show an increasing trend.Wheat shows highest trend with a slope of 43.1 during the study period and is followed by Rice, Maize Bazra and Jower. A linear and strong association were found between NDVI and the crop yields for the period 1982 to 2012.It is found that the crop yields are dependent on irrigation even for the case of rainfed crops such as Rice and Maize and the impact of ENSO is clearly seen on thepercentage area covered under irrigation. Furthermore, it is observed that a sufficient rainfall is essential to reduce the food inadequacy percentage over the country though there is a supplement of water through the irrigation area. Good correlation is found with the average yields of all crops and is (+0.72) with the increase in Indian population when compared to the correlation with individual crop yields. Crop yields such as Rice, Maize and Jower are not increasing at the required rate whereas the yields for Wheat and Bazra can meet the expectation by the 2050. Our analysis revealed that more efforts needs to be put in to increase an additional~8% of Rice yields as it is only ~12% and to be increased to make it ~ 20%.

T8 A297
THEME: VALUE ADDED AGRICULTURE- MARKET CHAIN
EXTRACTION OF PECTIN FROM KINNOW (*CITRUS RETICULATA* L.) WASTE

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Highlight
Meager level of processing (6-8%) and a sizeable post-harvest loss (15-30%) are responsible for a monetary loss of Rs 31,500/- crores annually. Dried kinnow peel was used to extract pectin using microwave and aqueous extraction methods. The maximum yield of extracted pectin was 13.5±1% for citric acid+degradative enzyme combination followed by only citric acid treatment using aqueous extraction.

Keywords: *Kinnow peel, waste utilization, crude pectin, purification, value addition*

Introduction
India is ranked 5th amongst the top ten citrus fruit (comprising of orange, lime and lemon only) producers while in India, citrus occupies third position with a total share of 12.4% after banana (*Musa acuminata*) (32.6%) and mango (*Mangifera indica*) (22.1%). The area under citrus cultivation is 10.42 lac ha and has production of near about approximately one billion MT with a productivity of 9.7 MT/ha. Kinnow mandarin (*Citrus reticulata* L.) is one of the major citrus fruit crops of India with an annual production of about 0.5 million metric tonnes**.** Meager level of processing (6-8%) and a sizeable post-harvest loss (to the tune of 15-30%) are responsible for lowering gross domestic productivity, remunerative losses and diminishing interest towards horticultural production and processing. This accounts for a monetary loss of Rs 31,500/- crores annually. The fruit, whether used for table purpose or for processing, yields a considerable amount of waste (30-50%) in the form of peel, seed, stone, pomace and fruit pulp. The waste generated through fruit processing contains compounds like flavonoids, limonoids, terpenes, pectins, carotenoids, biocolor etc.

Material and methods
Kinnow mandarin (*Citrus reticulata*) peel/waste was used to extract pectin using microwave and aqueous extraction methods. Hundred gram of dried peel powder was soaked in water, given various treatments, and heated for 20 to 80 min at 20 min intervals. The broth was cooled and pectin was precipitated using organic solvents. The extracted crude pectin was dried,

purified and stored for further studies. The experiments were replicated thrice using CRD.

Results

The resulted extract contained pectin and other soluble and insoluble ingredients released due to breakage of bonds because of heat and various treatments' effect. The pectin so obtained (crude pectin) was separated of excess water and dried in tray dryer at ambient temperatures. The crude pectin was further purified, dehydrated and quantified. The maximum yield of extracted pectin was 13.5±1% for citric acid+degradative enzyme combination followed by only citric acid treatment using aqueous extraction (Table 1). The control treatment (using sulfuric acid) resulted in 4.0±1% pectin with inferior quality. The developed process is ecofriendly as no harsh inorganic acid is being used for pectin extraction.

Conclusion

Extraction of pectin and other high value compounds can lead to further value addition of the processing residue and complete utilization of horticultural waste. Utilization of nearly 50% photo-synthetically fixed biomass (termed as waste) can pave a better way towards value addition and sustainability of agriculture.

Table 1: Yield of pectin with respect to treatment type

Treatment	Time of incubation (min)	Purified pectin yield (%)	
		Microwave extraction	Aqueous extraction
Enzyme+ citric acid	20	5.4	7.3
	40	9.8	13.5
	60	10.5	3.5
	80	10.4	2.2
Citric acid	20	5.4	5.8
	40	8.5	12.9
	60	9.5	2.6
	80	10.5	1.2
Control (Sulphuric acid)	20	1.4	0.8
	40	3.6	3.7
	60	4.0	4.5
	80	4.5	4.4

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ABSTRACTS OF POSTER PRESENTATIONS

P001A002

PERFORMANCE IMPROVEMENT USING SMART "ENERGY ENHANCER"- 4 M DEVICE AND ITS EFFECTS ON FLOWING WATERS FOR AGRICULTURE, INDUSTRIAL AS WELL AS COMMERCIAL APPLICATIONS.

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Abstract

In this paper we include Real case study of Improvement in Energy Efficiency and Reduce Maintenance in So many industrial applications with the help of Energy Enhancer Device. Electromagnetic energy and flowing water molecules has been experimentally investigated via measuring a number of physical & chemical parameters including TDS, P.H, Hardness, Absorbance, refractive index, thermal conductivity, viscosity and surface tension. An Energy Enhancer Device was used and arranged to attain a nearly homogeneous magnetic field of (Min –Medium) G over the region through which the water was allowed to flow. All experiments were performed at ambient room temperature when the water was allowed to pass the region of the magnetic field approx 1 minute. Water samples were taken from different sources and Different applications to have various compositions and passed through the same device to ensure the same path length of incident Magnetic flux throughout all measurements. For evidence of parameters after exposing to a magnetic field, all report carried out at NABL accredited laboratory. Other physical properties of magnetized water were also inspected with proper and precise measuring techniques. These include the pH, TDS, Hardness and EC. As well as notice that the mechanical parameters like viscosity and surface tension ,thermal conductivity was also change , it was found that some properties of water were changed a lot of new and strange phenomena were discovered aftermagnetization.

Key Words: Energy Enhancer Device-4 M (Save Money, Machine, Maintenance and Manpower), Magnetized water, water magnetization.

P002A003

APPLICATION OF LAND CONFIGURATION IN POORLY DRAINED FLAT LANDS OF GUJARAT FOR SUSTAINING COTTON CULTIVATION

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Abstract

Key changes to the hydrological cycle due to climate change results into changes in the seasonal distribution of rainfall, amount of precipitation, increase in rainfall intensity, increased evapo-transpiration and reduction in soil moisture. The two major constraints frequently occurring in cotton cultivation in flat lands like Bhal region of Gujarat state are: (i) Rain-water stagnation in the fields, which restricts germination of seeds or causes failure of delicate cotton plants due to their prolonged submergence in stagnated water, and (ii) Insufficient soil moisture when the rainfall is low. Under both situation drastic reduction in the yield of cotton crop takes place. Land configurations through appropriate tillage operations for sowing of cotton on ridges or raised beds could save the cotton seeds/seedlings from the possible failure due to prolonged submergence in rainwater and might store increased rainwater in the furrows providing sufficient aeration to the crops standing on ridges. During the experiment conducted in year 2003, significant numbers of cotton plants grown on the ridges/beds could successfully be saved from their possible submergence into the stagnated rainwater in the fields. Ridge-furrow and broad-bed & furrow systems increased soil moisture by 2.1 to 6.2 % as compared to flatbed (control). Land configurations such as ridge-furrow, ridge-furrow (modified) and broad-bed & furrow systems lead to sustained cotton yield as high as 68.4, 88.6 and 78.5 percent respectively as compared to flatbed in spite of prolonged rainwater submergence in the year 2003.
Key words: ridge, bed, furrow, cotton cultivation, land configuration, furrower, clay, poorly drained soils, climate change.

P003A006
EFFECT OF SPLIT APPLICATION OF NITROGEN ON WHEAT UNDER NORTH GUJARAT CONDITION

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Abstract
An experiment entitled "Effect of levels of nitrogen and its split application on wheat (*Triticum aestivum* L. emend. Fiori & paol.) under North Gujarat condition" was conducted at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during two consecutive *rabi* seasons of the years 2013-14 and 2014-15.The experiment consisted of fourteen treatment combinations comprised of two levels of nitrogen and seven split application of nitrogen, and conducted in RBD with factorial concept with three replications. The soil of the experimental field was loamy sand in texture, very low in organic carbon and available nitrogen, medium in available phosphorus and potash. Growth, yield attributes, yield and quality were affected with the split application of nitrogen. Significantly higher plant height (31.8 cm) and dry matter accumulation (64.0 g) at 30 DAS per meter row length were registered when nitrogen applied as 50% at sowing and 50% at CRI stage, while plant height at 60 DAS (87.5 cm), at harvest (94.1 cm) and dry matter accumulation at 60 DAS (218.0 g), 90 DAS (232.5 g) and at harvest (243.7 g) per meter row length, number of leaves (20.2), total tillers (107.5) and effective tillers (83.4) per meter row length, ear length (9.7 cm), number of grains per ear (53.4), grain yield (4964 kg/ha) and straw yield (5792 kg/ha) was significantly higher when nitrogen applied as 50% at sowing, 25% at CRI stage and 25% at 1st node stage.

Chlorophyll content at flag leaf stage (42.25 %) was significantly higher under treatment S_2 (50% at sowing, 25% at CRI stage and 25% at 1st node stage), while at flowering stage (40.91 %) it was higher with treatment S_5 (20% at sowing, 20% at CRI, 20% at 1st node stage, 20% at flag leaf stage and 20% at flowering stage).

Test weight and nitrogen content in wheat grain (1.953 %) and straw (0.550 %) were significantly higher with treatment S_7 (10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage).

Nitrogen uptake by grain (95.54 kg/ha), phosphorus uptake by grain (20.92 kg/ha) and straw (1.334 kg/ha) and potassium uptake by grain (75.97 kg/ha) and straw (24.90 kg/ha) were significantly higher when nitrogen was applied as 50% at sowing, 25% at CRI stage and 25% at 1st node stage. In case of nitrogen uptake by straw yield (30.90 kg/ha), it was higher under treatment S_5 (20% at sowing, 20% at CRI, 20% at 1st node stage, 20% at flag leaf stage and 20% at flowering stage).

Quality parameters *i.e.* protein content (12.21 percent), wet gluten content (29.87 percent), hectoliter weight (81.57 kg/ml), sedimentation value (41.23 ml) and grain diameter (2.82 mm) were significantly higher under splitting of nitrogen as 10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage (S_7).Significantly, the highest available nitrogen in soil after harvest of crop was recorded in treatment S_7 (10% each at sowing, CRI, 1st node stage, tillering stage, flag leaf stage, heading stage, flowering stage, milking stage, dough stage and hard dough stage).

P004A010
COMPARATIVE BODY WEIGHT OF INDIGENOUS SHEEP BREEDS ON DEHYDRATION AND REHYDRATION IN MIDDLE GUJARAT DURING SUMMER SEASON

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Abstract
Eighteen indigenous hoggets randomly divided in to three water restriction treatments viz. T_1 (0%), T_2 (20%) and T_3 (40%) on the basis of body weight after assessing water requirement during adaptation period at Instructional Farm, Department of Livestock Production and Management, Veterinary college, Anand during hot dry period (10th May to 10th June). The

animals were individually maintained on ICAR feeding standard (1998). The average body weight (kg) at the beginning of the experiment was 26.7 ± 1.75 where as the body weight (kg) of experimental animals at the end of experiment under T_1 (26.98 ± ٠,٢٥), T_2 (26.57 ± ٠,١٠) and T_3 (25.40 ± ٠,٥٥) did not differ significantly among the treatment groups. The body weight non significantly declined under 20% (1.5%) and 40% (6.4%) water restriction as compared to animals of control group. This indicated experimental animals can withstand water restriction up to 40% water restriction during summer season or non-significant effect of water restriction on feed and nutrient effect. The body weight of experimental animals under T_1 and T_2 during different periods of experiment remained almost same up to P_2 and declined little under P_3 and maintained in P_4 indicated animals under 20% water restricting did not produce any change in body of experimental animals but the body weight of experimental animals under 40% water restriction declined during P_1, P_3 and maintained in P_4 but increased during P_2 which might have nullified the effect of water restriction. The effect of rehydration on body weight was found no significant. The experimental animals of T_2 and T_3 recovered body weight (kg) upon rehydration after 2^{nd} (10.57 and 17.42%). The body weight (kg) of experimental animals after 4^{th} day of rehydration did not differ from 2^{nd} day rehydration indicated that even after 40% water restriction, experimental animals recovered their body weight (kg) less than 48 hrs of rehydration.

P005A016

EFFECT OF LIVESTOCK PRODUCTION ON CLIMATE AND MITIGATION STRATEGIES UNDER CHANGING CLIMATE SCENARIO IN INDIA.

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Abstract

Livestock and climate change are interdependent and mixed through a complex mechanism where adversity of one affects the other. Climate variation influences the livestock production via alteration in ambience, compositional and quantitative change in fodder crops, health, etc. On the other hand, Livestock production itself is the crucial factors accountable for climate change. It is reported that the contribution of livestock toward global anthropogenic GHG emission is 7,100,000 Giga gram Co_2 equivalent/ year (14.5% of total). It is reported that India contribution in this is 216,517 Giga gram/ year (3% of global), of which 97.65% is from enteric fermentation and the remaining from manure management

Livestock itself a large contributors to climate change through emission of methane and nitrous oxide. Global emission of methane from all sources was estimated to be 500-600MT/year and from rumen fermentation it is about 80 MT/year (IPCC, 2007). Enteric fermentation in ruminants produces 28% of the total anthropogenic emission of methane. Estimate of methane emitted from enteric fermentation and manure management of more than 500 million livestock in India is approximately 7.26-10.4MT/year (without taking in consideration quality and amount of feed available to animal).

Several options are available for mitigating enteric methane emission from livestock such as nutritional management like feeding of succulent fodder, feeding of oils and fat in the diet, increasing feeding frequency of the ration, use of total mixed ration or complete feed blocks, manipulating rumen fermentation like feeding of low methane producing diet, improve quality of feed, selective removal of ciliate protozoa from the rumen , stimulation of reductive acetogenesis in the rumen, incorporation of plant secondary metabolites, ionophore and other antibiotic, use of propionate enhancers in the diet, removal of methanogens by using vaccines and other manage mental strategies like grazing management, shelter management(site selection, wind break, shades), selection of faster growing breeds etc.

Keywords: Climate change, livestock production, greenhouse gases, enteric fermentation, manure management.

P006A027
IMPACT OF CLIMATE CHANGE ON SEASONAL INCIDENCE OF JASSID, *EMPOASCA KERRI* (PRUTHI) IN GROUNDNUT

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Abstract
Groundnut (*Arachis hypogaea* L.) is an annual legume crop, also known as peanut earthnut, monkey–nut and goobers. It forms the world' largest source of edible oil and ranks 13th among the food crops and is also 4th most important oilseed crop of the world. More than 100 species of insect and mites are known to attack groundnut. Among the various insect pests attacking this crop, jassid causes extensive damage and it is found to be serious on groundnut crop. Jassids are the major pest of importance on groundnut crop specially when raised under summer conditions and bunch varieties are severely infested. Keeping this in view field experiment was conducted to study the seasonal incidence and impact of weather parameters on jassid, *Empoasca kerri* (Pruthi) in groundnut. Field experiment was conducted to study the influence of weather parameters on the incidence of jassid, *Empoasca kerri* in groundnut during *summer* season of 2014-15 at college of agriculture, Junagadh Agriculture University, Junagadh. The data analyzed statistically with weather parameters using correlation and regression techniques. Relative humidity showed significant negative correlation with jassid population. Minimum temperature, mean temperature, evaporation and bright sunshine hours showed positive correlation with jassid population whereas, maximum temperature, morning relative humidity, mean relative humidity and wind speed showed negative correlation with jassid population. The study revealed that the incidence of jassid started in 2nd week of March which gradually increased and touched its peak during 3rd week of April and then decreased in 4th week of May.
Key words: Groundnut, Jassid, Population dynamics, weather parameters.

P007A028
FEED INTAKE OF INDIGENOUS HOGGETS ON DEHYDRATION AND REHYDRATION IN MIDDLE GUJARAT AGROCLIMATIC CONDITIONS

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Abstract
Eighteen indigenous hoggets randomly allotted to three water restriction treatments viz. T_1 (0%), T_2 (20%) and T_3 (40%) on the basis of body weight after accessing water requirement during adaptation period at Instructional Farm, Department of Livestock Production and Management, Veterinary college, Anand during hot dry period (10th May to 10th June). The animals were individually maintained on ICAR feeding standard (1998). The daily DMI (g/d), DMI (%) and DMI (g/kg $w^{0.75}$) did not significantly influenced by level of water restriction during hot dry season. The daily DMI (g/d), DMI (%) and DMI (g/kg $w^{0.75}$) declined non significantly to the tune of 8.19 , 2.3 and 3.8 % in the animals maintained under water 40 % water restriction group as compared to the animals of control group, respectively. The dry matter intake in terms of g/d, percent B. wt and g/kg $w^{0.75}$showed the same pattern of increment from P_1 to P_2 but then after wards declined up to the end of experiment during the experiment. The DMI (g/d), DMI (%) and DMI (g/kg $w^{0.75}$) neither influenced by TX P interaction indicated treatment and period neither produced significant effect in combination nor independently. The DMI (g/d), DMI (%) and DMI (g/kg $w^{0.75}$) recovered significantly ($P < 0.05$) in T_2 (28.67, 28.75 and 31.66%) and T_3 (35.56, 21.74 and 23.41 %), recovered significantly ($P < 0.05$) on 2nd day of rehydration where as it was at par with 4th of rehydration.

P008A030
EFFECT OF WATER RESTRICTION ON NUTRIENT INTAKE OF INDIGENOUS SHEEP BREEDS

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Abstract
Eighteen indigenous hoggets randomly allotted to three water restriction treatments viz. T_1 (0%), T_2 (20%) and T_3 (40%) on the basis of body weight after accessing water requirement during adaptation period at Instructional Farm, Department of Livestock Production and Management, Veterinary college, Anand during hot dry period (10th May to 10th June). The animals were individually maintained on ICAR feeding standard (1998). The DCPI and TDNI (g/d), DCPI and TDNI (%), DCPI and TDNI (g/kg $w^{0.75}$) did not influence either by level of water restriction and period of experiment and this may be due to body weight of experimental animals did not influence by the level of water restriction but DCPI in terms of g/d, percent B. Wt and g/kg $w^{0.75}$ marginally increased under water restriction group but TDNI in terms of g/d, percent B. Wt and g/kg $w^{0.75}$ declined marginally by 7.4, 2.0 and 3.3% in 40 % water restricted group. The DCP and TDN intake pattern showed drastic declining trend from P_2 onward. The DCP (g/d), DCP (%) and DCP (g /kg $w^{0.75}$) did not influence by the rehydration. The TDNI (g/d), TDNI (%) and TDNI (g/kg $w^{0.75}$) recovered significantly ($P < 0.05$) in T_2 (25.7, 18.84 and 20.52%) and T_3 (35.42, 24.24 and 27.20%) on 2nd day of rehydration where as it was at par with 4th of rehydration.

P009A031
STUDY OF PHYSIOLOGICAL RESPONSES OF HOGGETS ON DEHYDRATION AND REHYDRATION IN MIDDLE GUJARAT AGROCLIMATIC CONDITIONS

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Abstract
Eighteen indigenous hoggets randomly allotted to three water restriction treatments viz. T_1 (0%), T_2 (20%) and T_3 (40%) on the basis of body weight after accessing water requirement during adaptation period at Instructional Farm, Department of Livestock Production and Management, Veterinary college, Anand during hot dry period (10th May to 10th June). The animals were individually maintained on ICAR feeding standard (1998).Three important physiological responses recorded were Pulse Rate (no./min.), Rectal Temperature (^{O}F) and Respiratory Rate (no./min.). The rectal temperature (^{O}F) recorded at 7.30 a.m. and 2.30 p.m. did not differ significantly ($P<0.05$) due to water restriction but influenced significantly due to period and its interaction with treatment indicated rectal temperature influenced treatment alone did not produce any significant effect but in combination with period it influence the rectal temperature. The rectal temperature recorded at 7.30 am during experiment increased from significantly ($P<0.05$) P1 to P2 in all treatments but declined in control group and remained static in 20% water restricted group between P_2 to P_4 but constantly non significantly increased in 40% water restricted group between P_2 to P_4 where as rectal temperature recorded at 2.30 pm increased significantly ($P<0.05$) up to P_2, P_3 and P_4 under 0% WR, 20% WR and 40% WR, respectively indicated rectal temperature became static after P_2, and P_3 under 0% and 20% WR, respectively. The pulse rate recorded was influenced by level of water restriction and period of experiment at 7.30 am where as at 2.30 pm it was influenced by treatment, period and their interaction. The experimental animals showed significantly ($P<0.05$) higher pulse rate at 7.30 a.m. under 40% WR than 20% WR (4.76%) and 0% WR (10.77%) but pulse rate recorded at 2.30 under 40% WR were significantly ($P<0.05$) higher (4.21%) than 0% WR group and it was at par with 20% WR (3.96%) due to water restriction. The pulse rate recorded at 7.30 am increased significantly ($P <0.05$) from P1 to P2 after ward declined and became static. The pulse rate recorded at 7.30 am higher under T_3 as compared to T_1 and T_2 through the experiment. The pulse rate recorded at 2.30 pm sharply and significantly ($P<0.05$) increased from P_1 to P_2 and remains static between P_2 and P_3 and

again increased significantly ($P<0.05$) during P_4. The experimental animals under 40% WR showed significantly ($P<0.05$) higher respiratory rate at 7.30 than 0% WR (8.5%) and 20% WR (9.50%) where as at 2.30 pm the respiratory rate was at par among the treatment. The respiratory rate recorded at 7.30 am influenced by period and its combination with treatment where as respiratory rate recorded at 2.30 pm influenced by period only.

P010A036
POTENTIAL IMPACT OF CLIMATE CHANGE ON AGRICULTURE AND FOOD SECURITY

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Abstract
Climate change is the biggest threat to the mankind affecting our agriculture by a drastic effect on the growth and cultivation of the different crops due to global increase in temperature, moisture, methane and green houses gases like atmospheric CO_2 concentration in the last 100 years. These changes also affect the reproduction, spread, severity of many plant pathogens, also influences in livestock production and hydrologic balances, thus ultimately posing a threat to our food security. It affects agriculture and food security in a complex ways as directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes and thus creating more demand for agricultural produce.

Indian agriculture contributes 28% of green houses gases emissions by methane emissions from rice, enteric fermentation from ruminant animals and nitrous oxides from the application of manures and fertilizers. The appproaches to reduce these emissions include mid season drainage in rice, N use efficiency, developing advesrse climate tolerant genotypes and land use systems providing value added climatic risk management services to farmers and improving land used policies and risk management by early warning system and crop weather insurance.

A number of economic approaches and models are found in existing economic assessments. Several methods like historical data analyses by statistical tools and analogue approach has been used to assess the impact of climatic changes on agriculture. Besides, controlled environment facilities such as open top chambres, Free Air Carbon Dioxide Enrichment facilities, phytotron and green houses are now increasingly being used to understand the impact of temperature, humidity and CO2 on grop growth and productivity. Use of crop growth simulation models can be the best for studing the interaction effects of CO2, rainfall and temperature. Crop models like DSSAT series, ORYZA, WTGROWS and InfoCrop have been used to assess the vulnerability of agriculture to climate change and for the optimisation of crop management.

Thus, global warming is now causing unprecedentedly rapid changes in the climate conditions that affect agriculture in a much faster way. But at the same time, increasing the world's population will continue to grow through mid-century or later, increasing the demand for food just as climate change begins to depress yields. To adapt to these unavoidable states of climate change, it is essential to apply the rapidly developing resources of plant genetics and biotechnology to the creation of new heat resistant and drought-resistant crops and cultivars along with systematic interdisciplinary research among agricultural science, ecology, agricultural engineering, hydrology, meteorology and agricultural economics.

P011A038
EFFECT OF RATES OF IRON APPLICATION ON GROWTH, YIELD AND QUALITY OF RICE VARIETIES UNDER AEROBIC AND SUBMERGED CONDITIONS

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Abstract
A pot experiment was conducted during *summer*, 2014 in the Net House, SWMRU, NAU, Navsari on DTPA-Fe deficient soil.

The experiment was laid out in a FCRD, comprising 12 treatment combinations of two levels of moisture (S_1: Aerobic and S_2: Submerged), two varieties (V_1: GNR-2 and V_2: GNR-4) and three levels of iron (F_0: 0 kg/ha $FeSO_4.7H_2O$, F_1: 25 kg/ha $FeSO_4.7H_2O$ and F_2: 50 kg/ha $FeSO_4.7H_2O$) which were repeated three times. The results indicated that among the growth and yield attributes, submerged condition (S_2), variety V_1 (GNR-2) and iron level F_1 (25 kg/ha $FeSO_4.7H_2O$) recorded significantly higher plant height, panicle length, number of tillers/plant, number of grains/panicle, test weight, grain and straw yields of rice except effect of variety on no. of grains/panicle. The magnitudes of increase in grain and straw yields were 7.38 and 9.41, 7.38 and 8.27 and 19.2 and 12.9 per cent under submerged condition over aerobic, variety V_1 over variety V_2 and iron level F_1 over F_0 level, respectively. In case of nutrient content, significant effect of submergence and Fe level on P, Fe and Zn content and varietal effect on P and Fe content in grain while only submergence and Fe level on P and Fe content in straw were observed. As far as total uptake of the nutrients under study were concerned, significantly higher total uptake of N, P, K and Fe in submerged condition (S_2), N and K by variety V_1 and Zn by variety V_2 and P, K and Fe by F_1 and N by F_2 were observed. Significant increase EC, available P_2O_5 and DTPA-Fe under submergence and DTPA-Zn under aerobic condition were noted while decrease in available P_2O_5 and increase in DTPA-Fe was observed with raising Fe levels. Interactions between S X V and S X F for yield and S X V, S X F and V X F for total uptake of nutrients by rice were found significant. Among different combinations, S_2V_1 recorded maximum grain and straw yields, S_2F_1 recorded maximum grain yield and S_2F_2 recorded maximum straw yield. In case of total uptake, combination S_2V_1 recorded significantly higher total uptake of N, P, K, Fe and Zn, S_2F_2 recorded significantly higher uptake of N, K and Fe, S_1F_1 recorded significantly higher uptake of Zn and V_1F_2 recorded maximum total uptake of N, K and Fe.

Key words: Iron sulphate, Rice, Aerobic and Submerged condition, Growth Parameter, Quality, Yield, Uptake.

P012A045

APPLICATIONS OF IMAGE PROCESSING TECHNIQUES FOR COUNTING WHITEFLIES AND THRIPS ON COTTON LEAVES

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Abstract

Insect pathogens are a menace to the plants. In this paper a new and simple method for whitefly and thrips counting, based on digital image processing were provided. This approach allows counting of cotton whiteflies and thrips fully automated, considerably speeding up the process in comparison with the manual approach. The image enhancement techniques viz. Red-Green-Blue to Hue- Saturation-Intensity conversion, adaptive histogram equalisation, median filtering, thresholding and morphological operations are used before obtaining the final count of insects on the leaf. The proposed algorithm is capable of detecting and quantifying whiteflies and thrips on cotton leaves. Although this proposal was entirely developed using cotton leaves, it can be easily extended to other kinds of crops with little or no changes in the algorithm. The system employs only widely used image processing operations, so it can be easily implemented in any image processing software package.

Key words: Automatic, Cotton, Whiteflies, Thrips, Image, Processing Techniques.

P013A048
CLIMATE CHANGE PROJECTION BY STATISTICAL DOWNSCALING METHOD

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Abstract
Decision makers are interestingly demanding the climate information in understanding the impacts of climate change on specific sectors like agricultural production, food security, diseases prevalence and population vulnerability at global and continental spatial scales. In response to this, numerous impact and vulnerability assessments were produced at different scales, from global to local and provide climate change impact results at spatial scales. Global Climate Models (GCMs) simulate the Earth's climate via mathematical equations and describe atmospheric, oceanic and biotic processes, interactions and feedbacks. But it remain unable to resolve important sub-grid scale features such as clouds and topography and also cannot account for fine-scale heterogeneity of climate variability and change due to their coarse resolution, as a result, GCM output cannot be used for local impact studies. To overcome this problem, downscaling methods were developed to obtain local-scale weather and climate, particularly at the surface level, from regional-scale atmospheric variables that are provided by GCMs. Statistical downscaling established the statistical relationship between large scale variable, like atmospheric surface pressure, and a local variable, like the wind speed at a particular site. The relationship is then subsequently used on the GCM data to obtain the local variables from the GCM output. This model provides climate information at specific locations for which there is adequate daily data to calibrate the model, as well as archived GCM output.

Statistical downscaling can be represented in three categories as linear methods, weather classification and weather generator according to the relationship between the variables. Linear methods are appropriate when the predictor and predicted variable are approximately linear. Frequently used linear models are Delta Method, Simple and Multiple Linear Regression, Spatiotemporal Methods (Canonical Correlation Analysis and Singular Value Decomposition), etc. When the relationship between predictor and predicted variable are normal as well non-normal distributions then weather classification approach are applicable. Important weather classification approaches are Analog Method, Cluster Analysis, Artificial Neural Network (ANN) and Self-Organizing Map (SOM). A weather generator is a statistical model used to generate sequences of daily variables, e.g. daily precipitation, maximum and minimum temperature, humidity, etc., from monthly GCM output. Different types of weather generator are Long Ashton Research Station Weather Generator (LARS-WG), MarkSim GCM, Nonhomogeneous Hidden Markov Model (NHMM). In general statistical downscaling methods act as computationally inexpensive and efficient method for generating station scale climate information for projecting impacts of climate change on specific sectors mainly in agricultural production and food security.

P014A051
EFFECT OF SULPHUR AND ZINC ON YIELD AND NUTRIENT UPTAKE BY SUMMER GREENGRAM (*VIGNA RADIATA* L.) UNDER MIDDLE GUJARAT CONDITIONS

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Abstract
The field experiment was carried out at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat during summer season of 2013 to study the "Effect of sulphur and zinc on yield and nutrient uptake by summer green gram (*Vigna radiata* L.) under middle Gujarat conditions''. The experiment was laid out in a factorial randomized block design, comprising of four levels of Sulphur (S) (0, 10, 20 and 30 kg S ha^{-1}), and three levels of Zinc (Zn) (0, 10 and 20 kg Zn ha^{-1}) in three replications. The experiment was conducted in loamy sand soil having alkaline in reaction ($pH_{2.5}$ 7.9) and normal salt contents ($EC_{2.5}$ 0.20 dSm^{-1}). The soil was low in available N (184.7 kg ha^{-1}) and S (7.27 mg kg^{-1}), medium in available P_2O_5 (41.58 kg ha^{-1}) and Zn (0.61 mg kg^{-1}) and high in available K_2O (310 kg ha^{-1}). The *Meha* variety of green gram was fertilized

with 20–40–00:: N-P-K kg ha^{-1}. Application of S @ 30 kg S ha^{-1} registered significantly higher grain (1039 kg ha^{-1}) and straw (1967 kg ha^{-1}) yield as compared to control and 10 kg S ha^{-1}, but it was at par with 20 kg S ha^{-1}. Application of 30 kg S ha^{-1} resulted in higher N, P, K, S and Zn concentration and uptake by grain and straw as well as protein content in grain, but it was at par with 20 kg S ha^{-1}. Significantly the highest grain (1008 kg ha^{-1}) and straw (1883 kg ha^{-1}) yield was registered under the application of 2 kg Zn ha^{-1}. Similarly the S and Zn content in grain and N, P, K, S and Zn content in straw were noticed higher under the application of Zn @ 2 kg Zn ha^{-1}. In general, significantly the highest uptake of N, P, K, S and Zn by grain and straw as well as protein content in grain were registered under application of Zn @ 2 kg ha^{-1} than rest of the levels of Zn. Treatment combination of 30 kg S and 2 kg Zn ha^{-1} (S_3Zn_2) recorded significantly the highest grain (1233 kg ha^{-1}) and straw (2123 kg ha^{-1}) yield. The similar treatment combination also recorded significantly higher S and Zn content in grain and straw, N uptake by straw, P uptake by grain and straw, K uptake by grain, S uptake by grain and straw and Zn uptake by grain. It is concluded that application of 20 kg S ha^{-1} through gypsum (16.5% S) and 2 kg Zn ha^{-1} in form of zinc chloride (48% Zn) on loamy sand soil deficient in available S and medium in Zn increased the yield and nutrient uptake by green gram.

Keywords: Green gram, Sulphur, Zinc, Gypsum

P015A054
IMPACT OF BIOTECHNOLOGY ON FOOD SECURITY

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Abstract
One of the most important environmental challenges facing the developing world is how to meet current food needs without undermining the ability of future generations to meet theirs. Food security is the necessity for every individual, home. In developing countries, food security could be substantially improved by increased investment and policy reforms. Biotechnology’s ability to eliminate malnutrition and hunger through production of crops resistant to pests and diseases as pests and diseases causes heavy losses to the crop, having longer shelf-lives, refined textures and flavors, higher yields per units of land and time, tolerance to adverse weather and soil conditions, and generate employment, cannot be over-emphasized. This technology can be applied to improve agriculture in order to improve food production for human population in an environmentally sustainable manner. In the current practice of modern agriculture, which relies on high inputs such as fuel-powered tractors, chemical fertilizers and chemical pesticides, deploying smart mix of farming techniques using genetic engineering of biotechnology and integrating same into the traditional smallholders farming system offer a bright prospect of meeting the growing demand for food by improving both yield and nutritional quality of crops and reducing the impact on the environment.

Key words: biotechnology, nutrition and food security.

P016A057
IMPACT OF CLIMATE CHANGE ON CROP POLLINATORS

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Abstract
Crop pollination is a fascinating process, critical for our survival since it is an essential component of a major part of human food production, which depends on seed and fruit crops. In crop pollination, Pollinators play an ancient functional role in most terrestrial ecosystems and represent a key ecosystem service that is vital to the maintenance of both wild plant communities and agricultural productivity. Insects, birds, flies and beesare the different pollinators from which insects are the primary pollinators of mostgrowing crops and wild plants. So, our main focus will be on insects in this literature. Pollination

services depend on both domesticatedand wild pollinator populations, both of whichmight be affected by a range of recent and projected environmentalchanges, such as habitat loss and climate change,with unknownconsequences for pollination service delivery.However, whether substantial evidence exists for widespreaddeclines and negative impacts on pollination serviceswas recently questioned, although since thenpublished literature on the subject has greatly expanded.Here we review our current understanding of the impact of climate change on statusand trends of pollinators, and how pollinator declines andassociated loss of pollination services impact floral biodiversityand human livelihoods. We assemble and appraisea diverse set of literature addressing the question of what arethe actual impacts observed on their life-cycle, behaviour and physiologyand whatare the particular consequences by climate change.

P017A058
REHABILITATION OF WASTELAND BY MEDICINAL PLANTS

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Abstract
Despite having only about 2.4% of the total land area. India accounts for nearly 8.0 % of the biodiversity of the world. Though having great biodiversity, a very large part (20.16%) of total geographical area of the country is occupied by the degraded land. Different researches explain that the cultivation of various medicinal plants helps to reclaim the degraded lands.Medicinal and aromatic plants have a high market potential as the world demand for herbal products is growing at a rate of 7% per annum.Around 90% of the medicinal plants used by the Indian pharmaceutical industries today are collected from the wild. Over 70% of the plant collection involved destructive harvesting. Threat assessment exercises as per latest IUCN guidelines for Southern and Northern India has already listed around 200 species of medicinal plants that are rare, endangered and threatened. It is necessary to bear in mind that even if a particular variety of a plant is put under several million hectares of active cultivation, the species can still go extinct in the wild, if its wild populations with all their inherent intra specific diversity are not conserved. It is an established fact that the evolution of the species depends on diversity.The potential of wastelands can be extracted well by cultivating some economically beneficial medicinal plants. Creating vegetation cover by the cultivation of adaptable aromatic and medicinal plants of considerable market value in the wastelands with proper treatment is a practical way to prevent further soil erosion and extension of wastelands. Some plants also have the capacity to remove the heavy metals and toxic chemical compounds from the soil (phytoremediation) which can be successfully utilized for the treatment of degraded soil for rehabilitation.India has very good wealth of medicinalplants. Thus plantation of herbal plants at degraded land will help to save the diversity of these herbal plants and simultaneously will help to minimize the pressure on crop and reclaims the degraded land of the country.
Keyword- Degradation, Medicinal Plants, IUCN, Pytoremediation.

P018A061
FOOD SECURITY A MAJOR CHALLENGE IN AGRICULTURE - PERSPECTIVES AND OPTIONS

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Abstract
The past half century has seen marked growth in food production, allowing for a dramatic decrease in the proportion of the world's people that are hungry, despite a doubling of the total population. Nevertheless, more than one in seven people today still do not have access to sufficient protein and energy from their diet, and even more suffer from some form of micronutrient

malnourishment. Continuing population and consumption growth will mean that the global demand for food will increase for at least another 40 years. Growing competition for land, water, and energy will affect our ability to produce food, as will the urgent requirement to reduce the impact of the food system on the environment. A multifaceted and linked global strategy is needed to ensure sustainable and equitable food security. A wide range of agricultural investment options can improve food security, increase the adaptive capacity of the food system to respond to climate change, and contribute to mitigation. A more holistic vision of food security, agricultural mitigation, adaptation and development is needed if synergies are to be maximized and trade-offs minimized. This needs to be mainstreamed into global agendas and national strategies for addressing climate change and food security. Synergies between food security and agricultural mitigation are mostly found in strategies for agricultural intensification and for increased resilience of the food production system, while trade-offs tend to occur with changed land use. Realizing the synergies and minimizing trade-offs between agricultural mitigation and food security will require financing that values such synergies and combines new and additional climate financing with ODA.

Key Words: Malnourishment, Population, Global demand, Food security, Mitigation, Intensification.

P019A066

DEVELOPMENT OF LINKAGE MAP AND MAPPING FOR MYMV RESISTANCE IN MUNGBEAN.

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Abstract

Mungbean [*Vigna radiata* (L.) Wilczek] (2n=2x=22) is one of important legume crops in Asia and affected greatly by Mungbean yellow mosaic virus (MYMV) which is transmitted through the white fly, *Bemisia tabaci* Genn. (Nariani, 1960; Nene, 1973). It is one of the most devastating types of biotic stresses that can cause up to 100% damage to a large number of leguminous crops. The most seriously affected grain legumes are mungbean, black gram and soybean (Verma *et al*., 1992). Currently, MYMV (Mungbean yellow mosaic virus) is the most important disease of mungbean from molecular breeder's point of view.

In study carried at CPMB, Tamil Nadu Agricultural University it was found that rice bean (*Vigna umbellata*) is a source for MYMV resistance. Thus, it has been used to develop RILs and BC_1F_1 population by introgessing rice bean genome into mungbean genome and validated using azuki bean primers. The same azuki bean SSR markers were used for development of an interspecific *Vigna* linkage map between *V. umbellata* and *V. nakashimae* (Somata *et al*., 2006) and map was used to analyze the Bruchid resistance. Thus, the cross between rice bean and mungbean can be suitable candidate for development of mapping population. The mapping population can be developed by crossing resistant rice bean with mungbean, and new SSR markers can be developed (Kumpatla and Mukhopadhyay, 2005). The sequence database of model legume *Lotus japonicus, Medicago trucatula* and ESTs of commonbean, soybean are important sources for mining SSR markers. SSR primers of azuki bean, commonbean and soybean mapped on the linkage map by using bioinformatics tools such as Join Map, will be used to analyze parental polymorphism. Further using a bioassay for MYMV resistance reaction the population can be scored as resistant or susceptible. Agroinfection studies further will confirm the resistance to MYMV. This all data can be use to map MYMV resistance. The SNP markers developed using *in silico* approach can be useful for further fine mapping and association mapping studies. Thus the mapping of MYMV resistance will be useful in breeding programs to develop resistant lines.

P020A068
STUDIES ON EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY ON BIOLOGY OF RICE MOTH *Corcyra cephalonica* (STAINTON)

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Abstract
Some biological parameters of *Corcyra cephalonica* Stainton were studied in the laboratory at the temperature levels of 20±1, 25±1, 30±1 and 35±1ºC and humidity levels of 60, 75 and 85 per cent on broken conditioned sorghum grains. The findings revealed that the most favorable combination of temperature and relative humidity for fecundity and weight of full grown larva was 30^{0}C and 75% relative humidity at which maximum egg laying of 135.66 eggs per female and weight of full grown larva (0.070 gm) were recorded. The larval and pupal periods were observed highest to the tune of 49.55 and 14.66 days at 20 and 35^{0}C whereas, lowest to the tune of 34.79 and 10.11 days at 20^{0}C, respectively. The effect of humidity on larval and pupal periods showed that the highest periods of 39.75 and 13.41 days respectively were, recorded at 60% relative humidity. Thereafter, lowest larval period was observed 36.66 days at 85% relative humidity and pupal period of 11.58 days at 85% relative humidity. The larva completed its development in 25.00 days at 35^{0}C and 85% relative humidity. The shortest pupal period of 9.00 days was observed at 35^{0}C and 85% relative humidity while, the longest pupal period of 15.66 days was observed at 20^{0}C and 60% relative humidity. The most favorable combination for the development of *C. cephalonica* was 35^{0}C and 85% relative humidity at which it took least period of 31.33 days.

P021A069
STUDIES ON BIOLOGY AND FEEDING POTENTIAL OF *Chrysoperla zastrowi sillemi* (ESBEN-PETERSON) ON EGGS OF *Corcyra cephalonica* (STAINTON)

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Abstract
The results on biological parameters revealed that the average incubation period was 2.38 ± 0.49 days, while the hatching percentage was 88.70%. The mean duration of first, second and third instar larva was 1.93 ± 0.07, 2.86 ± 0.63 and 2.73 ± 0.70 days, respectively. The mean length of first, second and third instar larva was 2.81 ± 0.14, 4.84 ± 0.26 and 7.10 ± 0.33 days, whereas breadth of these larva was 0.66 ± 0.01, 1.00 ± 0.06 and 2.33 ± 0.08 days, respectively. The average pupal period and diameter of pupa were 6.61 ± 0.84 and 3.01 ± 0.23 days, as the mean pre-oviposition, oviposition and post oviposition period were 3.42 ± 1.02, 12.52 ± 2.87 and 10.23 ± 2.97 days, respectively and the mean fecundity was found to the tune of 352.9 eggs/female. An average longevity of male was 29.20 ± 1.46 and that of female was 33.90 ± 3.24 days. The feeding potential of *C. zastrowi sillemi* on *C. cephalonica* eggs indicated that the larvae of first, second and third instar consumed 63.8 ± 2.90, 268.5 ± 6.24 and 354.5 ± 5.90 eggs, respectively. A single predatory larva consumed on an average 686.8 ± 9.68 eggs during its developmental period.

P022A070
BIOLOGY AND PARASITIZATION ABILITY OF *Trichogramma chilonis* ON EGGS OF *Corcyra cephalonica* AT DIFFERENT TEMPERATURE CONDITIONS

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Abstract
The biological parameters study was conducted to sort out the effective laboratory rearing temperature for egg parasitoid *Trichogramma* by using the host eggs of *C. cephalonica* at 20, 25, 28, 31 and 35^{0}C temperatures in the BOD incubators. Biological parameters of parasitoid, *Trichogramma* such as parasitism (95.23%), developmental period (7.40 days), emergence (97.30%) and adult longevity (6.60 days) were very favorable at 28^{0}C followed by at 25^{0}C (92.73%, 8.23 days, 95.16% and 8.50 days), respectively. The lower and extreme limits of temperatures were evaluated as 20 and 35^{0}C with prolonged and reduced developmental period, respectively causing low parasitism and emergence. The experiment results divulged that the 28^{0}C temperature is very conducive for rearing of parasitoid to get good development of *Trichogramma*.

P023A071
EFFECT OF CLIMATE CHANGE ON PLANTING DATES OF PRESEASONAL SUGARCANE (VAR. COM 0265)

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Abstract
A field experiment was carried out at Central Sugarcane Research Station Padegaon during 2011-12 to 2013-14 to assess the effect of climate change on preseasonal sugarcane. Treatments comprises of nine planting dates of preseasonal sugarcane in different meteorological week i.e. 42nd MW (15.10.), 44th MW(01.11.), 46th MW(15.11.), 48th MW(01.12.), 50th MW(15.12.), 1st MW(01.01.), 3rd MW(15.01.), 5th MW(01.02.) and 7th MW(15.02.). The results revealed that significantly the highest cane and CCS yield was recorded when sugarcane planted in 42nd MW(171.15 t ha^{-1} and 25.01 t ha^{-1}), respectively. However, it was at par with planting in 44th MW (169.02 t ha^{-1} and 24.35 t ha^{-1}), 46th MW (165.64 t ha^{-1} and 23.32 t ha^{-1}), and 48th MW (163.32 t ha^{-1} 23.08 t ha^{-1}). The per cent reduction in cane yield over the 42nd MW was 12.23%, 14.38%, 16.23%, 17.84% and 19.13% in , 50th, 1st, 3rd, 5th and 7th MW, respectively. Same trend was observed among the different growth parameters. Significantly the highest Brix (21.27), Sucrose (20.44%), Purity (96.86%) and CCS (14.61%) were observed under planting in 42nd MW However, it was at par with the treatment 44th, 46th and 48th MW. At 300 DAP plant hight, number of internodes, internode length and cane girth was significantly and positively correlated with maximum temperature, wind velocity and pan evaporation. While plant hight was positively correlated with minimum temperature, bright sunshine hrs (BSS) and internode length and cane girth was also positively correlated with bright sunshine hrs. At harvest cane and CCS yield of sugarcane was positively correlated with maximum temperature, wind velocity and pan evaporation. Significantly positive correaltion of millable cane, weight per cane was observed with cane and CCS yield. Under the changing climatic situation the planting of pre-seasonal sugarcane (var. CoM 0265) during 15 October to 30 November was to be found suitable for high cane and CCS yield in medium to deep black soils of Western Maharashtra.
Key words: Climate change, Sugarcane, Preseasonal, and Planting dates.

P024A078
BIOCHAR FOR ENHANCING AGRICULTURAL SUSTAINABILITY UNDER CLIMATE CHANGE

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Abstract
Biochar is essentially fine-grained charcoal applied to soils, which is being promoted primarily for climate change mitigation and for raising soil fertility. Climate change is one of the biggest challenges facing our globalized world today. The poor population in developing countries will be particularly affected by global warming, of which developed countries are the major drivers. Science clearly indicates that a global temperature rise of 2°C above pre-industrial levels may change the face of the world irreversibly. A range of mitigation solutions is needed to avoid exceeding the 2°C limit. The need for truly sustainable agriculture and climate-friendly development is clear. A glance at global mitigation potentials shows that changes in agriculture and land use by using biochar, "climate friendly" agricultural solution. Biochar is a charred carbon-enriched material intended to be used as a soil amendment to sequester carbon and enhance soil quality. Sustainable biochar is produced from waste biomass using modern thermo-chemical technologies. Addition of sustainable biochar to soil has many environmental and agricultural benefits, including waste reduction, energy production, carbon sequestration, water resource protection, and soil improvement. Therefore, the use of sustainable biochar as a soil amendment is an innovative and highly promising practice for sustainable agriculture under climate change.

P025A079
HOST RANGE OF RICE BLUE BEETLE *LEPTISPA PYGMAEA* BALY (COLEOPTERA: CHRYSOMELIDAE) IN KONKAN REGION

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Abstract
In the present investigation it was observed that the pest carryovers through the off season in adult stage particularly on grasses which are present in the vicinity of rice. No egg laying was observed on such plants. Thus, it was clear that the pest overwinters on the reported host during off season. Voraciousness of beetles in the off season was reduced as compare to feeding on *Kharif* rice. Thus removal of weed hosts from the vicinity of rice would help in reducing the pest activity to a greater extent. However, the activity of the pest was observed to be retarded remarkably during the off season. Maximum numbers of hosts found are comes under Poaceae family. In the vicinity of rice plot, weeds like volunteer plants, ratoon rice (*Oryza sativa*) and Baradi (*Ischaemumrugosum*), wild rice (*Echinocloacolona*), even the cultivated sugercane also (*S. officinarum*) were infested by adults of blue beetle.Eight plant species were reported first time as alternate host *viz.,* cultivated nachani (*Elusinecoracana*), wild nachani (*Elusineindica*), lemon grass (*Symbopogan citratus*), swollen finger grass (*Chlorisbarbata*) dhoor (*Isachneglobossa),* guinea grass (*Panicummaxicum*), Napier grass (*Pennisetum purpurium*) and Kasai (*Coixlacryma-jobi*). The maximum population of adults was found in the off season on cultivated sugarcane, wild nachani and dhoor.
Key words: -Blue beetle, cultivated hosts, weed hosts, Poaceae, maximum population.

P026A080
INSECT PEST PROBLEMS IN GROUNDNUT: CHANGING TRENDS

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Abstract
Insect pest problems in agriculture have shown a considerable shift during first decade of twenty-first century due to climate changes. While there has been an overall decline in the severity of *Helicoverpa armigera* (Hubner) whereas tobacco caterpillar, *Spodoptera litura* (Fabricius) has shown an increasing trend in groundnut. So, *Helicoverpa* attained secondary pest status and tobacco caterpillar is emerging as major pests in groundnut. *Helicoverpa* had become a menace in cotton growing regions and started causing considerable damage to groundnut. However, after the introduction of *Bt* cotton in 2002 and its subsequent rapid adoption, its infestation significantly declined in the cotton-based cropping systems. *Helicoverpa* subsequently moves from cotton to groundnut. As *Helicoverpa* is not able to survive on Bt cotton, its cycle gets disrupted and there is no significant movement of the pest from cotton-to-groundnut. As Bt cotton does not provide protection against tobacco caterpillar, *Spodoptera*, it continues to inflict heavy losses in several cotton growing regions of India. Recently, there was an outbreak of *Spodoptera* on groundnut in saurastra region of Gujarat. Moreover, the intensity of *Spodoptera* is likely to further increase under the potential climate change, as it has been found to consume more than 30 per cent leaves at elevated CO_2 levels.

P027A081
"ENERGY SAVING AND RURAL DEVELOPMENT IN ARENA OF CLIMATE CHANGE"

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Abstract
Energy that is now a severe drain on the growth of the local economy can be converted into an engine for economic growth by an alternative approach.India has a vast extent of privately held, rain-fed farm lands and cultivable wastelandsthat can be utilized for development of energy plantations consisting of fast-growingtree crops such as bamboo, Casuarina, eucalyptus and prosopis, which can serve asthe raw material for a nation-wide network of small, decentralised bio-mass power plants. These power plants, ranging in size from 6-25 MW, can generate thousands ofmegawatts of power from renewable, forest-based fuel sources in a cost-effectivemanner.Curcas (*Jatropacurcas)* is a plant which already grows wild in India and isoften used as a fence crop. The plant produces large quantities of seeds which containup to 35% oil that is a substitute for No.2 diesel and kerosene and can be blended indiesel motor fuels up to 15%. The cost of production is competitive with other fueloils.Ethanol, which can be produced from maize, tapioca, sugarcane, sugar beet and othercrops, is another bio-fuel with enormous potential. It can be mixed as a pollution-freeblend with petrol and diesel.Paradise tree (*Simarubaglauca)* is a Brazilian oilseed-bearing plant that can becomean important source of edible oil for India. The plant is a drought-resistant, highyielding,perennial ever-green tree ideally suited for dry land areas of India. It growsunder rain-fed conditions and requires minimal inputs. It starts bearing seeds from the3rd or 4thyear. The seeds contain 50% oil, which when refined is very similar incharacteristics to groundnut oil.The greatest advantage of producing bio-mass power and bio-fuels from tree crops is that they can generate millions of rural jobs and stimulate enormous growth among the weaker sections. If the country makes a strong commitment to the development of bio-mass power and biofuels, it can act as a powerful stimulus to mitigate climate change and rural job creation and prosperity.

Keywords: Energy, Biomass, Bio-fuel, Climate change , Rural, Economy.

P028A087
DEVELOPMENTOFSUSTAINABLELIVELIHOODSECURITYINDEXFORAGRICULTURAL SUSTAINABILITY IN GUJARAT

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Abstract
Sustainable agriculture in terms of food security, rural employment, and environmentally sustainable technologies such as soil conservation, natural resource management and biodiversity protection are essential for holistic rural development. Agricultural sector has an influence over environment and is simultaneously affected by it too. It is the most aggressively managed ecosystem, which is closely linked to world's food system, therefore, environment friendly agriculture is essential for the sustainability of human beings and society. So, sustainable agriculture can be considered to be a food production that integrates the goals of environmental health, economic efficiency and social equity. Agriculture is the main occupation in India, where a majority of rural poor families are dependent on it for income and employment, therefore, sustainability of agriculture can't be defined in isolation of the issue of livelihoods. A livelihood consists of people, their capabilities and means of living, including food, income and assets. Livelihood is defined as adequate stock and flow of food and cash with an individual or a family to meet its basic needs. Sustainable Livelihood Security (SLS) is livelihood options which are ecologically secure, economically efficient and socially equitable and this can be estimated using Sustainable Livelihood Security Index (SLSI). This index would helps to identify whether necessary conditions for sustainable development are present in a given region/ecosystem or not. SLSI is a comprehensive indicator to reflect the ecology-economic-equity interface of sustainable development. The inter-related dimensions of sustainability are ecology, economics and equity, therefore, to ensure sustainable development, ecological security, economic efficiency and social equity are needed. SLSI was constructed for 26 districts of Gujarat using secondary data on certain variables under the ecology, economy and equity heads for the TE 2013-14. The results showed that Surat (0.515), Banaskantha (0.505), Dahod (0.466) and Rajkot (0.452) were high ranking districts in ESI while, Bharuch (0.155) ranked lowest. Whereas, in case of economics efficiency Rajkot and Banaskantha (0.773) ranked first while, Dangs (0.206) ranked last. In terms of social equity Ahmedabad (0.830) ranked highest and Dahod (0.204) ranked lowest. In overall SLSI ranking, Rajkot (0.587) ranked first followed by Ahmedabad (0.546), Banaskantha (0.511), Surat (0.531) and Junagadh (0.492) indicating comparatively sustainable development in these regions compared to Porbandar (0.246), Narmada (0.276), Dangs (0.290) and Patan (0.290) which ranked low due to their low values in equity, ecology and economy. Overall none of the districts over the years fare efficiently in all the three indicators especially ecological indicators which shows that there is a huge pressure on natural resources. The ecological resources need to be used adequately over the years as population density and growth are increasing at a rapid rate and hence for development to be sustainable in long run, these resources must be protected and maintained.

P029A089
ENZYMATIC, MICROBIAL, NUTRIENT COMPONENTS ESTIMATION AND ITS CORRELATION STUDY OF SOIL SAMPLES FROM THE COASTAL WETLAND OF GUJARAT

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Abstract
Gujarat (20º 07' - 24º 43' North and 68º 10' - 74º 29' East) situated on the western coast of India, covered longest coastal shoreline more than 1,600 km and the most extensive continental shelf of nearly 164,000 sq km. Coastal habitats serve as an ecological niche between terrestrial and marine realms, and formed important nature conservation sites having an environment

important functional aspects coastal regions are included in a recycling of nutrients, degradation of contaminants, carbon sink, ecological balance, etc. For the ecological functional aspects of the coastal wetland soil crust bioindicators such as bacteria and floral diversity and distribution, nutrient components and soil enzymes were investigated. For the evaluation of bacterial diversity mainly Exiguobacterium, Alkali bacterium, Halolactibacillus, Salinicoccus, and Halomonas, a group of bacteria isolated at lab culture technique. For the investigation of soil profile physico-chemical factors were investigated for a major nutrient source as a Carbon, Nitrogen, available Phosphorus and available sulfur. Existed essential minerals such as chloride (Cl), sodium (Na), potassium (K), iron (Fe), copper (Cu), zinc (Zn) were investigated to check out soil status. Significant results obtained in correlation studies of carbon source with amylase, cellulase, and invertase enzyme. Soil microbial activities showed effective dehydrogenase activity which catalyses the removal of a hydrogen atom from different metabolites and catalase enzyme activities for rapid decomposition of hydrogen peroxide to water and oxygen molecule. Various halophiles microorganism community abundance closely correlates with presence soil enzymes. Nitrogen associated enzyme activities evaluated by nitrate reductase and ureas enzyme activity in soil. In nitrate reductase nitrate is converted to nitrite and liberated nitrite were estimated. Ureas enzymes hydrolyzed compound in ammonia and CO_2 in the soil as a fertilizer, animal urine hydrolyzed and released from living and degenerated microbial cells in the soil it exists as an extracellular enzyme. Liberated ammoniacal nitrogen estimated for urease activity in the soil, which shows a significant result. Protease and phenol oxidase enzymes result showed degradation of proteins, polypeptides, amino acids and phenolic material. Towards liberated of free phenolic compounds estimated in phenol oxidase gave correlate significantly with microbial diversity. The nature of halophiles diversity correlation with soil nutrient with soil enzymes is a neglected area of investigation of coastal wetland ecology. The study reveals that close relationship between some biotic and abiotic components with soil enzymes in a natural coastal wetland environment.

P030A094
CLIMATE CHANGE ADAPTATION: REAL TIME NITROGEN MANAGEMENT USING LEAF COLOUR CHART AND CHLOROPHYLL METER

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Abstract
Climate change poses serious threats on crop productivity. Global warming may change growth and development pattern of crop plant, which alters most of the physiological and biochemical processes in plant. As an adaptation strategy, currently recommended cultivation practices, especially fertilizer and irrigation application, need to be adjusted suitably according to climate and plant growth. Among the primary nutrients, nitrogen is very important as it is intimately involved in the process of photosynthesis and thus directly related to total dry matter production. As N requirement of plant is not same throughout the growth period it is necessary to adjust fertilizer N application with the timings of plant N requirement to enhance N-use efficiency in crop. The real time N management approach can help increase N use efficiency by matching time of fertilizer application with plant need. Leaf colour chart (LCC) and SPAD meter (Chlorophyll meter) is a reliable tool for real time N management (Singh et al., 2002). It can be used for rapid and reliable monitoring of relative greenness of the leaf as an indicator of leaf N status. The guidelines evolved using LCC and SPAD meter helps adopt crop demand-driven N applications and result in high crop productivity and economic returns and reduce N losses to the environment (Singh et al., 2002;). Real time application of 60 kg N/ha in two equal splits at LCC 4 significantly increased grain, straw yield and grain protein content of wheat as compared to fixed time application of 60 kg N/ha at 25 DAS (Mathukia et al., 2014).
Key Words: Nitrogen, Leaf colour chart, chlorophyll meter.

P031A095
EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON SOIL PROPERTIES

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Abstract
Integrated Nutrient Management refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner. The aim of Integrated Nutrient Management (INM) is to integrate the use of natural and man-made soil nutrients to increase crop productivity and preserve soil productivity for future generations (FAO, 1995a). Rather than focusing nutrition management practices on one crop, INM aims at optimal use of nutrient sources on a cropping-system or crop-rotation basis. This encourages farmers to focus on long-term planning and make greater consideration for environmental impacts. INM enables the adaptation of plant nutrition and soil fertility management in farming systems to site characteristics, taking advantage of the combined and harmonious use of organic and inorganic nutrient resources to serve the concurrent needs of food production and economic, environmental and social viability. INM empowers farmers by increasing their technical expertise and decision-making capacity. It also promotes changes in land use, crop rotations, and interactions between forestry, livestock and cropping systems as part of agricultural intensification and diversification. The effect of integrated application of organic and inorganic fertilizer on bulk density was more pronounced than the sole application of inorganic fertilizer. the porosity of soil increase due to application of organic manures *viz*., FYM and vermicompost to the INM treatments, as reported by Gawai (2003).
Key Words: INM, Soil properties.

P032A096
EFFECT OF WINGED SUBSOILER ON SOIL CHARACTERISTICS AND SUBSOILER DRAFT.

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Abstract
Subsoiling is one of the most useful method to avoid soil compaction is deep tillage by using a subsoiler. A subsoiling experiment was conducted at the JAU university farm, Junagadh. The field soil was medium black soil. Subsoiling was done by a tractor (55 hp) with conventional subsoiler and winged subsoiler. Three sets of wing attachment with different width (W_5=5, W_{10}=10 and W_{15}=15cm) were developed and attached to conventional subsoiler. Conventional and winged subsoilers were operated at three different subsoiling depths (d_1=25-30, d_2=30-35 and d_3=35-40 cm) and effect of subsoiling was observed and analysed by large plot sampling technique. The main aim of study was to compare the performance of different types of subsoilers *viz*. Conventional and winged subsoilers with different size of wings on the basis of draft, soil disturbance and soil penetration resistance at working depths of 25-30, 30-35 and 35-40 cm. Soil profile meter was developed for measurement of soil disturbance area. Subsoiling just below the hardpan depth was found beneficial and hardpan was found at 30-35cm depth. The draft recorded by winged subsoiler (W_{15}) was found significantly higher (21.86 %, 32.06 % and 22.69 %) compared with that of W_0 subsoiler at d_1, d_2 and d_3 depths, respectively, while at d_1, d_2 and d_3 depth, soil disturbance area obtained from W_{15} subsoiler *i.e*. 70.87 %, 51.72 % and 79.26% compared with W_0 subsoiler and interaction effect on soil penetration result was found non-significant.
Key words: conventional subsoiler, draft, soil disturbance area, subsoiling, winged subsoiler.

P033A104
CONSTRAINS IN ADOPTION AND OPERATION OF DRIP IRRIGATION

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Abstract
The study was conducted to investigate the constraints in adoption and operation of Drip Irrigation for Farmers of Junagadh Taluka of Gujarat state and to suggest the possible solutions. The data were collected 50 adopters and 50 non-adopters from villages of Junagadh Taluka. Ranking was given to identified constraints by total score given by farmers as Most important (3), Important (2), Less important (1), Not important (0). 84 per cent under adopter category and 86 per cent under non adopter category were having less than 4 ha land. High initial investment ranked the most important constraint for the non-adoption of drip irrigation system by the farmers with score of 146 with 92 % of farmers indicting it as most important. More Maintenance require as compare to Surface Irrigation and Damage to system due to rats and other animals ranked II and III with a score of 130 and 123 respectively. Problem of clogging of system due to salty/impure water was ranked most important constraint in operation of drip irrigation with a score of 133 followed by More Maintenance require as compare to Surface Irrigation and Damage to system due to rats and other animals with rank II and III with a score of 118 and 114 respectively. It was found that measures to reduce cost of system, modification in system of subsidy, increase in training and demonstration, and research and policy making based on large scale location specific survey by involving all stake holders will uplift the adoption of drip irrigation.

P034A105
A SMALL SCALE BRIQUETTING MACHINE

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Abstract
Biomass as a source of energy is gaining importance as a renewable source that is additionally strengthened the country's agriculture as one of the prime source in the Indian economy. Use of biomass for thermal energy is age-old but the use of "modern biomass" is more recent. For effective utilization of biomass, briquetting technology is one of the convenient means. The development of a briquetting machine at a smaller scale can be used for making briquettes from the agricultural waste and can be used as a fuel at rural level or at a small scale. Briquetting consists of applying pressure to a mass of particles with or without a binder and converting it into a compact aggregate. In this study, a biomass briquetting machine suitable for use in rural communities was designed. The machine consists of hopper, cylinder, outlet die, screw worms, power transmission system and frame and was fabricated using mild steel. For making briquettes, groundnut-shells were used. The developed machine was tested for different particle sizes (4, 8, 12 and 16 mm), machine speed (40, 45, 50 and 55 rpm) and binder percentage (8, 10, 12 and 14 per cent). The maximum machine capacity obtained was 33.76 kg/h at 55 rpm and 10 binder percentage.
Keywords: Briquette, agro waste, rural, design, groundnut shells, testing.

P035A108
VEGETABLE PRODUCTION USING PLASTICULTURE

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Abstract

To be competitive in today's marketplace, vegetable growers must strive continually for high quality, superior yields, and extended production cycles that include spring and autumn crops. Plasticulture is a management tool that enables vegetable producers to realize greater returns per unit of land.Plasticulture is a system of growing crops in a way so that a significant benefit is derived from using plastic polymers likeearlier crop production (7 to 21 days earlier), higher yields per hectare (two to three times higher); cleaner and higher quality produce; more efficient use of water resources; reduced leaching of fertilizers, especially on light, sandy soils; more efficient use of fertilizer inputs through fertigation technology; reduced soil and wind erosion; potential decrease in the incidence of disease; better management of certain insect pests; fewer weed problems; reduced soil compaction and elimination of root pruning; and opportunity to double- or triple-crop with maximum efficiency. The discovery and development of polyethylene polymer in the late 1930s, and its subsequent introduction in the early 1950s in the form of plastic films, mulches, and drip-irrigation tubing and tape, revolutionized the commercial production of several vegetable crops and gave rise to plasticulture. The later discovery of other polymers such as polyvinyl chloride, polyproplene, and polyesters, and their use in pipes, fertigation equipment, filters, fittings and connectors, and row covers further extended the use of plastic components in this production system. The plasticulture system consists of plastic and non-plastic components: Plastic mulches, drip irrigation, fertigation/chemigation, fumigation and solarization, windbreaks, stand establishment technology, seasonal-extending technology, pest management, cropping strategies, postharvest handling and marketing. Significant increases in earliness, yield, and/or fruit quality with the use of plasticulture include muskmelon, tomato, potato, chilli, onion, pepper, cucumber, eggplant, watermelon, cucurbits, cruciferous crops and okra. The production of vegetable crops using plasticulture is a certainly a production system that involves high input costs and levels of management and is subject to mismanagement and risk, just like any other production system. With proper planning, attention to details, and dedication to all aspects of the plasticulture system, the opportunity exists to reduce the acreage of an existing operation and possibly increase profits using efficient production techniques.

Key word: Plasticulture, Drip irrigation, Mulching, Vegetable.

P036A109
EVALUATION OF BOTANICAL EXTRACTS AGAINST JASSID [*Amrascabiguttulabiguttula* (Ishida)] AND WHITEFLY [*Bemisiatabaci* (Gennadius)] ON OKRA [*Abelmoschus esculentus* (L.) Moench]

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Abstract

Investigations were carried out on Evaluation of botanical extracts against jassid[*Amrascabiguttulabiguttula* (Ishida)] and whitefly [*Bemisiatabaci* (Gennadius)] on okra [*Abelmoschu sesculentus* (L.) Moench] at Organic Farm, NAU, Navsari during 2015.Out of 13treatments of botanicals and tested at different intervals, data indicated that of datura leaves extract 10 per cent was thebest in reducing almost two major insect pests, recording (7.18 jassid/leaf)and (2.51whitefly/leaf). Among all the treatments, maximum pod yield(115.24q/ha) was recorded in the treatment datura leaves extract 10 per cent.With respect to BCR, highest BCR (1:18.05) was registered in the treatment datura leaves extract 10 per cent followed by ipomoea leaves extract 10 per cent (1:16.25).

Results revealed that the population of jassid was initiated from 3rdWAS *i.e.*4thweek of January (0.16 jassid/leaf) and continued

till crop maturity *i.e.* 5th week of April and reached to a peak level (21.68 jassid/leaf) during 11th WAS *i.e.* 4th week of March. The population of whitefly was started from 5th WAS *i.e.* the 2nd week of February (0.11 whitefly/leaf) and reached to a peak level (8.34 whitefly/leaf) during 12th WAS *i.e.* first week of April. Thereafter, the whitefly population was gradually declined and lower level (4.01 whitefly/leaf) at the time of harvest. The green lace wing population was observed from the 4th WAS *i.e.* the first week of February (0.15 per plant) and then it increased and reached to the peak level (1.05 per plant) 13th WAS *i.e.* the fourth week of March. Population of green lace wing slowly declined and reached to the lower level by the 16th WAS. The population of lady bird beetle appeared from the 4th WAS *i.e.* first week of February (0.15 per plant) and increased rapidly and reached to the peak level (1.10 per plant) during 10th WAS *i.e.* third week of March. Then it declined slowly and reached to the lower level by the 16th WAS.

Key word: Okra, Botanical, Jassid and Whitefly

P037A110
INTEGRATED FARMING SYSTEM IN NORTH GUJARAT REGION

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Abstract

Agriculture and allied enterprises were selected based on environment and performed in joint manner is called as integrated farming system.Agriculture is an important sector in our country. Production of agricultural crops, revise in response to changes of the seasons. In the present era stable income of agricultural crops has become unstable. Redressing these by integrating crops with agro-based industries like livestock farming,dairy farming, cattle maintenance, sheep or goat rearing, poultry, piggery, rabbit rearing, bee keeping etc. Any one or more can be combined with the cropping.is essential. In today's environment, increasing demand for milk in rural and urban areas can help small and part-time farmers earn good profits by trading with the dairy farming. It can be done in coordination with agriculture crops. Important key factor for north Gujarat region has dairy farming. Dairying is an important source of subsidiary income to small/marginal farmers and agricultural labourers. In addition to milk, the manure from animals provides a good source of organic matter for improving soil fertility and crop yields. The gobar gas from the dung is used as fuel for domestic purposes as also for running engines for drawing water from well. The surplus fodder and agricultural by products are gainfully utilised for feeding the animals. Almost all draught power for farm operations and transportation is supplied by bullocks. Since agriculture is mostly seasonal, there is a possibility of finding employment throughout the year for many persons through dairy farming. Thus, dairy also provides employment throughout the year. The main beneficiaries of dairy programmes are small/marginal farmers and landless labourers. The most important dairy breeds of buffalo are mehsani, zafarabadi, banni and important dairy breed of cow are kankrej, gir and Holstein Friesians. It will increase the economic status and standard of living of the farmers.Thus, there is a tremendous scope/potential for increasing the milk production through profitable dairy farming.

Key word: Farming, Dairy and Livestock

P038A116
SOLUBILIZATION OF PHOSPHATE AND POTASH THROUGH BACTERIAL INOCULATION IN WHEAT (*Triticum aestivum* L.) ON CALCAREOUS CLAYEY SOIL

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Abstract

A field experiment was conducted on calcareous clayey soil at Junagadh (Gujarat) during *rabi* season of 2014-15 to study the effect of phosphate and potash solubilizing bacterial inoculations on growth and yield of wheat.

The experimental results revealed that application of 45 kg P_2O_5/ha + phosphate solubilizing bacteria (PSB) seed inoculation + PSB soil application being statistically at par with application of 45 kg P_2O_5 + PSB seed inoculation significantly promoted plant height, effective tillers, grains/spike and 1000-seed weight, and ultimately gave higher grain yield (40.1 q/ha) and straw yield (60.2 q/ha) with higher net return (` 45256/ha) and B:C (2.10) over the control. Significantly higher values of growth and yield attributes *viz*., plant height, effective tillers and test weight were registered with application of 45 kg K_2O/ha + potash solubilizing bacteria (KSB) seed inoculation + KSB soil application, being at par with application of 45 kg K_2O/ha + KSB seed inoculation and resultantly gave higher grain and straw yield of 40.8 and 60.8 q/ha, respectively along with higher net return (` 46946/ha) and B:C (2.15) over the control. The results clearly indicated that PSB and KSB inoculation saved 25% P and K fertilizers.

Key words: Wheat, phosphate solubilizing bacteria (PSB), potash solubilizing bacteria (KSB), economics

P039A117

INTEGRATED WEED MANAGEMENT IN *RABI* POPCORN (*Zea mays* var. *everta*) Bhavna

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Abstract

The present study was carried out to find out economically effective methods of weed control for realizing higher productivity and profitability of rabi popcorn. The experiment was carried out at Instructional Farm,Department of Agronomy, Junagadh Agricultural University,Junagadh (Gujarat) during rabi-2013-14. The experiment comprised nine treatmentsviz.,T1: Atrazine 0.5 kg ha-1 as pre-emergence fb HW & IC at 30 DAS, T2:Pendimethalin 0.9 kg ha-1 as pre-emergence fb HW & IC at 30 DAS,T3:Atrazine 0.25 kg ha-1 + Pendimethalin 0.45 kg ha-1 tank-mix as pre-emergence fb HW & IC at 30 DAS, T4:HW & IC at 15 DAS fb Atrazine 0.5 kg ha-1 as post-emergence at 30 DAS, T5:HW & IC at 15 DAS fb 2,4-D (Na salt) 0.5 kg ha-1 as post-emergence at 30 DAS, T6:HW & IC at 15 DAS fb 2,4-D (Na salt) 0.25 kg ha-1 + Metsulfuron-methyl 2 g ha-1 tank-mix as post-emergence at 30 DAS, T7:HW & IC at 15 & 30 DAS, T8: Weed free and T9: Unweeded control, were evaluated in randomized block design with three replications. The experimental soil was clayey in texture and low in available N and moderate in available phosphorus and potash. The popcorn (cv. Amber) was sown in the last week of November with the seed rate of 15 kg ha-1 in the rows spaced 60 cm apart. The crop was raised as per the standard package of practices. Pre-emergence herbicides were applied next day of sowing. The spraying was done using knapsack sprayer with flood jet nozzle keeping spray volume of 500 L ha-1. In manual weed control treatments, weeds were uprooted and removed at 30 DAS as per treatments. Interculturing operation was carried out in inter row space through bullock-drawn implement and simultaneous removal of weeds manually in intra row space.In weed free plots, the weeds were removed manually after every 7-10 days for ensuring complete weed free condition. After uprooting of weeds, the weeds were sun-dried completely till reached to constant weight and finally the dry weight was recorded for each treatment and expressed as kg ha-1. Weed control efficiency (WCE) and weed index (WI) were calculated by the formulae suggested by Kondap and Upadhayay (1985) and Gill and Kumar (1969). Net returns and B:C ratio were calculated for drawing conclusion. On the basis of the results obtained from present one year field study, it could be concluded that effective and economical management of weeds with higher grain yield of popcorn in rabi season can be obtained by pre-emergence application of atrazine 0.5 kg ha-1fb HW & IC at 30 DAS or HW & IC at 15 & 30 DAS or pendimethalin 0.9 kg ha-1 as pre-emergence fb HW & IC at 30 DAS under south Saurashtra Agro-climatic conditions.

Key words: Popcorn, *Zea mays* var. *everta*, Herbicide, Hand weeding, Interculturing.

P040A119

ASSESSMENT OF NITRATE (NO_3^-) LEVELS AND SOME HEAVY METALS IN DIFFERENT VEGETABLES AVAILABLE IN NAVSARI MARKET

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Abstract

The Nitrate (NO_3^-) ions present in consumables or eatables; have been found to have carcinogenic effect on living beings. NO_3^- is a normal component of plant products. Exceptions to the vegetables that have been damaged poorly stored or stored for extended periods, as well as pickled or fermented vegetables. Heavy metal contamination of vegetables cannot be under estimated as these food stuffs are important components of human diet. Vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial antioxidative effects. However, intake of heavy metal-contaminated vegetables may pose a risk to the human health. This is a survey work to find out the status of $NO_3^-$and heavy metals in five different vegetables (spinach, beet root, ivy gourd, Indian bean and cabbage) available in the local market of Navsari district. The lowest nitrate level was determined in cabbage (45.39 ppm) and the highest in beetroot (97.84 ppm) followed by spinach (78.14 ppm). It was also observed that samples collected in winter showed higher nitrate content as compared to the summer. However, in all the months, the nitrate content in any vegetable sample did not cross the ADI limit of 3.65 ppm body wt day^{-1} set by the Scientific Committee for Food (SCF). No significant change was found in nitrate content in vegetable due to storage conditions however, boiling reduces nitrate content in vegetables significantly.. The magnitude of heavy metals detected in different kinds of vegetables was arranged as Fe>Mn>Zn>Cu> Cr>Ni>Pb>Cd. The result confirmed that vegetables under study content heavy metal content within safe limit prescribed by the FASSI and WHO.

Key words: Nitrate, heavy metals, vegetables, Navsari market.

P041A120

EFFECT OF APPLICATION OF DIFFERENT ORGANIC MANURES ON PHYSICAL AND CHEMICAL PROPERTIES OF MAIZE GROWN SOIL

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Abstract

The field experiment entitled "Effect of application of different organic manures on physical and chemical properties of maize grown soil" was carried out at the Certified Organic Farm of Navsari Agricultural University, Navsari during *rabi* seasons of the year 2012-13. The experiment was laid out in RBD and was consisted of ten treatments comprises T_1: 100% NADEP compost (basal application), T_2: 75% NADEP compost (basal application), T_3: 50% NADEP compost (basal application), T_4: 50% NADEP compost + 50% castor cake (basal application), T_5: Jivamrut @ 500 L ha^{-1} (15 days interval), T_6: Jivamrut @ 500 L ha^{-1} (30 days interval), T_7: Panchgavya @ 50 L ha^{-1} (15 days interval), T_8: Panchgavya @ 50 L ha^{-1} (30 days interval), T_9: Jivamrut @ 500 L ha^{-1} + panchgavya @50 L ha^{-1} (15 days interval) and T_{10}: Jivamrut @500 L ha^{-1} + panchgavya @50 L ha^{-1} (30 days interval) which were replicated three times. All the organic manures were applied on equivalent N basis of RDN. The result revealed that among the different treatments, the treatment receiving basal application of RDN through 50% NADEP compost along with 50% castor cake recorded significantly maximum WSA having diameter >1.0 cm as well as significantly higher concentration of available P_2O_5, K_2O, Ca, Mg, S, Fe, Mn, Zn and Cu contents in soil after harvest of maize crop.

P042A122

NUTRIENT CONTENT AND UPTAKE OF CORIANDER IS AFFECTED BY ORGANIC MANURE AND BIO FERTILIZER

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Abstract

A field experiment was conducted medium black calcareous soil of Agronomy Farm, Junagadh Agricultural University, Junagadh during rabi season of 2012-13 to investigated effect of varying levels of organic manures and bio fertilizers on nutrient content and uptake of coriander (Coriandrum sativum L.). Sixteen treatment combinations consisting of three levels each of organic manures along with recommended dose of fertilizer (RDF 20-10-0 N-P-K, FYM @ 5.0 t ha-1, vermicompost @) 1.0 t/ ha, and caster cake @ 0.5 t ha-1) and four treatments of bio fertilizer (no inoculation, Azotobactor @ 10 ml kg-1 seed, PSB @ 10 ml kg-1 seed inoculation and Azotobactor + PSB @ 10 mlkg-1 seed.) making sixteen treatment combinations tested in factorial randomized block design with three replications. Results indicated that application of recommended dose of fertilizer significantly highest nitrogen, phosphorus, potash content and uptake in seed and straw. Inoculation with Azotobactor + PSB @ 10 ml kg-1, gave significantly higher nitrogen content in seed (3.31%), phosphorus content in seed (0.30%), potash content in seed (0.62%), levels of bio-fertilizer did not exert their significant effect on nitrogen content in straw, significantly the highest potash content in straw (0.50%), nitrogen uptake by seed (34.82 kg/ha) levels of bio-fertilizer did not exert their significant effect on phosphorus uptake by seed, highest potash uptake by seed (6.42 kg/ha) levels of bio-fertilizer did not exert their significant effect on nitrogen uptake by straw. highest phosphorus uptake by straw (5.22 kg/ha), potash uptake by straw (8.14 kg/ha), highest nitrogen uptake by plant (55.71 kg/ ha), phosphorus uptake by plant (12.22kg/ha), potash uptake by plant (19.97 kg/ha) over no inoculation.
Key words: Coriander, Nutrient content, Nutrient Uptake.

P043A126

REDDENING AND PHYSIOLOGICAL WILTING OF BT COTTON – A PERSPECTIVE ON ITS MANAGEMENT UNDER FIELD CONDITION

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Abstract

The physiological wilting/ disorder of Bt cotton seems to be due to environmental factors and unavailability of micronutrients including nitrogen at the time of boll formation stage of the crop. In India, though the reddening of leaves of cotton was identified long back as due to imbalance of micronutrients, but the problem has acquired the status of major disorder in Bt cotton hybrids. In India various degrees of losses in seed cotton yield has recently been observed. The cotton yields reduced from 10-50% due to the disorder. Lint quality is also adversely affected because of the premature cracking of the bolls, which ultimately results in low price of their produce in the market. Reddening of leaves and physiological wilting of Bt cotton in middle Gujarat is increasing alarmingly. The field experiment was conducted with ten treatments for management of reddening of leaves and physiological wilting of Bt cotton during *kharif* 2009-10 and 2010-11 using RBD design with three replication having net plot size of 3.6 x 2.7 m and spacing of 120 x 45 cm. The results of pooled data of two years experiment and third years of demonstration revealed that the application of recommended dose of fertilizer (280 kg N/ha) in four equal splits *i.e.* 70 kg N as basal application at the time of sowing and at 30, 60 and 90 days after sowing, in addition to foliar spray

each of 50 g urea, $FeSO_4$, $ZnSO_4$ and $MgSO_4$ in 10 litre of water at 30, 60 and 90 days after sowing was found most effective in managing the reddening of leaves and physiological wilting of Bt cotton and thereby significantly increase in the cotton yield.

P044A132
EFFECT OF DIFFERENT INSECTICIDES AND INFLUENCE OF ABIOTIC FACTORS ON POPULATION OF STEM BORER, *Sesamia inferens* WALKER IN *DURUM* WHEAT

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Abstract
A field experiment was conducted during *rabi* season of 2014-15 in order to evaluate the field bio-efficacy of different insecticides on population dynamics of stem borer, *Sesamia inferens* Walker in *durum* wheat *cv.* Gujarat Wheat-1. All the treatments were significantly effective in managing stem borer in comparison to the control. The foliar application of chlorantraniliprole 18.5 SC proved effective in reducing tillers damage in wheat. The seed treatment of wheat with chlorpyriphos 20 EC + foliar application of chlorantraniliprole 18.5 SC, seed treatment with chlorpyriphos 20 EC + foliar application of flubendiamide 20 WG and seed treatment with fipronil 5 SC + foliar application of chlorantraniliprole 18.5 SC were also found effective with lower per cent of tillers damage. The highest grain and straw yield registered with treatment of foliar application of chlorantraniliprole 18.5 SC. In case of correlation study, weather parameters *viz*., temperature, soil temperature, rainfall, bright sunshine hours and relative humidity revealed that maximum temperature, average temperature, soil temperature at 10 and 20 cm depth and bright sunshine hours showed significant positive effect with tillers per cent damage. The minimum temperature, soil temperature at 5 cm and rainfall were positively correlated with per cent damage but found non-significant. The relative humidity negatively correlated with per cent stem borer damage and found non-significant.

P045A133
CLIMATE CHANGE AFFECTING CROP DIVERSIFICATION IN GUJARAT

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Abstract
Impact of climate change on agriculture will be one of the major deciding factors influencing the future food security of mankind on the earth. Agriculture is not only sensitive to climate change but also one of the major drivers for climate change. Climate change phenomena are now a global reality. Agriculture continues to be the primary occupation for the majority of rural people in the Gujarat state. About 51.8 per cent of total workers are cultivators and agricultural labourers. Thus, the agriculture in the state has been a major source of labour absorption. Moreover, agriculture provides indirect employment to large portion of population in agro-based occupations. Thus, prosperity and well being of people in Gujarat is closely linked with agriculture and allied activities. The State is divided into 7 sub agro-climatic zones based on the characteristics of their agriculture and climate. The State is endowed with abundant natural resources in terms of varied soil, climatic conditions and diversified cropping pattern suitable for agricultural activities. Diversification has occurred in oilseed crops over the period of time in Gujarat because of increase in the area under castor, sesamum, rapeseed and mustard crops. Low level of crop diversification was seen in commercial crops mainly due to the dominance of cotton cultivation in commercial crop group. Considerably high level of crop diversification was prevailed in overall agriculture sector of Gujarat. Low level of crop diversification was associated with those districts where cotton and/or groundnut and /or sugarcane cultivation was dominant. High yielding varieties, consumption of nitrogen, phosphorous and potash fertilizer, gross irrigated area, number of pumps,

number of small and marginal farmers, markets, urbanisation, maximum temperature, minimum temperature and total annual rainfall were the important variables which has affected the process of crop diversification (Positive or Negative) in Gujarat state.

Key words: Climate change, Important of agriculture, Climatic zones, Crop diversification.

P046A139
THE ACTIVITY OF SUCKING PESTS ON OKRA IN RELATION TO WEATHER PARAMETER

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Abstract

Field investigations on pest fluctuation of sucking pests in summer okra were carried out at Main Vegetable Research Station, AAU, Anand during 2012 and 2013. The outcome of the investigation showed higher activity of aphid during 4th week of March to 2nd week of April with a peak incidence on 2nd week of March. The higher activity of jassid and mite was found during 2nd week of February to 2nd week of April and 2nd week of February to 4th week of April, respectively. The peak activity of jassid was observed in 1st week of March, whereas mite in 2nd to 3rd week of March. The higher activity of whitefly was observed from 3rd week of February to 1st week of April with a peak incidence on 1st week of March. The higher incidence of *E. vittella* was noticed during 4th week of February to 3rd week of April with a peak incidence in 4th week of March. The correlation coefficient results indicated that aphid activity on okra during summer (2012 and 2013) showed significant positive and highly significant negative correlation with bright sunshine and evening relative humidity, respectively. Whitefly had highly significant negative association with morning relative humidity, whereas highly significant positive relationship with minimum temperature. Mite had significant and highly significant positive correlation with minimum and maximum temperature as well as evening vapor pressure, respectively during both the years. The incidence of *E. vittella* found highly significant and significant negative relationship with evening vapor pressure and evening relative humidity, respectively.

P047A140
EFFECT OF BIO-PHOS (*CHAETOMIUM GLOBOSUM*) ON CASTOR *(RICINUS COMMUNIS* L.) YIELD AT DIFFERENT LEVELS OF PHOSPHORUS UNDER IRRIGATED CONDITIONS

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Abstract

The field experiments were conducted at the Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh to assess the response of bio- phos (*Chaetomium globosum*) on castor and compared its efficiency with applied inorganic phosphorus through fertilizer during *kharif* season of year 2011-12 to 2013-14 on medium clay soil under irrigated conditions. The experiment consisted of eight treatment combinations of seed treatment with bio-phos @ 30g. inoculants/ 50 g. castor seed (cv. GCH 7) seed with different doses of phosphorus (20 kg, 40 kg and 60 kg/ha). The seed yield of castor was increased due to seed inoculation with bio-phos to the tune of 309 kg/ha, 33 kg/ha, 188 kg/ha and 156 kgha over sole application of 0, 20, 40 and 60 kg P_2O_5 /ha, respectively. The increment in seed yield of castor with bio-phos was higher at 40 kg/ha applied P and decreased with addition of inorganic P. Castor seed yield improvement of 8.35%, net returns of Rs 36989/- and B:C ratio of 2.64 were recorded under application of 40 Kg P_2O_5 /ha along with seed inoculation.

Key words: Castor, bio-phos, phosphorus, seed inoculation, yield.

P048A141
EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD OF GROUNDNUT UNDER RAINFED CONDITIONS

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Abstract
A field experiment was conducted during rainy season of 2011, 2012 and 2013 in medium black soil of Main Oilseeds Research Station farm of Junagadh Agricultural University, Junagadh to study the effect of nutrient management practices on maximizing the production of groundnut crop. The results revealed that different nutrient management practices exerted significant influence on pod, haulm and yield attributes of groundnut under rainfed conditions. Soil application of FYM @ 7.5 tha^{-1} + recommended dose of NP (12.5-25.0 NP $kgha^{-1}$) + Zn @ 5 $kgha^{-1}$ (M_4) to groundnut considerably increased yield, yield attributes, quality parameters and secured maximum net realization of 45058 ha^{-1} with benefit cost ratio of 2›23. No significant influenced was exerted by foliar application of urea on groundnut crop.
Key words: Nutrient, FYM, Zn, groundnut, yield.

P049A142
ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY IN CLIMATE CHANGE

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Abstract
Now a day climate change is the burning and challenging issue all over the world. As climate change appears to be irreversible, world have to think of the quick combat to overcome the climate changing issues. Average temperature rising is not only the reason but other symptoms like changing rain and snow patterns, melting glaciers, more droughts, warmer oceans etc. are the other reasons for climate change. Agricultural and food sector will have to suffer as a whole due to climate change. World is moving towards the digital products and services which also leads to reduce environmental impacts across all sectors of the economy. It is found that ICT is an important tool which can be used to mitigate and monitor climate change and helps to overcome the climate changing issue.

P050A146
MAXIMUM USE OF PLASTIC FOR VEGETABLE CROP PRODUCTION IN CHANGING CLIMATE

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Abstract
India is the second largest producer of vegetable crops in the world. However, its vegetable production is much less than the requirement if balanced diet is provided to every individual. There are different ways and means to achieve this target,

e.g., bringing additional area under vegetable crops using hybrid seeds, use of improved agro-techniques, but changing weather and adverse climatic conditions like extreme temperature heavy rainfalls heat and cold vawes do not allow vegetable production in open and normal conditions. use of plastic material i.e. polythene films for mulching, in the form of covering material in green house and polyhouses, covering of surface for heat sterilization, putting barrier to stop heat and cold vawes using plastic films, portrays and other materials made from plastic is extensively used in vegetable production. Structures like playhouses allows production of vegetables like chili, tomato, capsicum, cucumber etc. not in adverse climatic conditions but also in off seasons. Vegetables are being produced in protected environments. Greenhouses being the most efficient means to overcome climatic diversity. Greenhouse vegetable productions make the use of recent advances in technology to control the environment for maximizing crop productivity percent area and increasing the quality of vegetables produce. India has entered into the area of greenhouse vegetables cultivation more recently and the total area under protected vegetable production is not more than 10,000 hectares. India being a vast country with diverse and extreme agro-climatic conditions, the protected vegetables cultivation technology can be utilized for year round and off-season production of high value, low volume vegetables, crops production of virus free quality seedlings, quality hybrid seed production and as a tool for disease resistance breeding programs. Plastic material with low cost and longer durability proved as great aid to off season and year round vegetable production at lower costs.

Key words: Polythene, Greenhouses, Vegetable crops, Agro-climatic conditions.

P051A147

IMPACT OF VARIOUS ABIOTIC FACTORS ON INCIDENCE OF APHID, *UROLEUCON COMPOSITAE* (THEOBALD) IN GAILLARDIA TRANSPLANTED IN DIFFERENT PERIODS

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Abstract

To study the impact of various abiotic factors on activity of aphid, *Uroleucon compositae* (Theobald) in gaillardia raised at different interval, an experiment was carried out at Agronomy farm, B. A. College of Agriculture, AAU, Anand during 2014-15. The data indicated that aphid population commenced from 14^{th} Week After Transplanting (WAT) (7.96 aphids / 10 cm terminal twig) and remained active till 28^{th} WAT in crop transplanted during 3^{rd} week of October. Gradually, population built up and reached to its peak during 25^{th} WAT *i.e.* 14^{th} Standard Meteorological Week (SMW) and recorded 145.28 aphid population per 10 cm terminal twig of gaillardia. So far the activity of aphid in the crop transplanted during 1^{st} week of November is concerned, initiation of pest was noted during 12^{th} WAT. The pest showed increasing trend and reached on peak (162.68) during 24^{th} WAT *i.e.* 15^{th} SMW. Thereafter, aphid population declined in subsequent weeks. Crop transplanted in 1^{st} week of November suffered the most from the pest. In crop sown during 3^{rd} week of November, pest appeared during 10^{th} WAT *i.e.* 3^{rd} SMW, continuously increased and reached to the highest level *i.e.* on peak (127.96) at 22^{nd} WAT *i.e.* 15^{th} SMW. Population showed declining trend in subsequent weeks. The pest reached on peak at 20^{th} WAT *i.e.* 15^{th} SMW (114.12) in crop transplanted during 1^{st} week of December. The peak activity of the pest was noticed during 18^{th} WAT *i.e.* 15^{th} SMW (108.64) and 17^{th} WAT *i.e.* SMW16^{th} (93.40) in crop transplanted during 3^{rd} week of December and 1^{st} week of January, respectively. Correlation study revealed that Maximum Temperature (MaxT), Minimum Temperature (MinT) and Morning Vapor Pressure (VP_1) exerted highly significant and positive association with the pest population in all the transplanting periods whereas, Morning Relative Humidity (RH_1) reported as highly significant and negatively associated with the pest in the crop transplanted during 3^{rd} week of October and 1^{st} and 3^{rd} week of November. Further, Evening Vapor Pressure (VP_2) was significant and positively correlated with the fluctuation of pest in all the transplanting periods except 1^{st} week of November whereas, Morning Relative Humidity (RH_1) was found significant and negatively associated with the pest in the crop transplanted during1^{st} and 3^{rd} week of December. Bright Sunshine Hours (BSS) and Wind Speed (WS) failed to establish any significant association with the incidence of pest.

P052A152
MICROBIAL CONSORTIA FOR PRODUCTION AND ENRICHMENT OF BIO-COMPOST FROM WHEAT STRAW

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Abstract
Owing to both rise in population and economic development, an array of organic and inorganic by-products are generated from agricultural based industries, which are disposed off according to their physical and chemical traits. The disposal of large quantities of agro based industrial waste causes energy, economic and environmental problems. These wastes have a high content of organic matter and mineral elements; they can potentially be used to restore soil fertility. Wheat straw is an abundant by-product from wheat production. The average yield of wheat straw is 1.3-1.4 lb per lb of wheat grains. Composting is useful for waste recycling and produces a chemically stable material that can be used as a source of nutrients and for improving soil structure. In this study microbial consortia was applied to enhance quality of compost. The parameters like pH, temperature, moisture, TKN, TOC, cellulose and lignin content were checked. Various enzymatic activities like Endocellulase and exocellulase, β-glucosidase, laccase and lignin peroxidase were also analyzed. The FTIR analysis confirmed the utilization of cellulosic substrates as a source of carbon by showing breakage of the different bonds holding structure of cellulose and lignin. The C: N ratio of wheat straw at 30 days was 28.67 as compared to natural composting which were 34.13. It increased to 15.02 and 25.30 at 75 days, respectively. Endocellulase and exocellulase activity also found to be increased up to 30 days and the values were 17.05 U/g and 21.29U/g respectively. The data suggested that bacterial consortia can degrade wheat straw maximum between 60-90 days. All the physicochemical parameters measured supported the applied bacterial consortium for farmer's convenience and for nurturing soil ecosystem with best nutritive organic compost.

P053A153
EFFECT OF WEATHER PARAMETERS ON POPULATION FLUCTUATION OF MAJOR SUCKING INSECT PESTS IN *BT* COTTON (BG II)

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Abstract
An experiment was conducted under field condition at B. A. College of Agriculture, AAU, Anand during 2013-2015 to determine effect of different weather parameters on population fluctuation of major sucking insect pests in *Bt* cotton (RCH-2 BG-II) by using Large plot sampling. The plot was divided into four equal sectors and one sector was considered as one repetition. The results revealed that the highest activity of aphid was noticed during 3rd week of November and 2nd week of December during 2013-14 and 2014-15, respectively with significant positive association with bright sunshine hour (BSS) (r = 0.662**) and significant negative with morning wind direction (WD_1) (-0.866**), wind speed (WS) (r = -0.760**), minimum temperature (MinT) (-0.819**), evening relative humidity (RH_2) (r = -0.869**), evening vapour pressure (VP_2) (r = -0.885**) as well as rainfall (RF) (-0.484*). Leaf hopper appeared right from the beginning of the crop growth stage to the maturity of crop with higher activity during September-October. Maximum temperature (MaxT) (r = 0.757**) showed significant positive association on the activity of this pest. The population of whitefly showed three peaks during 2013-14 and two peaks during 2014-15 with significant positive association of evapotranspiration (EP) (r = 0.793**), MaxT (0.708**), MinT (0.523**) and VP_1 (0.517*).Thrips population exhibited three peaks during 2013-14 and 2014-15 with significant positive association with EP (r = 0.668**), BSS(r = 0.604**) and MaxT (r = 0.776**); and significant negative with evening relative humidity RH_2 (r = -0.681**) and WS (r = -0.637**). As far as activity of mealybug, red cotton bug and dusky cotton bug is concerned, comparatively higher activity was recorded at later stage of crop with one peak during 2014-15. BSS, WS, WD, MinT, RH

and VP exhibited a significant role in the fluctuation and activity of these pests.

P054A157
CLEAN ENERGY GENERATION FROM AGRICULTURAL BIOMASS

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Abstract
Biomass is clean and safe energy sources which are available in abundance in India. Disposal of the biomass waste is a major concern that includes both environmental and capital issues. All the biomass ultimately decomposes to its molecules with the release of heat and the combustion of biomass imitates the natural process. So the energy obtained from biomass is a form of renewable energy and it does not add carbon dioxide to the environment in contrast to the fossil fuels. Biomass is the only renewable energy source of carbon and is able to convert into convenient solid, liquid and gaseous fuels. The energy from biomass may be obtained either through bio-chemical reactions or thermo- chemical reaction. The process for utilizing biomass through thermo- chemical process in its widest sense covers the conversion of any carbonaceous fuel to a gaseous product with a useable heating value. The dominant process is partial oxidation, which produces the fuel producer gas consisting of carbon monoxide and hydrogen in varying ratios, whereby the oxidant may be pure oxygen, air, and/or steam. Using this surplus biomass, more than 15,800 MW of grid quality power can be generated utilizing modern technologies to reduce the crisis of power shortage in the country. In addition, about more than 4500 MW of power can be produced, if all the 550 sugar mills in the country switch over to modern techniques of co-generation. Production of CO_2 for aerated drinks is another application through this process. Biomass thermo- chemical technology provides good opportunity to promote employments, improve land use patterns and makes wealth out of wastelands. For bigger projects, customer can apply independently and can get carbon credit under Clean Development Mechanism (CDM) defined in the Kyoto Protocol.

P055A163
STUDIES OF WEATHER EFFECT ON FROG-EYE SPOT DISEASE IN BIDI TOBACCO USING LOGISTICS REGRESSION

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Abstract
The frog-eye spot (FES) disease caused by *Cercospora nicotianae* Ell. and Eve. is a major problem in both nursery as well as in the main field of bidi tobacco growing environments. Losses due to this disease have been estimated to the tune of 21 per cent in bidi tobacco Due to change in monsoon pattern and weather conditions, since last few years, it is desirable to study the relation between weather parameters and incidence and severity of frog eye spot disease in tobacco. The study was based on eight years data (2008-2015) on occurrence of disease and weather parameters Bright sunshine hours (BSS), Ranifall (RF), Rainy days (RDAY), Wind speed (WS), Maximum and minimum temperature (MAXT, MINT), relative humidity evening (RH1, RH2) and morning, vapor pressure morning and evening (VP1, VP2) using logistics regression analysis. The results of logistic regression analysis indicated that weather parameters BSS and MINT were found positive and highly significant, whereas MAXT and TOTRF were found negative and highly significant. Further results of odd ratio was indicated that every increase in 1 unit in BSS and MINT, the risk of FES increases 1.7 and 1.4 times, respectively, whereas increase in 1 unit in MAXT and TOTRF, the risk of FES decreases at rate of 0.6 and 1.0 times, respectively. Probability of FES occurrence (>0.5) increase when BSS>8.5, MINT>18^{0}C, MAXT <31^{0}C and TOTRF<750 mm.

P056A165
BIOCHAR FOR SUSTAINABLE AGRICULTURE

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Abstract
Biochar, also known as *black carbon,* is a product derived from organic materials rich in carbon (C) and is found in soils in very stable solid forms, often as deposits. Biochars can persist for long periods of time in the soil at various depths, typically thousands of years. The most common example is charcoal, derived from wood. Biochars are obtained through pyrolyzing biomass at temperatures above °٣٠٠C in the absence of oxygen. Degraded, dry lands and soils with poor fertility and low organic matter can immensely benefit from biochar amendments. Biochars have improved nutrient and water-holding capacities, increased fertility and productivity, and improved crop management efficiency. Additional benefits come from biochar's ability to sorb contaminants, including inorganic and organic pollutants in the soil and leaching waters, thus improving soil and water quality. Biochar production holds great promise for bioenergy, a value-added manure product, and a soil conditioner. Using biochar as a soil amendment can help sequester stable carbon in soils and combat climate change. However, responses to biochars may depend on the type of biochar used and the specific characteristics of that biochar. Because biochar characteristics determine its suitability for specific agronomic or environmental purposes, biochar production must be tailored to address such specific needs. Biochars differ from composts commonly added to soils for agricultural production in that compost is a direct source of nutrients through further decomposition of organic materials. However, biochars do not decompose with time and so additional applications should not be necessary.
Key word: Biochar, Pyrolyzing, Soil amendment, Conditioner.

P058A182
EFFECT OF DROUGHT STRESS ON QUALITY COMPOSITION IN UPLAND COTTON SEED

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Abstract
Cotton cultivars that can endure and recover from drought are needed to taken care for their biochemical seed quality traits. The experiment was conducted to determine the effect of drought stress at the boll development stage on quality characteristics of cotton seed. The study was carried out with seventeen genotypes grown under two irrigation treatments, one has no irrigations (water stress) totally dependent on rain fall and other has four irrigations (non-stress) in addition to rainfall. Seeds from both the irrigation treatment were analyzed for crude protein, crude oil, total soluble sugar, sugar profile, phenol and gossypol content. The oil, protein and gossypol content accounts for most of the value of the seed. Whole cotton seed and its meal are widely used as a nutrient source in ruminant diets. Gossypol (a polyphenolic terpene) is an anti-nutritive component of the seed that limits its feeding value in ruminant animals and completely prevents the feeding of cottonseed products to non ruminant animals. Despite continued utilization of cottonseed (*Gossypium hirsutum* L.), little information exists regarding nutrient rich with low gossypol containing cottonseed production strategies. Oil and total soluble sugar content increased by 5 and 3% respectively, under irrigated condition, whereas, about 8.5% reduction in protein content. However, the level of anti-nutrient source (Gossypol) in seed is decreased under rainfed condition. Irrigation offer potential for improved seed index yield but with altered seed composition. Given the proper economic incentives, producers could alter seed composition and can produce more competitive nutrient rich cotton seed.

P059A186
ROLE OF GLOBAL CLIMATE CHANGE FOR INDIAN AGRICULTURE AND MITIGATION

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Abstract
Recent IPCC report and several other studies indicate a probability of 10-40% loss in crop production in India and other countries of South Asia with increases in temperature by 2050 and decrease in irrigation water. India could lose 4-5 million tons wheat production with every rise of 1°C temperature throughout the growing period even after considering carbon fertilization (but no adaptation benefits). These modeling-based estimates are in line with the recent field observations. Droughts, floods, tropical cyclones, heavy precipitation events, hot extremes, and heat waves are known to negatively impact agricultural production, and farmers' livelihood. The projected increase in these events will result in greater instability in food production and threaten livelihood security of farmers. Producing enough food for meeting the increasing demand against the background of reducing resources in a changing climate scenario, while also minimizing further environmental degradation, is a challenging task. This would require increased adaptation and mitigation research, capacity buildup. Simple adaptations such as change in planting dates and crop varieties could help in reducing impacts of climate change to some extent. Additional strategies for increasing our adaptive capacity include bridging yield gaps to augment production, development of adverse climate tolerant genotypes and land use systems, assisting farmers in coping with current climatic risks through providing weather linked value-added advisory services to farmers and crop/weather insurance, and improved land and water use management and policies.

P060A187
PERFORMANCE OF SOIL HEALTH CARD PROGRAMME IN GUJARAT

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Abstract
The present study analyses various aspects of implementation of Soil Health Card (SHC) Programme in Gujarat, India. The impacts of adoption of recommended doses of fertilisers on the basis of SHC on crop productivity, fertiliser consumption pattern and farmers income have been analysed and relevant institutional problems have also been assessed. The two major crops grown in the state (groundnut and cotton) were selected for the detailed study. The household survey was administered on 400 farmers from 8 talukas of four districts (Surendranagar and Rajkot for cotton and Jamnagar and Junagarh for groundnut) of Gujarat. The study was conducted following a cluster approach on a sample of 160 control farmers (no soil test) and 240 soil test farmers. The study finds that the Soil Health Card (SHC) programme is an important and beneficial Scheme to the farmer. However, it was not implemented in proper manner in the State. In view to achieve the quantity targets fixed for some period/s, quality norms were not given proper attention which defeated the main purpose of the Scheme. The level of adoption of recommended doses by the soil test farmers was reasonably less (around 40 per cent for both cotton and groundnut groups) among the sample farmers. However, the adoption of recommended doses of fertiliser based on soil test has helped the farmers in increasing the agricultural productivity and income. The crop yield after soil tests has increased by 23.8 per cent and 22.9 per cent in case of groundnut and cotton respectively. The low adoption of recommended doses of fertilizers by the soil test farmers was due to various constraints, viz. difficulty in understanding and following application of recommended doses as stated in Soil Health Cards, unavailability of technical advice on method and time of fertiliser application, high prices of fertilisers and unavailability of required fertilisers in adequate quantity. The quality of implementation of the Scheme was badly affected due to focus on target achievement ignoring quality norms, inadequate staff strength, unavailability of required number of soil test laboratories (STLs) and mobile STLs and lack of upgradation of skills of the personnel involved in the implementation of the Scheme.
Key words: Soil Test, Soil Health Card, Recommended Doses of Fertilizer, Technology Adoption

P061A189

MITIGATION OF CLIMATE CHANGE THROUGH CULTIVATION OF DROUGHT AND HEAT TOLERANT WILD VEGETABLE SPECIES

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Abstract
Cultivated vegetable crops are subjected to a variety of abiotic stresses such as drought, temperature, salinity, air pollution, heavy metals, UV radiations, etc. Wild relatives of the domesticated crops serve as a reservoir of genetic material, with the potential to be used to develop new, improved varieties of crops. They can even be incorporated to the commercial production system during this ever changing climate scenario because of their adaptability to low input agricultural systems and nutritional composition. Now a days many breeding technologies and biotechnological advances are being used to incorporate beneficial genetic traits of wild relatives into the cultivated varieties of the crops to tackle both abiotic and biotic stresses. *S. chilense, S. pennelli, S. chessmanii* etc. are the wild species used for drought tolerance in cultivated tomato (*Solanum lycopersicon*). Crop wild relatives are vulnerable to changes in land use patterns due to growing cities and climate change. Many are at risk of extinction. Their vulnerable position is compounded by the fact that crop wild relatives fall between the agricultural and conservation agendas.

Drought stress is the major abiotic stress for many Indian states *viz.* Rajasthan, Parts of Gujarat, Haryana and Madhya Pradesh (Mitra, 2001). For the development of an improved drought tolerant high yielding variety, it is necessary that the variety should have short life span (drought escape), well-developed root system, high stomatal tolerance, high water use efficiency (drought avoidance), and increased and stabilized yield during water stress period (drought tolerance) (Kumar et al., 2012). All these characters can easily be adopted and enhanced by the use of wild relatives of the cultivated crops.

P062A191

REGRESSION ANALYSIS OF RAINFALL, MAXIMUM TEMPERATURE AND BRIGHT SUNSHINE IN RELATION TO YIELD OF GROUNDNUT FOR JUNAGADH DISTRICT IN CLIMATE CHANGE CONTEXT.

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Abstract
Climate change is now reality and changes are with different magnitudes at different levels like global, national and local in absolute term as well as in relation to the yield of any crop. The results of trend analysis of 30 years (1983-2012) yield of groundnut, rainfall, maximum temperature and bright sunshine (BSS) of Junagarh district revealed that increasing trend was observed in yield and rainfall whereas the decreasing trend was found for maximum temperature and BSS. The result of simple regression analysis of yield on rainfall, maximum temperature and BSS showed that the yield of the crop increased as the rainfall increases but it decreases as maximum temperature and BSS increases. The same results were also observed in case of multiple regression of yield of the crop on all-weather parameters with and without their quadratic terms.

P063A196
IMPACT OF CLIMATE CHANGE AND POPULATION GROWTH ON WATER RESOURCES IN INDIA

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Abstract
Water is an abundant natural resource as three-fourths of the earth's surface is covered with it, but only 2.7% of the global water available is fresh water and of this, only 30% is available to meet the water demands of the human and livestock population, both of which are increasing at an alarming rate. On 2.3% of the world's land area, India supports almost 17% of the world's population with only 4% of world's fresh water resources. The per capita water availability is decreasing day by day, it was more than 5300 m^3 in 1951, but decreased to 1905 m^3 in 1999 and is likely to be less than 1500 m^3 by 2025. The per capita availability of water less than 1700 m^3 is considered as the 'stress' level. However, studies by the Central Water Commission have predicted that per capita availability of water will go down drastically by 2050, even without considering climate change, due to population growth. The future adequacy of freshwater resources is difficult to assess, owing to a complex and rapidly changing geography of water supply and use. The rise in temperature associated with climate change leads to a general reduction in the proportion of precipitation falling as snow or rainwater, and a consequent reduction in many areas causing severe water stress. In order to minimize the adverse impacts of climate change on water resources and attaining its sustainable development and management, there is a need for developing rational adaptation strategies. In India the distribution of rainfall is highly non-uniform both in terms of time and space. As a result water is required to be stored and utilized for meeting the demands of different sectors throughout the year. Efficient water management requires sustainable development of the available surface and ground water resources and their optimal utilizations. Integrated water resources management helping to conserve water, minimize wastage and ensure more equitable distribution of water. The studies done on the impact of climate change on various aspects of water availability in India are as yet very few and far between. As knowledge is a prerequisite for managing adaptive strategies, we need to bridge our knowledge gaps in all areas that are relevant to better planning for mitigation of water stress.

P064A200
WOMEN SHGS' AMELIORATION THOURH GROUP DYNAMIC EFFECTIVE IN GUJARAT

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Abstract
Several forces are working and influencing the process of "self-help group" (SHGs) dynamics. The important personal and socio-psychological factors which are responsible for effect on SHGs dynamics need to be thoroughly undertaken and activities on sustainable basis. Hence, the study on correlates of effectiveness of group dynamics of women SHGs was taken in Junagadh district of Gujarat state. By using simple random sampling procedure, 120 members were selected for study. Statistical tool like correlation, multiple regression and path analysis were employed to draw suitable inference. The relationship of personal and socio-psychological characteristics on, Group dynamic effectiveness index (GDEI) was established in this study by simple correlation analysis. Education, Annual income, Social participation, Proactive attitude, Skill development had a positively higher significant relationship with GDEI at 1 per cent level of significant. The skill development had a highest direct effect on GDEI. It was also indicated that proactive attitude had largest indirect effect on GDEI through skill development. This article helps to manage, improve and strengthen group interaction. It is also helpful in mobilizing SHGs.

P065A206
MEASURING DECISION-MAKING AND ECONOMIC PERFORMANCE OF FARMERS TO MANAGE CLIMATE-INDUCED CRISIS IN COASTAL KARNATAKA (INDIA)

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Abstract
Climate change has shifted from being a hypothesis to being a reality. Coastal Karnataka prioritized climate variability as their primary agricultural and fishery productivity-reducing factor. The study was focus on the interaction with farmers, aiming to evaluate their decision-making and economic response to the climate change, through face-to-face interviews. The decision-making ability was significantly better from low to high crisis management groups and from marginal to big farmers. Besides, the mean decision-making ability of crisis management groups, as well as farmers' categories, varied significantly. Concerning economic performance, the benefit-cost ratio of high crisis management group was greater than medium and low crisis management groups. Studies of climate-induced crisis, therefore, must account for behavioral responses of the individuals.
Key words: Climate change, Decision-making, Economic performance, Farmers'

P066A207
THE POTENTIAL IMPACT OF CLIMATE CHANGE ON WEEDS AND CORRESPONDING INFLUENCE ON FOOD SECURITY

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Abstract
According to the IPCC, global temperatures are expected to increase between 1.1 and 6.4 °C during the 21st century and precipitation patterns will be altered. Current and projected increases in the concentrations of CO_2 and other radiatively-active gases in the Earth's atmosphere lead to concern over possible impacts on agricultural weeds. The entire weed flora would be affected by the global warming and consequent changes in precipitation, wind patterns, and frequencies of extreme weather events which may accompany the "greenhouse effect". However, only weeds are likely to respond directly to the increasing CO_2 concentration. An important question being asked is: Given that many of the most troublesome agricultural weeds are C_4 plants, will the competitive ability of these weeds be reduced relative to C_3 crops as climate change occurs? As 'colonising plants', weeds have many biological traits, including wide ecological amplitudes, which give them advantages over other plants to exploit more successfully disturbed habitat and changed environmental conditions. Also, there are a large number of C_3 weeds in the world, which may become more aggressive in many situations, under elevated CO_2 and warmer conditions. Higher CO_2 will stimulate photosynthesis and growth in C_3 weeds and reduce stomatal aperture and increase water use efficiency in both C_3 and C_4 weeds. Respiration, and photosynthate composition, concentration, and translocation may be affected. Perennial weeds may become more difficult to control, if increased photosynthesis stimulates greater production of rhizomes and other storage organs. Changes in leaf surface characteristics and excess starch accumulation in the leaves of C_3 weeds may interfere with herbicidal control. Global warming and other climatic changes will affect the growth, phenology, and geographical distribution of weeds. Under such changed climatic conditions, the likely scenario is that both C_3 and C_4 weeds will become more competitive, with potentially negative consequences for the environment, as well as agricultural productivity across different regions of the globe which have significant ramifications for food security, negating some of the otherwise beneficial effects of CO_2 'fertilization' of the C_3 world crops. It is also probable that many colonising plants will extend their bio-geographical ranges as global environmental changes occur, and weed management in the field will become more costly and difficult.
Keywords: climate change; weeds, food security; ecological weed management.

P067A208

Performance of National Agricultural insurance Scheme in Gujarat

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Abstract

India is an agrarian country and agriculture continues to be the main stay of economy providing livelihood to 2/3rd of its population. The fortune of the majority of the population depends on the agricultural output. Small and medium sized land holdings farmers with inherent lacunae like apathy of farming community towards newer technologies, unscientific post harvest management, un-organized and chaotic marketing system makes agriculture a perilous endeavor. Apart from these, it is also affected by numerous risks viz., natural, social, economic and personnel risks. Natural risks include drought, flood, cyclone, earthquake, pests and diseases (Raju and Ramesh, 2008). Farmers are also affected by social risks, viz., civil disturbances and malicious damage. In addition, farmers continue to be haunted by the economic risks in the form of price fluctuations in input and output markets. These risks are eating into the profitability of agriculture and also causing several welfare implications through forward and backward linkages of agriculture sector with other sectors of the economy. Risks in production of crops also affect the credit worthiness of the farmers (Gurudev, 2010 and Jose 2013). The aim of this paper is to analyze the status and prospects of NAIS in India, which is considered as world's largest crop insurance scheme. In this regard, crop insurance in India came into being after the launching of Comprehensive Crop Insurance Scheme (CCIS) in 1985. However, the scheme not achieved the objectives set, due to innate lacunae associated with its design. In 1999 – 2000, Government of India launched National Agricultural Insurance Scheme (NAIS) with broad objective of insuring the farmers against different categories of risks in farming. The details of NAIS along with present scenario have been analyzed in this paper. The ratio of farmers benefited to farmers covered and claims to premium is 0.26 and 2.98 respectively from 2000-01 to 2013-14 in India. Positive trend was observed in major states in terms of number of farmers covered under the scheme since its inception. However, scheme apparently seems to be successful in minimizing the risks of farming, 95 million farmer households are not being covered. Delay in settlements, huge administrative costs and lack of outreach transparency are the major constraints inherent in the NAIS. It is suggested to consider Village level /Grama Panchayat to fasten the claims settlement by simplification of procedure for revival of the scheme.

P068A209

INVESTIGATION ON VARIATION IN BIOCHEMICAL PROPERTIES OF MANGO cv. KESAR DUE TO VARIOUS ENVIRONS AND EDAPHIC CONDITIONS OF SAURASHTRA REGION (GUJARAT)

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Abstract

The present study entitled "Investigation on variation in biochemical properties of mango cv. Kesar due to various environmental and soil conditions of Saurashtra region (Gujarat)" was carried out at Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh during the year 2013-14. Saurashtra region has various ranges of topography, vegetations, mountains, sloppy areas and many other natural parameters. As Saurashtra has ten districts, in some them districts like Junagadh, Amreli, Gir-somnath, Porbandar, Bhavnagar and some extents of Jamnagar, Kesar mango is grown on commercial scale. Among these pockets some are near coastal area of Arabian Sea, whereas some pockets are surrounded or near forest area of Gir. These areas have specific climatic as well soil conditions. That's why Kesar mango of these regions has variability in its physical and bio-chemical properties. The Gir Kesar Mango was exhibited in the state as well as in the national level mango shows and received several trophies and shields. The variety has got registered Geographical Indication

under GI number-185 as Gir Kesar Mango Class-31 under on June 14, 2011 (Geographical Indications Journal-2011). A very little work has been done on the mango crop cv. Kesar in Gujarat in general and in Saurashtra in particular to study the adaptability of mango cv. Kesar at different locations. The experiment was conducted in Completely Randomized Design. In the experiment, comparatively highest values were found for most of biochemical parameters in fever of treatment L_5 (Talala) *viz.*, total sugar content (117.78 mg/g), non-reducing sugar content (87.33 mg/g), lowest acidity (0.21 %), lowest ascorbic acid content (42.46 mg/100g pulp) Whereas in treatment L_1 (Una) higher reducing sugar content (26.85 mg/g) was found. Higher sugars and lower acidity in fruits are responsible for their distinct taste (A perfect sugar: acid blend !). The myth has been proven to be real from this scientific study. From the conducted experiment over nine different locations, it can be concluded that the Talala is more congenial for mango cv. Kesar or it can be truly say that mango orchards located at/near Talala region produces better quality fruits as compared to others of Saurashtra region (L_1-L_9).

P069A215

MODELLING AND SIMULATING THE WEATHER VARIABLES ON CHICKPEA YIELD IN VALSAD DISTRICT OF GUJARAT STATE

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Abstract
Climate change is now the single gravest threat in the current century. Its impact is being intensely felt by the countries which largely depend on agriculture, and India being recognized among the worst hit countries of the world. Crop production and productivity depend on climate in general and weather in particular. The productivity of the crop depends on soil characteristics and weather conditions during season. The daily observed data (Minimum temperature, maximum temperature, minimum relative humidity, maximum relative humidity, bright sunshine hours and rainfall) were collected from the department of agrometeorogy, NAU, Navsari. The research study was undertaken to quantify the feasibility of estimating the yield of chickpea crop based on weather variables using past weather records of Valsad districts of Gujarat state. Weekly average data of weather parameters were analyzed for the crop weather relationship to develop regression model. The time trend (T) was also included as explanatory variable. The approach used for forecasting yield was original weather variables and week wise approach. For the Valsad district, the model of 13 weeks period (week wise approach) was selected. Result revealed that the model could be suggested as a pre-harvest forecast model. The variation explained by this model was 74.15% (R^2) and simulated forecast error was less than 1%. The model for Valsad district can be used for providing pre-harvest forecast three weeks before expected harvest.
Key words: Chickpea, Weather variables, Regression, Statistical model, Forecasting.

P070A219

BURL INTENSITY AND INCIDENCE IN MANGO DIVERSITY UNDER DIFFERENT AGRO ECOLOGICAL ZONES OF INDIA

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Abstract
Mango (*Mangifera indica* L.) is a national fruit of India, grown over an area of 2.4 Mha with production of 162.0 MT. Mango trees are often affected by a number of diseases and disorders, which reduce productivity and fruit quality. Recently, new woody disease, 'burl' was observed in mango growing regions of India. Burl, typically manifest as a swelling of the trunk and main branches, is a relatively unknown disease. We studied the morphology, incidence, yield loss and effect of land topography in mango cultivars. Information was also collected on the relationship

between the growth of the burl and age of the trees, together with detail of burl intensity. Mango diversity has been screened under different agro-ecological zones of India. Mango germplasm *viz*., Langra, Arka Aruna, Mahuvas, Seedling, Tree 253, Unknown-5-3, Mehmud Vikarabad, Hybrid 10, Khaja Pasand, Gopalbhog, Malai, Seedling 68 and Seedling 307 were observed most sensitive. Bathua, Sukul, Arka Punit, Olour, Rajapuri, Krishnabhog, B/L, Alphanso ×Baneshan, Alphanso × Sabja, Banganpalli, Prince, and Sindhu germplasm were also infected by this disease. The growth of burl and intensity were increases as increase in age of trees. Maximum yield loss was observed in germplasm *viz.,* Langra, Mehmud Vikarabad, Seedling 68, Sindhu, Arka Aruna, Seedling 307 and Bathua germplasm showing symptoms of elongated type burl formation with yield loss (%) as 69.61, 60, 51.47, 48.12, 36.42, 29.67 and 27.85, respectively. Similarly, orchards planted on sloppy and flat land were severely infected with large size of burls as compare to bottom land.

P071A220
EFFECT OF WEATHER PARAMETERS ON INCIDENCE OF MAJOR INSECT PEST OF BRINJAL

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Abstract
Field experiments were conducted during *Kharif* 2007 and 2008 at experimental farm, Department of Horticulture, Marathwada Agricultural University, Parbhani (Maharashtra) on well drained black cotton soil to study population dynamics of major insect pests of brinjal. Results revealed that incidence of aphids, jassids, thrips, whiteflies, epilachna beetle and brinjal shoot and fruit borer ranged from 0.20-37.70, 5.95-65.50; 0.40-12.10, 5.75-10.00; 4.10-5.00, 2.85-8.70; 0.80-35.10, 2.05-44.25; 3.20-4.60, 0.45-4.25 and 0.05-1.15, 0.05-1.25 during 2007-2008 and 2008-2009, respectively showing preponderance of aphids, whiteflies and brinjal shoot and fruit borer. Simple correlation studies between weather parameters and major insect pests of brinjal revealed significant and negative correlation of rainfall, rainy days, morning RH and evening RH with aphids and similar association was found for whitefly with rainfall, rainy days, minimum temperature and morning RH. Rainy days, minimum temperature, morning and evening RH showed significant and negative association with Brinjal shoot and fruit borer during both the season.

P072A222
ANALYSIS OF COMBINING ABILITY AND GENE ACTION IN INDIAN BEAN (*Lablab purpureus* (L.) Sweet)

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Abstract
An experiment was conducted involving 10 diverse parents and their 24 hybrids obtained by line x tester mating design laid out in randomized block design with three replications. The analysis of variance revealed presence of ample variability for fifteen quantitative traits studied. The genotypes Katargam, GP-167, GP-158 and GP-kh-64 were found to be good general combiners for one or more yield attributes. The cross combination GP-167 x Katargam exhibited highest mean values and standard heterosis over check variety Gujarat Papadi-1 for green pod yield per plant followed by GP-167 x GNIB-21 and GP-189 x GNIB-21. These hybrids had good general combining parents, high sca effects and heterotic effects over better parent as well as standard check. Both additive and non-additive gene actions played important role for the inheritance of most of the traits. While, only non-additive gene action was responsible for days to flowering, plant height, primary branches per plant,

seeds per pod and straw yield per plant. The ratio of σ^2gca / σ^2sca indicated the preponderance of non-additive gene action for all the traits except green pod yield per plant. The superior hybrids may be advanced to obtain transgressive segregants and purelines for higher green pod yield per plant. As the development of hybrid variety is not possible in Indian bean, diallel selective mating system may be adopted for improvement of remaining traits followed by some sort of biparental mating and recurrent selection.

P073A225
CLIMATE CHANGE: ERASE THE GENETIC RESOURCE FOR FOODS AND AGRICULTURE

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Abstract
Genetic resources for food and agriculture include the variety and variability of animals, plants and micro-organisms used by farmers, pastoralists, forest dwellers and fishers to provide food and non-food agriculture products and sustain the ecosystem structures, functions and processes in and around production systems. Genetic resources can play a central role in meeting the challenges of climate change to food security and nutrition, and in maintaining and improving. Climate change is also one of the key drivers of the erosion of genetic resources for food and agriculture, the raw materials that local communities and researchers rely upon to improve the quality and output of food production. The stressors and risks posed by climate change on the various sectors of genetic resources for food. The crop varieties, animal breeds or fish and forest species populations that will be required for the changing climate conditions will have to come from the existing pool of genetic resources for food and agriculture. Increased tolerance to biotic and abiotic stresses (*e.g.* heat, drought, flood, frost, rising water temperatures) will be needed and new varieties, breeds and populations adapted to higher production. However, climate change is also threatening the strategic reservoir of crop and livestock genetic resources from which to breed the varieties that will be needed to adapt production systems to future challenges. As conditions change, varieties and breeds may be abandoned by farmers and livestock keepers, and may be lost forever. Micro-organisms also play key roles in the carbon cycle. They are, therefore, vitally important to climate change mitigation efforts. Changes to temperature, moisture regimes and atmospheric CO_2 levels affect these organisms and their capacities to provide ecosystem services. However, little is known about precisely how they will be affected by climate change. The rapid advancement of genomic science and techniques of genomic selection, along with international research cooperation, efficient use of genetic resources and innovative breeding strategies, are already opening ways for coping with climate change. We imperiously need innovative breeding strategies and a more efficient use of genetic resources to increase tolerance to climate. Steps are being taken globally and in countries to ensure increased efforts for the adequate conservation and the proper use of genetic resources for food and agriculture.
Keywords: Genetic resources, Climate change, Carbon cycle, Abiotic stresses, CO_2 effect, Temperature, Moisture regimes.

P074A228
PERFORMANCE OF SUMMER GROUNDNUT (*Arachis hypogaea* L.) UNDER DRIP IRRIGATION AT DIFFERENT PLANT GEOMETRY

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Abstract
The field experiments were conducted for consecutive three years to assess the crop performance and economics of drip irrigation along with three levels drip system and four levels of plant geometry with surface irrigation as control for groundnut during summer season of year 2010-11to 2012-13 at the Main Oilseeds Research station, Junagadh Agricultural University, Junagadh. The results revealed that alternate day drip irrigation at 100 % of cumulative pan evaporation(CPE) recoded highest

pod yield(2623 kgha^{-1}), haulm yield(4725 kgha^{-1}), oil yield(915 kgha^{-1}) and yield attributing characters with 3.89 kg ha^{-1} mm^{-1} water use efficiency. Among the drip system highest net return (60024 □ ha^{-1}) and B:C ratio (2.38) obtained by drip irrigation at 100% CPE and magnitude of increase in pod yield over border strip irrigation at 1.0 IW/ CPE ratio was to the tune of 18.0 per cent. Border strip irrigation recorded lower pod yield (2221 kgha^{-1}), haulm yield (3841 kgha^{-1}) and oil yield (723 kgha^{-1}) with net return (57275 □ ha^{-1}) and B: C ratio (2.91). The drip irrigation at 60% CPE found better one having the highest water use efficiency of 5.01 kgha^{-1}mm^{-1}. Also, in case of deficit water conditions (60% of CPE) the drip was not that profitable**.** Significantly maximum pod yield of 2670 kgha^{-1} was recorded by the conventional sowing (row to row: 30 cm) with one lateral to each row. One lateral between two rows in conventional system layout found more economical (net return, 61401 □ ha^{-1}) and cheaper in terms of capital investment (B:C ratio, 2.55).

P075A229
CARBON SEQUESTRATION THROUGH AGROFORESTRY SYSTEMS - A NEED MORE THAN OPTION

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Abstract
The importance of agroforestry systems as carbon sinks has recently been recognized due to the need of climate change mitigation. Agroforestry, the practice of introducing trees in farming has played a significant role in enhancing land productivity and improving livelihoods in both developed and developing countries. Although carbon sequestration through afforestation and reforestation of degraded natural forests has long been considered useful in climate change mitigation, agroforestry offers some distinct advantages. The planting of trees along with crops improves soil fertility, controls and prevents soil erosion, controls water logging, checks acidification and eutrophication of streams and rivers, increases local biodiversity, decreases pressure on natural forests for fuel and provides fodder for livestock . It also has the ability to enhance the resilience of the system for coping with the adverse impacts of climate change.

The fact that agroforestry systems can function as both source and sink of carbon. There is also clear evidence to suggest that the type of agroforestry system greatly influences the source or sink role of the trees. For example, agrisilvicultural systems where trees and crops are grown together are net sinks while agro silvipastoral systems are possibly sources of GHGs. Practices like tillage, controlled burning, manuring, application of chemical fertilizers and frequent soil disturbance can lead to significant emissions of GHGs . According to the IPCC agroforestry systems offer important opportunities of creating synergies between both adaptation and mitigation actions with a technical mitigation potential of 1.1-2.2 PgC in terrestrial ecosystems over the next 50 years. Additionally, 630 Mha of unproductive croplands and grasslands could be converted to agroforestry representing a carbon sequestration potential of 391,000 MgC/yr by 2010 and 586,000 MgC/yr by 2040. The carbon in the aboveground and belowground biomass in an agroforestry system is generally much higher than the equivalent land use without trees (i.e. crop land without any trees). (Murthy *et al*. 2013)

A growing interest in the role of different types of land use in reducing atmospheric CO2 (CO2 atm) concentration and lowering the emissions rate of this greenhouse gas (GHG), has led to an increased research on the function of forestry and agroforestry systems as carbon sinks. Tropical deforestation and forest degradation are considered to be an important source of GHG contributing to 17.4% of the global emissions (IPCC 2007); the use of fire in agriculture is also an important driver of climate change, especially in the tropics (Canadell and Raupach, 2008). Undoubtedly, forests are the main land-based CO2 sinks (Houghton *et al.* 2001). However, it is difficult to determine how and to what extent forest carbon sinks and reservoirs may be managed to mitigate CO2atm (Canadell and Raupach, 2008). In this context, further research is needed to be able to select areas of priority and adequate land-use practices in order to reduce effectively emissions caused by deforestation and at the same time that could provide additional benefits (Miles and Kapos, 2008).

P076A231
GENETIC ARCHITECTURE FOR YIELD AND ITS COMPONENTS IN BRINJAL (*Solanum melongena* L.)

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Abstract
The present investigation was carried out with a view to study the *per se* performance, magnitude of heterosis, combining ability and gene action through diallel analysis excluding reciprocals involving eight parents and their twenty eight F_1s in brinjal. The experimental material was planted in randomized block design with three replications at College farm, Navsari Agricultural University, Navsari during late *Kharif* 2014. Among the parents, only GBL-1 recorded as the best performing parents for fruit yield per plant. Cross combinations *viz*., PLR-1 x GBL-1, PLR-1 x Doli-5, KS-224 x Doli-5 and PLR-1 x GJB-2 recorded significant heterosis over local check Surati ravaiya, which can be used for further breeding programme. The general combining ability effects revealed that only parent GBL-1 was the good general combiner for fruit yield and was also found good general combiner for fruit length, fruit weight, total soluble solids and total sugar. The hybrids GJB-3 x GOB-1, PLR-1 x GOB-1, KS-224 x GJB-2, KS-224 x GBL-1, Pant rituraj x Doli-5 and Pant rituraj x GOB-1 were found good in respect of sca effects for fruit yield per plant, which involved poor x average, average x good and average x average gca effects. In the present study majority of the characters govern by both additive and non-additive type of gene actions. However, predominant role of sca variance was noticed, suggesting the suitability of heterosis breeding programme for improving these traits. In crop like brinjal, development of open pollinated varieties is also given importance. Hence, the additive and non-additive gene actions could be utilized through recurrent selection by intermating the most desirable segregants followed by selection. Multiple crosses and bi-parental mating might also prove to be effective alternative approaches.

P077A234
PRODUCTION TECHNOLOGY OF CUCUMBER UNDER CHANGED CLIMATIC CONDITIONS

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Abstract
Cucumber (*Cucumis sativus* L.) is one of the most important cucurbitaceous vegetable crop grown extensively in tropical and sub-tropical parts of the country Cucumber is a thermophilic and frost susceptible crop species, growing best at a temperature above 20°C. In the recent years, due to changing climatic conditions in the country, production and quality of most vegetable crops have been directly and indirectly affected by high temperatures and exposure to elevated levels of carbon dioxide and ozone. In general, the vegetables those require hot temperatures to grow, have faster growth and better quality as the temperatures rise until it reaches the growth inhibition limit (35°C). The temperature in the hilly as well as in the plain regions of the country is increasing rapidly due to global warming, which has resulted in poor yield and reduced quality of cucumber. Rise in the temperature during summer months has affected the sex expression, flowering, pollination and fruit setting in cucumber. Extremely high temperatures can even cause early flower drop in cucumber. Moreover, exposure of cucumber plants to heat stress during fruit development stage causes bitterness of fruits. Various other climatic factors like humidity, rainfall, light intensity etc. also affect the normal growth and development in cucumber if they are not provided in optimum range during the growing season. The important strategies/techniques developed to overcome the adverse effects of climate change on cucumber production like, Improved varieties, Use of grafting techniques, Protected cultivation is very effective. Cucumber under open fields is grown in two seasons, one in summer and second in rainy season. During winter season, it cannot be grown under open field conditions. Keeping in view the abiotic stresses in changing climate under open field, production technology of cucumber has been developed and standardized for cultivation under two types of protected structures namely, naturally ventilated greenhouse and insect-proof net house. The yield of cucumber in protected structures can be increased as compared to their open field cultivation.

P078A240

EFFECT OF IRON ON GROWTH PARAMETERS CONTRIBUTING IN INCREASING PRODUCTION EFFICIENCY OF CHICKPEA (CICER ARIETINUM L.)

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Abstract

Chickpea (*Cicer arietinum* L.) also known by different names in various countries, such as gram, bengal gram, chana, pois, hoos, hommos, grao-de-beco and garbanzo. Among the pulses, chickpea is a most important *rabi* crop with high acceptability and wider use (Singh, 2011). Micronutrient malnutrition affects more than half of the world population particularly in the developing countries (Alloway, 2008) and in particular Fe and Zn deficiency in human nutrition are wide- spread in developing Asian countries including India. Iron is the most important micronutrient for chickpea crop. Fe is present at high quantities in soils but its availability to plants is usually low and therefore Fe deficiency is common problem (Nozoye *et al*., 2011). Iron plays an important role in synthesis and maintenance of chlorophyll in plant. It helps in the formation of chlorophyll and it is an important constituent of the enzyme nitrogenase, which is essential for nitrogen fixation (Yadav *et al.,* 2002). The results of experiment conducted at Department of Agronomy, Junagadh Agricultural University, Junagadh during *rabi* 2014-15 indicated that growth parameters *viz*. plant height, dry matter accumulation at 90 DAS and at harvest, branches per plant, number and dry weight of root nodules per plant increased significantly with the increase in iron levels up to 4.0 kg Fe ha^{-1} whereas significant response was obtained up to 6.0 kg Fe ha^{-1} in dry matter accumulation at 60 DAS.

P079A242

FARMING UNDER URBAN LANDSCAPE FOR CLIMATE RESILIENCE: A REVIEW

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Abstract

Majority of the urban landscape is composed of building and with the expansion of urban area, buildings are also on a rise. According to UN report, 30 % of the global annual green house gas emissions and consumption of 40 % of all energy is done by the building sector alone. With another report they have also shown concern of expansion of urban area where 70 % of global population will be living in urban area in 2050. To reduce the GHG levels, building can do a better part by mandating the rule of green buildings which is getting accepted in many of the countries in a phenomenal way. However, concept of green building mainly comprises of the plants which are having additional benefit of beautification and not for consumption. With the rising population which is expected to reach 9 billion in 2050 and reduction in the farming land has made it important to produce food along with reduction in the GHG to feed the rising population. This review comprises different ideas (*viz.* Roof top gardening, indoor farming, farming on the lawns, kitchen gardening at public areas, hydroponic cultivation, etc.) on how an urban area can be utilized for the production of food along with reduction of the urban emissions which stands at par with the idea of green buildings.

P080A244

EFFECT OF CLIMATE CHANGE ON LIVESTOCK PRODUCTION

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Abstract

In pastoral and agro-pastoral systems, livestock are key assets for poor people, providing multiple economic, social, and risk management functions. The impacts that climate change will bring about are expected to exacerbate the vulnerability of livestock systems and to reinforce existing factors that are simultaneously affecting livestock production systems such as rapid population and economic growth, increased demand for food and products, increased conflict over scarce resources. For rural communities losing livestock assets might lead to the collapse into chronic poverty with long-term effects on their livelihoods. Major impacts on vector-borne diseases: Expansion of vector populations into cooler areas (in higher altitude areas: malaria and livestock tick-borne diseases) or into more temperate zones (such as bluetongue disease in northern Europe). Changes in rainfall pattern may also influence expansion of vectors during wetter years, leading to large outbreaks of disease. Climate change may affect trypano tolerance in sub-humid zones of West Africa: could lead to loss of this adaptive trait that has developed over millennia and greater disease risk in the future. To respond to this threat it will be necessary to focus on both mitigation, to reduce the level of emission of gases contributing to global warming, and adaptation, to support local communities deal with the impacts. At present, very few development strategies promoting sustainable agriculture and livestock related practices have explicitly included measures to support local communities to adapt to or mitigate the effects of climate change. Activities aimed at increasing rural communities resilience will be necessary to support their capacity to adapt and to respond to new hazards.

Key words: Livestock, Climate change, Sustainable Agriculture, Risk, Management.

P081A245

CLIMATE RESILIENT VEGETABLE PRODUCTION SYSTEM FOR NUTRITIONAL AND FOOD SECURITY – A REVIEW

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Abstract

Vegetables play a crucial role in ensuring food and nutritional security, but they are highly perishable and their prices rise fast under situations like droughts or floods, putting them out of reach of the poor. The ever altering patterns of climatic parameters like changes in precipitation patterns, rise in atmospheric temperature, excess UV radiation and increased incidences of extreme weather events like droughts and floods are becoming major threats for vegetable production in the tropical zones of the world (Tirado et al., 2010). Under changing climatic situations crop failures shortage of yields reduction in quality and increasing pest and disease problems are common and they render the vegetable cultivation unprofitable. To mitigate the adverse impact of climatic change on productivity and quality of vegetable crops there is need to develop new adaptation strategies. Development of genotypes that are more tolerant to high temperature, moisture stress, salinity and climate proofing through conventional, non conventional breeding techniques, genomics and biotechnology etc. are essentially required to meet these challenges and to develop climate resilient vegetable crops. For reducing malnutrition and alleviating poverty in developing countries through improved production and consumption of safe vegetables will involve adaptation of current vegetable systems to the potential impact of climate change. To mitigate the adverse impact of climatic change on productivity and quality of vegetable crops there is need to develop sound adaptation strategies. The emphasis should be on development of production systems for improved water use efficiency, adaptability to the hot and dry condition to that will ultimately lead to nutritional and food security of the nation.

P082A247
FOOD SECURITY THROUGH THE LENSES OF LAW

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Abstract
"Food is essential for living as air is for breathing"

Global warming and climate change have numerous effects on the environment but the grey area that alters and suffers the most is food production and food security. One of the most significant challenges of the 21st century is to achieve global food security which feels threatened by rapid climate change and therefore to make available sufficient food for the increasing population while sustaining the already stressed environment is a major dilemma that all Nation States are presently facing worldwide.

According to United Nations Food and Agriculture Organization (FAO) food security exists 'when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life'. Consequently it can be understood food security rests on the three pillars of: Food availability where sufficient quantities of food available on a consistent basis, Food access where sufficient resources are available to obtain appropriate foods for a nutritious diet and Food use where appropriate use of food is made based on knowledge of basic nutrition and care, as well as adequate water and sanitation.

This paper would address the multiple effects that global warming and climate change could have on food production and food security, the profound impact that climate change has on the agricultural activities engulfing within its domain the severe impact on the flora and fauna. Further, it would also address how affirmative action can help in achieving the interplay of ample food production with stable and reliable access of food to everyone so as to achieve one aspect of food security globally.

Furthermore, in India, as a large chunk of the population stays below poverty line; the issue of food insecurity subsists and is an issue of key significance for India because it then again brings out the other challenge of malnourishment in public health. India to curb food security has enacted an all-inclusive legislative framework National Food Security Act, 2013 but its success still needs to be explored.

Through the lenses of law, this paper would address the role so played by the legislature to ensure food security and also the challenges that India is facing at present. Moreover, this paper would also address issues like whether it's necessary to have an enacted legislation i.e. whether Food Security Act is necessary for India? Whether the right to food can be considered as a Fundamental Right under the ambit of Indian Constitution? Can it be claimed against the State? And finally whether this act is self sufficient in finding a solution for this global issue of food scarcity and poverty?

P083A248
JURISPRUDENTIAL STUDY ON CLIMATE CHANGE WITH SPECIAL EMPHASIS ON INDIAN CONSTITUTION.

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Abstract
The increasing concern over climate change has gained momentum in the recent times. The world nations are very much concerned over tackling the excessive emissions of Green House Gases (GHGs) locally as well as globally. In this paper the researcher attempts to explain the causes for climate change, impacts of climate change in the environment and the ways to curb the excessive emissions of Green House Gases (GHGs). Further, an effort has been made to analyze the difficulties in combating climate change in the context of various international and local laws. Proceeding further, the environmental aspects enshrined in the Indian Constitution are explained in this paper. The researcher would also touch upon the steps taken by the Government of India in addressing climate change coupled with the current issues on climate change such as El-Nino effect, carbon emission, carbon trading etc. This paper shall shed light over the positive (alternate) utilization of Green House Gases (GHGs) such as carbon capture, methane capture etc. Energy sector in India is the major source of Green House Gases

(GHGs) followed by industry sector, agricultural sector, waste sector and hence this paper shall delve upon the effective management of energy and agricultural sectors with respect to climate change. Moving forward, the researcher attempts at elaborating the concept of climate change on the lines of economical aspects of the country. The aftermath of erratic climate such as farmer's suicide, soil infertility and the reasons for shrinkage in cultivable area in India are addressed by the researcher in this paper. This research paper further traces the landmark judgments delivered by the Hon'ble Supreme Court of India, High Courts of the states in India and National Green Tribunals of India in the context of 'Environmental Jurisprudence'. Lastly, the researcher attempts to provide his views on the 'Compensatory Afforestation Fund Bill, 2016' in the light of CAMPA Funds and suggestions for combating climate change such as levy of a special tax called Environment Protection Cess (EPC), strengthening of environmental laws, switching over to biofuels, Sustainable Development, plantation of trees which can absorb more CO_2 etc.

Key words: Green House Gases (GHGs) – El-Nino effect – Environmental Jurisprudence – Sustainable Development – CAMPA – Biofuels.

P084A252

LONG TERM EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON YIELD ANDCARBON MINERALIZATION UNDER GROUNDNUT-WHEAT CROPPING SYSTEM IN MEDIUM BLACK CALCAREOUS SOIL

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Abstract

The effect of integrated nutrient management (INM) on active pools of soil organic carbon (SOC) under groundnut-wheat cropping sequence of a Haplustepts soil was studied in a long-term field experiment initiated during *kharif*1999 at Junagadh, Gujarat. Effect of varying doses of N, NP, NPK with FYM, Zn, S and *Rhizobium* on yield and carbon mineralization after 12[th] year of groundnut-wheat crop sequence was studied. Application of 50% NPK + FYM @ 10 t $ha^{-1}$to groundnut and 100% NPK to wheat significantly increased the yield and carbon mineralization. The carbon mineralization fraction ascribed highly significant positive relationship with organic carbon (r=0.793**) and groundnut haulm yield (r=0.0.635**).Significant positive relationship with wheat grain yield (r=0.577*). The highest per cent depletion of carbon mineralization noted 66.8 % in T_4, lowest depletion occurred 48.3 % in treatment T_8.Integrated use of FYM with chemical fertilizers or use of FYM alone exerted significant effect on the carbon mineralization of soil organic carbon.

P085A254

CLIMATE CHANGE: A CURSE FOR GLOBAL WATER IMBALANCE

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Abstract

Water is valuable not only for domestic uses, but also for its role in supporting aquatic ecosystems and environmental amenities, including recreational opportunities, and as a factor of production in irrigated agriculture, hydropower production, and other industrial uses. Water security is the key challenge under climate change as it is highly vulnerable to continuously changing climatic patterns. Climatic change is a phenomenon, we can no longer deny as the year 2015 has been hottest since 1992. the climatic system and the hydrological cycle are strongly connected with each other. The largest changes in the hydrological cycle are predicted for the snow-dominated basins of mid to higher latitudes due to global warming but more importantly, because of the important role of snow in the water balance. Of all ecosystems, freshwater ecosystems will have the highest proportion of species threatened with extinction due to climate change. The average global temperature may increase by 1.4-5.8 °C and there would be substantial reduction in fresh water resources and agricultural yield by the end of the 21[st] century. Approximately 75% of the Himalayan glacier are on retreat and will disappear by 2035. Moreover in Africa

(Sub-Saharan Africa) by 2050, the rainfall could drop by 10%, which would reduce drainage by 17%. Increasing atmosphere concentration of greenhouse gases, mainly carbon dioxide, have led to a warming at the surface, by nearly 0.6 ^{o}C during the 20th century and it is widely believed that this trend will continue in the 21th century, leading to higher sea surface temperature resulting in higher vapour pressure difference between the sea surface and the adjacent atmosphere. This would enhance the evaporation rate and hence, imbalance hydrologic cycle. Climate change and reforestation can contribute to a decrease in river discharge but before 2070, the largest impact can be expected from a shift in rainfall due to decadal-scale climate variability. Intergovernmental Panel on Climate Change has stated that climate change has been a scourge for water imbalances as greenhouse warming affects water planning and evaluation include changes in precipitation and runoff patterns, sea level rise, land use and population shifts and changes in water demands.

Keywords: Climate change, global water, hydrological cycle, global warming, reforestation, greenhouse gases, population shifts.

P086A260

EFFECTS OF CLIMATE CHANGE ON AGRICULTURE A CASE STUDY IN DELHI REGION, INDIA

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Abstract

Climate is the primary important factor for agricultural production. Concerning the potential effects of climatic change on agriculture has motivated important change of research during the last decade. Climate change would have a major impact on the hydrological cycle and consequently on available water resources, the potential for flood and drought, and agricultural productivity. The main interests are findings concerning the role of human adaptations in responding to climate change, possible regional impacts to agricultural systems and potential changes in patterns of food production. A key to reducing these uncertainties is improved understanding of the relative contributions of individual factors. We evaluated uncertainties for projections of climate change impacts on crop production specifically, we focused on the relative contributions of two factors climate model projections of future temperature and precipitation, and the sensitivities of crops to temperature and precipitation changes. Surprisingly, uncertainties related to temperature represented a greater contribution to climate change. We conclude that progress in understanding crop responses to temperature and the magnitude of regional temperature changes are two of the most important needs for climate change impact assessments and adaptation efforts for agriculture. In this study, the impacts of climate change on the agricultural water cycle and their implications for agricultural production. The forecasting of future precipitation can be considered by using the outputs of the General Circulation Models (GCMs) based on CMIP5. In the study, a downscaling strategy was improved to forecast monthly precipitation and temperature over Delhi region for climate change scenarios. Finally, the simulation results were examined to assess the possibility of climate change effect on precipitation and temperature in the study area.

Keywords: Climate Change, Agriculture, General Circulation Models (GCMs), Temperature.

P087A261
INTEGRATED NUTRIENT MANAGEMENT IMPARTS THE CLIMATE CHANGE

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Abstract
Agriculture is the backbone of national income as well as the whole country population will depends on this, nation development has to be mainly measure on the basis of agriculture development and its production, because it only the source of supplying raw materials for the industries and only the source for the food supply without this we can not be survive on the earth, so that has to be considering here that with increasing production in tremendous manner farmer can implementing the many changes in the agriculture. As the present day agriculture is considering, which has to be fully depending upon the inorganic source of inputs which will directly impairing on the soil climate which reduces environmental quality as well as soil quality. It has consider that to minimize effects of this at optimum level with aim of increasing the food production as economically and sustainably with the maintaining the soil climate and environment. To this context we can be Introduce organic and inorganic inputs in integrated way which will balance the ill effect of inorganic inputs on soil environment in optimum level . organic sources which are beneficially increasing the soil quality in many directions and which also well compatible with inorganic sources. The present day growing population which is near to touching sky so the problem of hugerness is increasing in maximum level, so the problem can be mitigate in sustainable manner. The main organic sources which we are includes in the farming are bio-fertilizers, FYM, Green manure, vermi-compost etc,. and inorganic sources are chemical fertilizer, livestock feed stuffs, compost, blood meal, raw bone meal etc,. the integrated farming , integrated nutrient management, and integrated pest management also have to be included in this context to improve climate of soil. As we are considering climate change which is changing day by day by the cause of faulty agriculture practices and policies. To consider of global warming which contributes in unhealthier environmental effect so this can be mitigate by the organic agriculture with minimum use of inorganic inputs. This type of farming not only increasing food production and income it also maintaining climate change in significant manner with sustainable manner.

Key words: Organic source, inorganic source, sustainable agriculture and climate change.

P088A264
INCREASED INCIDENCES OF MICROBIAL CONTAMINATION AND DISEASE OUTBREAK IN FRESH VEGETABLES DUE TO CLIMATE CHANGE - A REVIEW

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Abstract
The popularity in the consumption of fresh and fresh-cut vegetables continues to increase globally. Fresh vegetables are an integral part of a healthy diet, providing vitamins, minerals, antioxidants and other health-promoting compounds. The diversity of fresh vegetables and packaging formats (spring mix in clamshell container, bagged heads of lettuce) support increased consumption. Unfortunately, vegetable production and processing practices are not sufficient to ensure complete microbial safety. This review highlights a few specific areas that require greater attention and research. Selected outbreaks are presented to emphasize the need for science-based 'best practices'. Laboratory and field studies have focused on inactivation of pathogens associated with manure in liquid, slurry or solid forms. As production practices change, other forms and types of soil amendments are being used more prevalently. Information regarding the microbial safety of fish emulsion and pellet form of manure is limited. The topic of global climate change is controversial, but the potential effect on agriculture cannot be ignored. Changes in temperature, precipitation, humidity and wind can impact crops and the microorganisms that are associated with production environments. Climate change could potentially enhance the ability of pathogens to survive and

persist in soil, water and crops, increasing human health risks. Limited research has focused on the prevalence and behaviour of viruses in pre and post-harvest environments and on vegetable commodities. Globally, viruses are a major cause of foodborne illnesses, but are seldom tested for in soil, soil amendments, manure and crops. Greater attention must also be given to the improvement in the microbial quality of seeds used in sprout production. Human pathogens associated with seeds can result in contamination of sprouts intended for human consumption, even when all appropriate 'best practices' are used by sprout growers.

With the developing temperament of health consciousness and healthy living, the demands of fresh vegetables has dramatically increased globally. Fresh vegetables contain higher amounts of antioxidants. These antioxidants include vitamins C and E, folic acid, lycopene, alpha-carotene and beta-carotene. Vitamins C and E neutralize free radicals and protect your body cells. Consumption of fresh produce is part of a healthy diet, but serious public health consequences has been resulted due to contamination of the fresh produce. This contamination is most prominently seen recently in vegetable crops like tomatoes, spinach, lettuce and seed sprouts. There is no exception for the fresh vegetables that can be contaminated by foodborne pathogens. Globally, the number of outbreaks and cases of foodborne illness associated with the consumption of contaminated produce continues to escalate (Critzer and Doyle, 2010; Teplitski *et al*., 2011; Hoelzer *et al*., 2012). Processing of Fresh and fresh-cut vegetables are not done effectively enough to eliminate pathogens that can harm human. Changes in precipitation, humidity, temperature and wind can affect crops and the microorganisms that are associated with production environments. Climate change could potentially enhance the ability of pathogens to survive and persist in soil, water and crops, increasing human health risks. In India, in the last decade the disease scenario of many crops like cowpea, cluster bean and pigeon pea has changed drastically; dry root rot (Rhizoctonia bataticola) of chickpea and Phytophthora blight (Phytophthora drechsleri f. sp. cajani) of cowpea have emerged as a potential threat to the production of these crops.The transfer, prevalence and survival of enteric pathogens in soil amendments, soil, agricultural water and on crops may individually or collectively be influenced by climate change or geographic location (Liu *et al*.,2013). Implication of new guidelines and regulations for proper vegetable processing and handling can bring about improvements in the microbial safety of fresh vegetables, along with this continued research to support development of 'best practices' for production and processing of fresh and fresh-cut vegetables to improve the microbial quality and safety of those commodities can greatly reduce the pathogen outbreak in vegetable crops in this scenario of climate change.

P089A269

POPULATION OF MAJOR NATURAL ENEMIES IN *BT* COTTON GROWN IN VADODARA DISTRICT

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Abstract

To combat the sucking insect pests, farmers generally reliance on synthetic insecticides indiscriminately in *Bt* cotton. As a results, it will effect may be on the population of natural enemies and environment too. A project "National Information System for Pest Management (*Bt* cotton)" was sponsored by NCIPM (ICAR), New Delhi during 2008-09 to 2012-13 to monitor the natural enemies prevailing in *Bt* cotton grown in Vadodara district. During this period, two *Bt* cotton fields in each villages were selected and the population of coccinelids (Grubs and adults), chrysopids (eggs) and spiders were recorded at weekly interval from the 20 randomly selected plants. The data recorded on the population was also uploaded in websites 'ncipm.org.in' regularly. Higher activity of coccinelids was recorded 43^{rd} to 2^{nd} Standard meteorological Week (SMW). As far as eggs of chrysopids is concerned, more or less it was observed throughout the study period (0.02 to 0.33 eggs/plant). Spiders, a universal predator was also recorded throughout the study period cotton grown in Vadodara district. Although, comparatively higher activity was observed during 42^{nd} to 50^{th} SMW (0.36 to 0.83/plant).

P090A274

A PLANT BIOTECHNOLOGY AND BIODIVERSITY

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Abstract

Advances in plant biotechnology provide new options for collection, multiplication and short- to long-term conservation of plant biodiversity, using in vitro culture techniques. Significant progress has been made for conserving endangered, rare, crop ornamental, medicinal and forest species, especially for non-orthodox seed and vegetatively propagated plants of temperate and tropical origin. Cell and tissue culture techniques ensure the rapid multiplication and production of plant material under aseptic conditions. Medium-term conservation by means of in vitro slow growth storage allows extending subcultures from several months to several years, depending on the species. Cryopreservation (liquid nitrogen, −196 °C) is the only technique ensuring the safe and cost-effective long-term conservation of a wide range of plant species. Cryopreservation of shoot tips is also being applied to eradicate systemic plant pathogens, a process termed cryotherapy. Slow growth storage is routinely used in many laboratories for medium-conservation of numerous plant species. The diversity of life at all three organisational levels, genetic, species and ecosystem, is thus being rapidly modified by modern man. This is a great loss to future generations who will follow us. Today, the large-scale, routine application of cryopreservation is still restricted to a limited number of cases. However, the number of plant species for which cryopreservation techniques are established and validated on a large range of genetically diverse accessions is increasing steadily.

Keywords: biotechnology; conservation; plant biodiversity; in vitro collecting; slow growth storage; cryopreservation; endangered species.

P091A281

ORGANIC FARMING IN INDIA: STRATEGY FOR CLIMATE CHANGE MITIGATION

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Abstract

Organic farming have attracted increasing attention world over due to the wide adverse effects of conventional agriculture practices on human diet, environment and sustainability of agricultural production. The growing health concerns and increasing non-tariff barriers like Sanitary and Phyto-sanitary (SPS) measures in the international market, coupled with non-viability of modern farming on a small scale, are some of the factors behind the move from chemical based to organic production and consumption systems. In most of the major organic product markets such as the industrialized countries, demand for organic products far outstrips domestic supply, and therefore imports are required to fill the gap. Thus, organic agriculture offers trade opportunities for farmers in the developing and developed countries. The global demand for organic food which was worth US $ 54.9 billion in 2009 increased to US $ 80 billion in 2014. India as of now is emerging as a very important player in the global organic sector. Organic farming, mainly for export markets, has made significant progress in many parts of India. As in other parts of the developed and developing world, Organic farm production and trade has emerged as an important sector in India and is seen as an important strategy of facilitating sustainable development. Organic farming systems can also help to mitigate and adapt to climate change in a number of ways, such as (a) use of nitrogen fixing legumes and manures in place of manufactured fertiliser; (b) increased greenhouse gas efficiency through mixed farming systems; (c) less fossil energy use; (d) carbon sequestration and (e) agro-forestry. the food and agriculture organisation of the united nations regards organic agriculture as an effective strategy for mitigating climate change and building robust soils that are better adapted to extreme

weather conditions associated with climate change5. The IPCC's Fourth Assessment Report also recommends the use of practices which are standard in Organic Agriculture for mitigating climate change. Organic Agriculture optimally combines these different practices in a systematic manner and sustains agricultural production in source limited regions.

P092A282
FLORICULTURE: A VIABLE OPTION OF DIVERSIFICATION IN CLIMATE CHANGE

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Abstract
Flowers being most sensitive part of a plant is expected to be affected most by the climate change. The impact of climate change on flowering plants and crops will be more pronounced. Indigenous species in the natural habitat will be under threat for not getting favourable agro-climatic conditions for their proliferation. Most of the flower crops are grown under protected; therefore change in climate may not affect the global floriculture. But in India, commercial production of flowers particularly grown under open field conditions will be severely affected leading to poor flowering, improper floral development and colour besides reduction in flower size and short blooming period. That's why flower farming is a major problem to cultivation, due to the higher temperature (climate change) and for that protected cultivation is one of the best option to most of the burning issues by facing Indian floriculture for the varying climate condition and climate change. Higher concentration of CO_2 increase the flowering productivity but many pests and fungi are thrive during warmer temperature so, protected cultivation is another way to farmer for cultivated under controlled condition. Carbon dioxide levels of 800–1,800 ppm have proven to be optimal for the majority of flower crops grown under protected cultivation. CO_2 concentrations increased then most of the flower crops are responding positively by the enhanced rates of photosynthesis and biomass production. Floriculture, as an intensive farming under protected conditions, is often not affected by the outside temperatures. With increasing climatic vagaries, flower crops grown under protected conditions may prove to be one of the safest cultivations to overcome the climate change. Protected cultivation minimizes the effect of pests and diseases. In our country most of the farmer is small holders and they mainly suffer from the climate change for those farmer greenhouse farming technology has made a complete business opportunity. Compare to traditional farming it requires less water and less labour cost with higher yield return. Therefore, this article is written to aware about impact of climate change on floral farming with its mitigation and remedies.

P093A283
COMPARATIVE PERFORMANCE OF BIVOLTINE SILKWORM HYBRIDS FOR DIFFERENT ECONOMIC TRAITS UNDER LATUR (MAHARASHTRA) CONDITION

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Abstract
The present investigation was carried out for the comparative performance of bivoltine silkworm hybrids for different economic traits. The result revealed that out of ten silkworm races, KPG-A x CSGRC-3 and KPG-B x CSGRC-3 was found superior for economic traits studied. Significantly highest hatching percentage (94.02 %), larval weight (44.82 g), single cocoon weight (1.87 g), single shell weight (0.42 g), shell ratio (22.55 %), filament length (1021 m) and cocoon yield per 10,000 larvae brushed (18.48 kg), were recorded by bivoltine silkworm hybrid KPG-A x CSGRC-3. The fecundity was recorded significantly superior by NB-1 x KPG-B (508.96) over the rest of the hybrids followed by KPG-B x CSGRC-6 (482.66) whereas, NB-1 x KPG-A was showed lowest (432.0) fecundity.

P094A287

ASSOCIATION OF VARIOUS PHYSICAL FACTORS ON ACTIVITY OF APHID, *Uroleucon compositae* (THEOBALD) INFESTING GAILLARDIA GROWN AT DIFFERENT PERIODS

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Abstract

To establish the association between various physical factors on fluctuation of aphid, *Uroleucon compositae* (Theobald) infesting gaillardia transplanted at different period, a field experiment was carried out at Agronomy farm, B. A. College of Agriculture, AAU, Anand during 2013-14. The infestation of *U. compositae* commenced from 14th and 12th Week After Transplanting (WAT) in the crop transplanted during 3rd week of October and 1st week of November, respectively and recorded comparatively higher population. The crop transplanted during 1st week of November suffered the most from this pest. The pest appeared on 10th WAT in the crop transplanted during 3rd week of November and 1st week of December. The initiation of pest was observed from the 9th WAT in the crop raised during 3rd week of December and 1st week of January. The peak activity of the pest was noticed during 25th WAT and 23rd WAT (141.00 and 160.96 aphids/ 10 cm terminal twig, respectively) in the crop transplanted during 3rd week of October and 1st week of November, respectively while it was during 22nd week in the crop transplanted during 3rd week of November (126.00) and 20th week in the crop transplanted during 1st week of December (111.96). The activity of pest reduced afterwards. Crop succumbed due to heavy infestation of aphid when it was transplanted during 3rd week of October and 1st week of November. While looking to correlation coefficient, there was highly significant and positive association of Bright Sunshine Hours (BSS), Maximum Temperature (MaxT), Minimum Temperature (MinT) and Morning Vapor Pressure (VP_1) in all the transplanting periods whereas, highly significant and negative association with Morning Relative Humidity (RH_1) and Evening Relative Humidity (RH_2) except in the crop transplanted during 3rd week of December and 1st week of January. However, Wind Speed (WS) exerted significant and positive association with the incidence of pest in the crop transplanted during 3rd week of October, 1st and 3rd week of November as well as 1st week of January. Evening Vapor Pressure (VP_2) was positively associated with the pest but failed to exert significant effect on activity of the pest.

P096A290

QUANTIFY THE RELATIONSHIP OF METEOROLOGICAL PARAMETERS FOR WHITE FLY (*Bemisia tabaci*) POPULATION OVER COTTON (*Gossypium* spp.)

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Abstract

Experiment conducted at university research farm of Cotton Section, Department of Genetic and Plan Breeding, CCS HAU Hisar, Haryana, India and field area situated adjacent to agrometeorological observatory at Lat.: 29^0 10' N, log.: 75^0 46' E and 215.2 meters altitude of observation to recorded at *Gossypium* spp. in Kharif season from 2006 to 2014 and white fly weekly population was collected at weekly interval (26th to 43rd SMWs) over the cotton plant, selected three leaves per plant for the white fly population count (average white fly population 12.32/3 leaves/season) with meteorological parameter as T_{max} 32 °C, T_{min} 23.9 °C, average wind speed 5.9 km/hr, evaporation 5.56 mmday^{-1}, rainfall, net short wave radiation 2.55 MJm^{-2} day^{-}1, the highest was 3.0 MJm^{-2}day^{-}1 and lowest 2.3 MJm^{-2} day^{-}1, net radiation, rainy days, crop rainy days, seasonal rainfall, accumulated rainfall and annual rainfall found negative correlation with white fly population but RH_m and RH_e, bright sunshine hours. Radiation component was computed with used of empirical formulation during crop seasons. The weather parameters shows the significant negative or positive correction as well as different rate as increase and decreases with the white fly population from the emergence/establishment stage to picking of cotton.

Key Words: White fly population, weather parameters, radiation component, correlation, weather interaction

P097A294

PROTECTED CULTIVATION AS A TOOL AGAINST CLIMATE CHANGE

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Abstract

In last past 10 years temperature has increased and rainfall has decreased significantly; it is directly affecting the productivity of the crops, so to produce more yield from same piece of land and from available water, farmers need to switch on protective cultivation for optimum utilization of agricultural resources round the year without any significant effect of climate change. A survey was carried out to study the reason for success and unsuccess of green house in middle Gujarat condition. On the basis of study it was found that successful farmers have sufficient knowledge and curiosity for cultivation practices of suitable crops for green house, they were also maintaining proper book records and had attained training programme as well as regular visited the other green houses and agricultural university. While, unsuccessful farmer were lack of proper knowledge about cultivation practices of crops, market and they were not spending time for farming because they have other source of income.

P098A295

ASSESSMENT OF ACCURACY OF MEDIUM RANGE WEATHER FORECAST AT JUNAGADH

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Abstract

The medium range weather forecast issued by NCMRWF and IMD for South Saurashtra agro climatic zone, Junagadh for the last 20 years (1996 to 2015) has been analysed and verified for its accuracy. The results revealed that the usability of rainfall (ratio score and HK score) was higher and better in pre monsoon, post monsoon and winter seasons, indicating accurate and successful forecasting. However, during monsoon period, the accuracy of rainfall forecast varied from 28.80 % to 90.00 % in different years. The critical examination of the results revealed that the usability (%) was comparatively less in high rainfall years than in the low rainfall years. The maximum temperature forecast was very good in all the seasons except the summer season, whereas the minimum temperature was excellent in monsoon season, good in pre monsoon and post monsoon seasons but poor in winter season. The wind speed forecast was very good and excellent in all the seasons. The performance of wind direction forecast was satisfactory for this region. From the forgoing results it has been observed that the usability, accuracy and reliability of dominant weather parameters in a particular season for example (maximum temperature in summer season, rainfall in monsoon season and minimum temperature in winter season) were comparatively less.

Key words: Medium range weather forecast, Rainfall, Maximum, minimum temperature, wind direction and speed, usability and RMSE.

P099A307

RESPONSE OF *KHARIF* AND *RABI* CROPS TO UREA PHOSPHATE FOR APPLICATION IN PEARLMILLET-WHEAT CROPPING SYSTEM IN *Typic Ustochrepts* SOIL OF ANAND DISTRICT, GUJARAT

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Abstract

The field experiment was conducted during 2011-14 to study the "Response of *Kharif* and *rabi* crops to urea phosphate for application in pearlmillet- wheat cropping system" at Agronomy Farm, B.A. College of Agriculture, AAU, Anand. The soil of the experimental plot was loamy sand, alkaline (pH: 7.85), low in electrical conductivity (EC 1: 2.5, 0.16 dSm^{-1}) and low in organic carbon (0.40%), medium in available P_2O_5 (40.84 kg ha^{-1}) and K_2O (210 kg ha^{-1}). The five treatments viz., T_1: Recommended NPK dose, T_2: RDF +2% DAP spray at pre flowering and 15 days after 1st spray, T_3: RDF +2% urea phosphate spray at pre flowering and 15 days after 1st spray, T_4: 75% RDF + 2% DAP spray at pre flowering and 15 days after 1st spray, T_5: 75% RDF + 2% urea phosphate spray at pre flowering and 15 days after 1st spray. The treatments were tested in randomized block design with four replications. The results revealed that the significantly highest grain yield (1147 kg ha^{-1}) was observed with treatment T_3 (RD- NPK 80:40:00 $kgha^{-1}$ + two spray of 2 % urea phosphate) being at par with T_2, T_4 and T_5 treatments on pooled basis. In individual years, the treatments were found significant in second and third years. On pooled basis, treatments T_2: RDF +2% DAP spray at pre flowering and 15 days after 1st spray and T_3 (RDF +2% urea phosphate spray at pre flowering and 15 days after 1st spray) gave maximum fodder yield (5579 kg ha^{-1}) which was at par with treatment T_4. The plant height and length of ear head were found non-significant due to different treatments in all the years as well as on pooled basis. The effects of different treatments were found significant for grain and straw yield in the year 2011-12 only. The significantly maximum grain (2917 kg ha^{-1}) and straw (7211 kg ha^{-1}) yield was recorded due to T_4 (75% RDF + 2% DAP spray) being at par with T_5 (75% RDF + 2% UP spray) in 2011-12 It was found non-significant in remaining years as well as on pooled basis. Plant height and spike length were non-significantly affected due to different treatments in all the years as well as on pooled basis. The N, P and K content in pearlmillet plant were significantly influenced by foliar spray of fertiliser treatments. The significantly highest N and P content was recorded before first and second spray with treatment T_2 : RDF +2% DAP spray at pre flowering and 15 days after 1st spray as compared to control (T_1). Whereas K content was found non-significant in both foliar sprays. In case of wheat, the N, P and K content in wheat were found significant due to first spray and second spray treatments on pooled basis except K in second spray. Significantly highest value of N, P and K content were recorded under treatment T_2 : RDF +2% DAP spray at pre flowering and 15 days after 1st spray in first and second spray. The significantly highest uptake of N (19.54 kg ha^{-1}), P (4.43 kg ha^{-1}) and K (3.62 kg ha-1) by pearlmillet were recorded under treatment T_3 (RDF +2% urea phosphate spray at pre flowering and 15 days after 1st spray) and significantly highest uptake of P (20.42 kg ha^{-1}) was recorded under T_2 : RDF +2% DAP spray at pre flowering and 15 days after 1st spray, whereas N and K uptake by fodder were found non-significant. The significantly highest N uptake (45.23 kg ha^{-1}) by wheat was recorded under T_3 which was on par with T_2 & T_4 and significantly highest K uptake (11.54 kg ha^{-1}) was recorded under T_5 which was at par with T_2, T_3 & T_4. The P uptake by grain was differed non-significantly due to different treatments. The significantly highest P uptake (12.29 kg ha^{-1}) was recorded under T_2 on pooled basis which was at par with T_3, T_4 and T_5. The N and K uptake by wheat straw were found non-significant due to different treatments. The effect of different treatments on soil organic carbon and available P_2O_5 was significant in years 2011-12 & 2013-14 and 2013-14, respectively, but soil nutrients status after harvest of pearlmillet was found non-significant on pooled basis. The maximum net income (Rs.16050/ha) and BCR (1.34) recorded in T_4 (75% RDF + 2% DAP spray at pre flowering and 15 days after 1st spray) followed by treatment T_5 (75% RDF + 2% urea phosphate spray at pre flowering and 15 days after 1st spray) with net income of Rs. 13899/ha and BCR of 1.29 in pearmillet – wheat crop sequence. The significantly highest value were noticed for organic carbon (0.47%), total N (874 kg ha^{-1}) and K_2O (288 kg ha^{-1}) after harvest of wheat with T_1 treatment on pooled basis. The treatments T_3 (RDF + 2 % UP spray) recorded significantly highest available P_2O_5 (37.88 kg ha^{-1}) on pooled basis. From the results, it could be concluded that foliar application of 2% DAP or 2% urea phosphate at pre flowering and 15 days after 1st spray along with 75% RDF (Pearlmillet 60:30:00, Wheat 90: 45:: 00) gave higher yields of pearlmillet and wheat in crop sequence besides net income and net return

as compared to application of RDF (NPK only) to both the crops. The nutrients content in pearlmillet and wheat were also increased due to supplementation of nutrients both through soil and foliar application. The 25% reduction in fertilizer addition will helps in reduction in incurring inputs and soil pollution too. Moreover foliar application as low cost technology will also helps in getting higher crop yields in pearlmillet – wheat crop sequence.

P100A308

EFFECT OF DIATOMACEOUS EARTH AS A SOURCE OF SILICON ON YIELD AND CHEMICAL COMPOSITION OF BT COTTON IN SANDY CLAY LOAM SOIL OF MIDDLE GUJARAT

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Abstract

The field experiments conducted to study "Diatomaceous earth as a source of Silicon in Bt cotton under middle Gujarat condition" during the 2012-13 & 2013-14 at Agricultural Research Station on Irrigated crops, AAU, Thasara (Gujarat). The soil of the experimental site was slightly alkaline in nature, low organic C & DTPA-Zn and medium in available P_2O_5 & SO_4-S and high in available K_2O status. The treatments comprised of T_1: Control (Absolute), T_2: Package of practice (POP) , T_3: ½ POP, T_4: POP + DE @ 150 kg ha^{-1}, T_5: POP + DE @ 300 kg ha^{-1}, T_6: POP + DE @ 600 kg ha^{-1}, T_7: ½ POP + DE @ 150 kg ha^{-1}, T_8: ½ POP + DE @ 300 kg ha^{-1}, T_9: ½ POP + DE @ 600 kg ha^{-1}, T_{10} : 300 kg DE alone ha^{-1}. The seed cotton yield of Bt cotton was significantly influenced by an application of DE as a source of silicon. Among the different levels of DE with POP (T_4 to T_9) treatments were found significantly superior over T_1 (Absolute control) and T_9 (DE @ 300 kg ha^{-1}) also. The comparison of treatments (T_2 with T_4, T_5 & T_6) indicated that significant effect of T_6: POP + DE @ 600 kg ha^{-1} was observed on seed cotton yield over 100% POP (T_2). Whereas comparison of treatments (T_3 with T_7, T_8 & T_9) indicated that significant effect of T_9: POP + DE @ 600 kg ha^{-1} was noticed on seed cotton yield over ½ POP (T_3). The overall response of DE application was 107, 161 and 323 kg ha^{-1} in seed cotton yield at 150, 300 and 600 kg DE ha^{-1}, respectively. The growth and yield attributes of cotton revealed that the highest number of balls/plant and plant height of Bt cotton were recorded in T_6 : POP + DE @ 600 kg ha^{-1} followed by T_9 :**½ POP + DE @ ٦٠٠ kg ha**$^{-1}$. The chlorophyll content of Bt cotton increased due to POP+DE treatments at 60 DAS growth stages of Bt cotton. The application of DE @ 300 kg ha^{-1} was not efficiently improved the nutrients content in Bt cotton, while in case of nutrient content in seed cotton, P, K, S and micronutrients content were significantly affected due to higher dose of DE application i.e. 600 kg ha^{-1} along with POP. The DE application @ 300 and 600 kg ha^{-1} along with POP or ½ POP helps in improving the available N, P_2O_5, K_2O, SO_4-S and micronutrients (Fe, Mn & Zn) at the harvest. The overall results showed that comparison of treatments (T_2 with T_4, T_5 & T_6) had significant effect of T_6: POP + DE @ 600 kg ha^{-1} was observed on seed cotton yield over 100% POP (T_2). Whereas comparison of treatments (T_3 with T_7, T_8 & T_9) indicated that significant effect of T_9: POP + DE @ 600 kg ha^{-1} was noticed on seed cotton yield over ½ POP (T_3). Therefore, application of ½POP + DE @ 600 kg ha^{-1} helps in increasing cotton yield and thereby reduce 50% of chemical fertilizer (POP) which will help in cost reduction and soil pollution too and for getting higher economic return.

P101A309

BIO-EFFICACY OF BOTANICAL AND MICROBIAL INSECTICIDES FOR THE CONTROL OF TEAK SKELETONIZER, *Eutectona machaeralis*, INFESTING ON TEAK IN ANAND REGION

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Abstract

A field study of bio-efficacy of various botanicals and microbial insecticides against Teak skeletonizer, *Eutectona machaeralis* Walker, infesting on Teak were studied during 2006 and 2007 at Medicinal and Aromatic farm, Anand Agricultural University, Anand. The insecticides *viz,* neem seed kernel extract (NSKE) 5%, azadirachtin 0.0006%, eucalyptus leaf extract (ELE) 5%, castor leaf exract (CLE) 5%, lantana leaf extract (LLE) 5%, ardusa leaf extract (ALE) 5%, naffatia leaf extract (NLE) 5%, biosoft 2% and biolep 2% were evaluated. The insecticides evaluated based on per cent healthy and damage leaves were recorded from 5 twigs and number of larvae per twig. The observations were recorded before spraying and 1, 3, 7, 14, 21, 28, 35 and 42 days after spraying, respectively. The result on the comparative bio-efficacy of different botanical and microbial insecticides against *E. machaeralis* on Teak showed that biolep 2%, azadirachtin 0.0006%, biosoft 2%, LLE 5% and NSKE 5% were found to be the most effective for the control of this pest under field conditions. Whereas, ALE 5%, NLE 5%, ELE 5% and CLE 5% were found comparatively less effective against *E. machaeralis*.

P101A310

SULPHUR AND MOLYBDENUM EFFECT ON NUTRIENT CONTENT AND UPTAKE OF *KHARIF* FORAGE COWPEA (*Vigna unguiculata* (L.) Walp.)

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Abstract

The field experiment was conductedto find out the “sulphur and molybdenum effect on nutrient content and uptake of *kharif* forage cowpea (*Vigna unguiculata* (L.) Walp.)”. The experiment was laid out in factorial randomized block design, comprising sixteen treatments combinations of four levels each of S (0, 20, 40 and 60 kg ha^{-1}) and Mo (0, 0.5, 1.0 and 1.5 kg ha^{-1}), which were replicated four times. The application of S and Mo at varying levels did not significantly modify N, P and K contents of forage cowpea, while the uptake of N and K by S levels and P uptake in Mo levels was significantly affected. The sulphur @ 60 kg ha^{-1} and Mo @ 1 kg ha^{-1} registered significantly the highest values for N and P uptake, respectively, while K uptake under S_{60} was on par with S_{40}. The increase in N and K uptake under S_{60} over control was 14.5 and 18.6 % respectively, while P uptake was 13.7 % over Mo_0 and $Mo_{1.0}$.

The S content and uptake by forage cowpea were significantly higher under S_{60} and S_{40} (0.15 %) than rest of the levels, while Mo content and uptake were non-significant due to S levels. However, molybdenum application significantly changed content and uptake of both S and Mo. Among different levels, $Mo_{1.5}$ and $Mo_{1.0}$ were at par with regard to S content and uptake as well as Mo uptake, but Mo content was significantly the highest under $Mo_{1.5}$. The improvement in S content and uptake under $Mo_{1.0}$ was to the extent of 7.7 and 16.2 % over control, respectively. The increase in Mo content and uptake under $Mo_{1.5}$ was 99.2 and 101.1 % over $Mo_{0,}$ respectively. The interaction effect of sulphur and molybdenum did not shown significant in N, P, K content and uptake.

P103A009
EFFICIENCY OF C5 (*B. cereus*) FOR REDUCTION IN COD OF DAIRY WASTE EFFLUENT

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Abstract
Pilot scale aerobic treatment plant with air pressure 6 kg/cm^3 was made in which all the conditions were similar to the main aerobic plant of any dairy industry. The COD (Chemical oxygen in Demand) of the control effluent i.e. without aeration decreased from 588.5 mg/l to 147.75 mg/l on 7th day while the effluent with C5 decreased the COD load from 588.5 mg/l to 38.75 mg/l on the 7th day. It was observed that C5 showed 50.68 % COD reduction, 44.07 % BOD (Biochemical oxygen in Demand) reduction, while pH increased from 6.7 to 8.54 also 44.06 % increase in TDS (Total Dissolved solids) was seen after 24h of aeration.
Key Words: Pilot scale, air pressure, effluent, TDS.

P104A011
SCREENING OF PROMISING GENOTYPES FOR BLAST DISEASE RESISTANCE IN RICE (*Oryza sativa* L.) OVER ENVIRONMENTS

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Abstract
The rice blast disease often causes a significant yield loss, as high as 70-80% during an epidemic. It has been found in over 85 countries across the world. Utilization of genetic resistance is the most effective and economical way of controlling blast disease. But, in addition to affecting rice production, climate change may alter pathogen dissemination and development rates, and modify the resistance, growth and metabolism of host plants. The geographical distributions of pathogens are very likely to change, and losses can be expected, in part due to altered effectiveness of control strategies. Thus climate change is a serious threat to agriculture because it can lead to significant changes in the occurrence and severity of plant diseases. Hence, field evaluation of 48 promising segregating generations of rice was undertaken in epiphytotic condition at Main Rice Research Station, AAU, Nawagam during *Kharif*-2012 and *Kharif*-2013 to study their resistance to blast disease. Many number of entries were identified as moderately resistance. Genotype GR-7xCRMAS-2231-36/8-4-1-1-1 was found resistant for neck blast for both the seasons. The genotype IR-28xIET-16804/4-1-1-1-1,2 found to be moderately resistant for both the diseases in both seasons which revealed its stability for resistance against blast disease.

P105A037

DEVELOPMENT OF FINGERPRINTS AND THEIR UTILIZATION IN SEED GENETIC PURITY ASSESSMENT OF FLAX (*Linum Usitatissimum* L.) CULTIVARS OF CHHATTISGARH STATE OF INDIA

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Abstract

Fingerprinting with molecular markers allows precise and rapid variety identification. The present investigation was carried out with the following objectives: (i) to identify informative SSR marker allele(s) for fingerprinting popular flax cultivars cultivated in Chhattisgarh state of India, and (ii) to validate the utility of the genotype specific SSR markers in seed genetic purity assessments. A set of 38 SSR markers located across the 30 chromosomes of flax were used for fingerprinting the selected flax cultivars, out of which 28 SSR markers were observed to be informative enough to distinguish the cultivars considered in the study. A set of two SSR markers (LU 1 and LU 7) exhibited unique alleles for four flax cultivars (Kartika, Deepika, Indira Alsi 32 and RLC 92) and could serve as molecular IDs (Identities) for these cultivars. To validate the utility of the SSR markers in genetic purity assessment, certified seed lots of Kartika, Deepika, Indira Alsi 32 and RLC 92 were assessed for their genetic purity using both SSR marker analysis and 18 morphological characters in a grow-out test (GOT). The impurities detected in the SSR marker analysis were 2-3% higher as compared to those detected based on morphological characters in GOT. The results indicated practical utility of the molecular markers in assessing the genetic purity of the flax cultivars.

P106A040

ROLE OF DAIRY INDUSTRY IN ARENA OF CLIMATE CHANGE

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Abstract

At the time of independence milk production in India was only 17 million tones per annum. Today India has become number one in milk production, producing more than 127 million tones per annum with approx. 20% of the total milk production is handled by the organized sectors. Dairy and food industries are fast growing industries and day-by-day newer technologies are being introduced to get better quality of foods. Use of conventional energy is common practice for major processing of milk. At present all most all dairy operations are performed using grid supply which is generated by conventional fuel.The all conventional fuel emits greenhouse gases which leads to climate change. To fight against global warming, remove greenhouse gases from the earth or reduction in production of them is very essential.

The use of non-conventional energy in dairy industry is the best idea to avoid climate change and their effects on environment. Solar energy, wind energy, tidal energy etc. are non-conventional energy which are renewable and green energy reduce the generation of greenhouse gases in environment. The use of non-conventional energy in dairy industry in various unit operation such as heating, cooling etc. help the earth from burning.

P107A064

EFFECT OF DIFFERENT GROWING MEDIA ON GERMINATION, SEEDLING GROWTH OF PAPAYA (*Carica Papaya* L.) CV. MADHU BINDU

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Abstract

The study was carried out to study the effect of growing media on germination and seedlings growth of papaya (*Carica papaya* L.). For germination, five types of media and were studied. The result showed that the treatment T_8 (M_1+M_4)i.e. Control + Cocopeat (3:1) took significantly minimum days (7.00 days) for initiation of germination with significantly maximum seed vigour index-II (1.04) at 15 DAS, germination count (34.33 and 37.33), seed vigour index-I (1007.08 and 2114.42) at 15 and 30 DAS, respectively and root : shoot ratio (weight basis) (0.152 and 0.186) at 30 and 45 DAS, respectively, while significantly maximum number of leaves (6.92), vigour index-II (13.73), relative growth rate (0.163 g/day) at 30 DAS, length of seedlings (12.09 cm and 23.73 cm), length of tap root (4.65cm and 8.28 cm), fresh weight (0.173 g and 1.417 g) of seedling as well as dry weight of seedling (0.0125 gand 0.1630 g) at 15 and 30 DAS , respectively was recorded in the treatment T_{11} (M_2+M_4) i.e. Vermiculite + Cocopeat (3:1). Whereas, the treatment T_{13} (M_3+M_4) i.e. Sphagnum Moss + Cocopeat (3:1) recorded significantly maximum seedling length (50.06 cm), number of leaves (11.50), fresh weight of seedling (9.10 g), dry weight of seedling (1.10 g), length of tap root (19.40 cm), RGR (1.09 g/day),vigour index-I (4797.85) and vigour index-II (105.58) at45 DAS, number of roots (6.62, 8.67 and 13.70) at 15, 30 and 45 DAS, respectively and number of leaves (23.17 and 28.20) as well as height of seedling (61.50 cm and 75.80 cm) in field at 30 and 45 DAT, respectively. Significantly maximumgermination count (38.67) of papaya seeds at 45 DAS, was noted in treatment T_{15} (M_4+M_5) i.e. Cocopeat + Vermicompost(3:1).

P108A065

IDENTIFICATION OF DIFFERENTIALLY EXPRESSED GENES IN ROOTS AND SHOOTS OF MAIZE GERMPLASMS FOR DROUGHT TOLERANCE

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Abstract

Among the different cereal crops grown in India maize is the third most important food grain after rice which however is affected by various abiotic stresses during its crop period of which drought is the most prominent one. In India, area affected by drought is 42-45% out of total maize grown area and loss in yield is 20-30%. Plants respond to water stress by biochemical and physiological modifications that may be involved in tolerance or adaptation mechanisms. In maize, roots are most important for plant adaptation to soil water deficits, (Turner 1979). However, the responses of maize roots to drought stress, especially at molecular level, have not been fully understood. Maize is most susceptible to stress at flowering, when silk growth, pollination, and kernel set occur (Shaw, 1977). The susceptibility of early developing grain to water stress is a major problem in maize where a shortage in assimilate supply has been indicated as the likely cause for insufficient grain filling and/or sterility (Boyer and Westgate, 2004). Significant difference for drought tolerance among maize germplasms implicates the hope of improving production of maize varieties under drought stress (Fu *et al.*, 2008).

Transcriptional analysis can be used to identify genes induced/repressed in drought stress. By comparing them to genes which are upregulated or downregulated during drought stress through a comparative analysis of the drought transcriptome can reveal genes that are important for the regulation of drought physiological responses, signalling and resistance. Alternatively the genes which are reported for root development (*rtcs, scr* etc) and root system development (*rth*1, *rth*2 etc) can be validated in the drought tolerant/resistant maize genotypes. Identification of differentially expressed genes in roots and shoots of maize germplasm will provide a key insight to drought tolerance mechanisms operating in the maize genome. Analysis of gene

expression using *Arabidopsis* whole genome microarrays on drought resistant genotypes and a drought susceptible wild type will reveal the detection of several drought resistance associated genes. Identification of putative orthologs of these genes responsible for drought tolerance in maize will facilitate understanding of the molecular mechanisms of drought tolerance. This information about genes will facilitate development of drought resistant/tolerant maize genotypes through marker-assisted selection or gene transformation.

P109A085
EFFICIENT IRRIGATION SCHEDULE, SEED RATE AND SOWING METHOD FOR MAXIMUM WHEAT YIELD UNDER SEMI-ARID INCEPTISOLS

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Abstract
Effective irrigation scheduling to manage water requirement for wheat (*Triticum aestivum* L.) was studied with four treatments of water application (I_1: Irrigations at Crown root initiation + Tillering + Jointing + Flowering; I_2: Irrigations at CRI + Tillering + Jointing + Flowering + Milking; I_3: Irrigations at CRI + Tillering + Jointing + Flowering + Milking + Dough; and I_4: Irrigations at 0.8 IW:CPE ratio) in combination with two seeding rates (125 and 150 kg ha^{-1}) and two sowing methods (line sowing at 22.5 cm and broadcasting) during 2010 and 2011. Observations were recorded on plant height, leaf area, dry matter, total tillers, effective tillers, length of spike, number of spikelets/spike, number of grains/spike, 1000 grain weight, grain yield, straw yield, harvest index, plant population, protein content and field water use efficiency in each year. The plant height, dry matter and leaf area significantly increased with an increase in the irrigation frequency. The irrigation treatments of I4: Irrigation scheduled at 0.8 IW:CPE ratio and I3: Crown root initiation (CRI) + Tillering + Jointing + Flowering + Milking + Dough stage gave significantly higher grain and straw yields (5361 and 6535 kg ha^{-1}) compared to providing irrigation at 4 or 5 critical growth stages. Seed rate @ 150 kg ha^{-1} gave significantly higher number of plant population and taller plants. Dry matter accumulation/plant increased with a decrease in the seed rate from 150 to 125 kg ha^{-1} at 30 and 45 DAS. Higher seed rate of 150 kg ha^{-1} gave significantly higher grain and straw yield compared to 125 kg ha^{-1}. Among sowing methods, maximum leaf area and dry matter accumulation/plant were produced under line sowing. Line sowing gave significantly higher grain yield compared to broadcasting method. The grain and straw yield, protein content and field water use efficiency were significantly correlated with different plant traits observed during the crop growth period. Based on ranking of treatments and rank sum criteria adopted for the observations recorded on different plant traits in the two years, I4 + line sowing + seed rate @ 150 kg ha^{-1} was efficient with lowest rank sum of 68 for attaining maximum growth of plant traits and sustainable wheat yield under semi-arid Inceptisols.

P110A091
MICROALGAE - A MULTIDIRECTIONAL TOOL TO COMBAT WITH CLIMATE CHANGE

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Abstract
Global warming is recognized as the world's biggest environmental challenge. Carbon dioxide emitted from burning of fossil fuels is responsible for over half the warming potential of all greenhouse gases (GHG). The processes involving CO_2 capture

and storage are gaining attention as an alternative for reducing CO_2 concentration in atmosphere. In the global effort to combat the climate change, several CO_2 sequestration technologies are deliberated. However, these technologies are considered as short-term solutions, as there are still concerns about the environmental sustainability of these processes. In order to achieve environmental and economic sustainability, a renewable, carbon neutral fuels are required that are also capable of sequestering atmospheric carbon dioxide. A promising technology could be the biological capture of CO_2 using microalgae due to its incomparable advantages over higher plants. Photosynthetic efficiency of microalgae ranged from 10–20 % in comparison with 1–2 % of most terrestrial plants and one kilogram of algae (dry) can absorb carbon dioxide up to 1.83 kilogram per year. Algae are used as food, feed, fodder, fertilizers, fuel and pharmaceuticals. Besides carbon sequestration, microalgae can be used for production of biofuels which can replace fossil fuels so that it will provide environmental and economic dual benefits.
Key word: Greenhouse gas, carbon sequestration, fossil fuel, microalgae, biofuel.

P111A099
INTER-RELATIONSHIPS BETWEEN RAINFALL DISTRIBUTION AND GROUNDNUT YIELD IN BHAVNAGAR AND JUNAGADH DISTRICTS OF GUJARAT STATE

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Abstract
Groundnut crop in Saurashtra region of Gujarat is predominantly grown as rainfed crop in kharif season. The year to year fluctuation in the crop yields are mainly attributable to the variation in rainfall and its distribution. In order to study Inter-Relationships between rainfall distribution and groundnut yield in Bhavnagar and Junagadh districts of Gujarat State, correlation and regression techniques were employed. The district-wise average yield data of groundnut and daily rainfall data were used over a period of 44 years i.e. from 1970-2014. Five broad approaches were tried to study the Inter-Relationships between rainfall distribution and groundnut yield. They were (1) Aggregate rainfall (2) Monthly rainfall (3) Fortnightly rainfall (4) Week-wise rainfall and (5) Crop phase-wise rainfall. In general it could be inferred that sufficient rainfall at flowering and peg initiation crop stage was most critical for groundnut yield in both the districts.

P112A100
WEB-BASED IRRIGATION SCHEDULING SYSTEM

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Abstract
To optimize production and minimize adverse environmental impacts on an agricultural field, it is crucial to apply irrigation water at the right time and in the right quantity. This can be ensured by good irrigation scheduling. Irrigation scheduling involves deciding when and how much water to be applied to a field. Bad scheduling, practice such as not enough water applied, more than the required water applied or water not applied at the right time, results in under-watering or over-watering, which can lead to reduced yields, lower quality and inefficient use of nutrients. The efficiency of water in agricultural production is generally low. Only 40% to 60% of the water is effectively used by the crop and the rest of the water is lost in the system or in the farm by evaporation, runoff, or percolation into the groundwater. Irrigation scheduling, if properly managed can offer a good solution to improve water efficiency in the farm. Irrigation Scheduling System is a multi-lingual web based application for farmers and researchers to generate an easy and scientific date-wise irrigation schedule and check crop's water needs in real time by using the moisture accounting method, which takes climate, soil and crop properties into consider web-based Irrigation Scheduling System.

P113A101
EMPOWERING AGRICULTURAL EXTENSION WITH RS & GIS INFORMATION

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Abstract
In order to strengthen sustainable agriculture, agricultural extension is nourished since decades. Last two decades belongs to ICT and it is assisting all most all sectors including agriculture. ICT revolution impact was felt with invasion of Mobile phones. For imparting cutting edge information and knowledge to the farmers' assorted modes are availed by NGO's, Agriculture Universities, government and even private sector in India. Best options today is bombarding information on farmers' mobile via short message service (SMS) or WhatsUP. To disseminate timely related and required cognitive updated knowledge in an inferable form to each individual farmers' is still a big issue. To increase knowledge and ultimately sustainability of farmers, this paper proposes an innovative method of dissemination of timely precise information via SMS by integrating information from Remote Sensing (RS) & Geographical Information System (GIS).

P114A102
SUCCESSION OF MAJOR INSECT PESTS IN OKRA, *ABELMOSCHUS ESCULENTUS* (L.) MOENCH

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Abstract
The field experiment was carried out to study the succession of major insect pests in okra at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *kharif* 2014, summer, 2015 and *kharif* 2015. Leafhopper population showed two peaks with highly significant positive association of Bright Sunshine Hour (BSS) (r = 0.72**) and maximum temperature (MaxT) (0.70**) during *kharif*, 2014. Whereas, during summer, 2015 and *kharif* 2015; it was noticed with two peaks. The population aphid showed two peaks during *kharif*, 2014. During summer, 2015 aphid population showed highly significant negative association with BSS (r = -0.72**). The incidence of whitefly remained low during all three seasons. The highest activity of mites was recorded during 3rd week of October, 4th week of May and 2nd week of September during *kharif* (2014), summer (2015) and *kharif* (2015), respectively. Temperature (minimum and maximum), BSS and wind speed (WS) were the important abiotic factors affected on the fluctuation of mites population. The activity of mealybug was recorded only during *kharif*, 2015 with highly significant positive association of BSS (r = 0.77**) and significant negative association of WS (-0.62*). Fruit damage caused by *Helicoverpa armigera* (Hubner) Hardwick showed highly significant negative association with WS (r = -0.73**), MinT (-0.78**) and RH_2 (-0.83**) whereas, BSS (0.77**) and MaxT (0.74**) revealed highly significant positive association during *kharif* (2014). During *kharif* (2015), MinT (-0.70*) exerted significant negative association. The activity of *Earias vittella* Fab. as fruit borer was observed in all the seasons. Correlation study revealed that BSS (r = 0.88**) and MaxT (0.86**) exhibited highly significant positive impact whereas, WS (-0.75**) and RH_2 (-0.90**) had highly significant negative association during *kharif*, 2014. During summer (2015); BSS (0.83**), WS (0.74**), MaxT (0.79**) and MinT (0.85**) showed highly positive significant association with the fruit damage. The activity of spiders, a universal predator was seen in all the three seasons. MaxT, MinT, BSS and WS are important physical factors interfered significantly on the activity of spiders in okra. During *kharif*, 2014; *Scymnus* sp. showed highly significant association with mites (0.99**) and spiders revealed highly significant association with aphid (0.77**). During *kharif*, 2015; coccinellids showed significant positive association with aphid (0.88**).

P115A114
IMPACT OF METEOROLOGICAL FACTORS ON ACTIVITY OF MAJOR INSECT PESTS IN TOMATO, *Lycopersiconesculentum* MILL. UNDER MIDDLE GUJARAT CONDITION

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Abstract
Investigation on succession of major insect pests in tomato was carried out at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *Rabi* season of two consecutive years (2012-13 and 2013-14). Whitefly population was commenced from 40th SMW during 2012-13 with two peaks during 45th SMW (4.52/ 3 compound leaves) and 48th SMW (3.88), whereas the population was noticed from 39th SMW during 2013-14 with three peaks, 42nd SMW (0.92), 47th SMW (1.52) and 51st SMW (3.12). Aphid population was noticed from 42nd SMW during 2012-13 with three peaks, 45th SMW (0.40/ 3 compound leaves), 48th SMW (0.96) and 52nd SMW (0.72), whereas during 2013-14, the population was observed from 46th SMW and showed gradual increasing trend till 50th SMW (1.44). Infestation of leaf miner was commenced from 41st SMW and 38th SMW during 2012-13 and 2013-14, respectively. Larval population of leaf miner exhibited two peaks, 44th SMW (1.12) and 48thSMW (1.08) during 2012-13, whereas, maximum larval population was noticed during first fortnight of December *i.e.*49th and 50th SMW in 2013-14. The activity of *Helicoverpa armigera* was commenced from 41st SMW and 39th SMW during 2012-13 and 2013-14, respectively. Larval population of *H. armigera* was recorded in the range of 0.08 to 2.56/ 3 twigs and 0.24 to 1.92/ 3 twigs, respectively. The population of leaf hopper, mealybug and natural enemies was minimum throughout the crop season during both the years.

Correlation study was also carried out to find out impact of physical factors on the activity of insect pests. Evapotranspiration on egg population of *H. armigera*(r = -0.635*), larvae (-0.738**) and aphid (-0.772**);bright sunshine on whitefly (0.557*) and *H. armigera* egg (0.527*); morning wind direction on *H. armigera* egg population (-0.545*), whitefly (-0.591*), aphid (-0.732*) and leaf miner (-0.702**); evening wind direction on both egg (-0.789**) and larva (-0.617*) of *H. armigera* and leaf miner (-0.654**); wind speed on leaf miner (-0.632**); minimum temperature on whitefly (-0.696**), aphid (-0.776**) and leaf miner (-0.689**); evening relative humidity on whitefly (-0.527*), leaf miner (-0.675**), *H. armigera* larvae (-0.509*) and spiders (-0.619*); morning vapour pressure on whitefly (-0.687**) and leaf miner (-0.709**) and evening vapour pressure on whitefly (-0.679**), leaf miner (-0.698**) and *H. armigera* larvae (-0.496*) were found key abiotic factor and influencing significantly on the fluctuation of the pests. Further, there was positive association between/ among the insect pests activity in tomato. Spiders, a universal predator was in co-existence with the population of *H. armigera* and aphid, pests of tomato.

P116A135
IMPACT OF CLIMATE CHANGE ON GROUND WATER RESOURCES IN INDIA

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Abstract
Global climate change is not a new phenomenon. Changes in climate are affecting hydrological cycle, altering surface water levels and ground water recharge, changes in quantity and quality of ground water resources with various other associated impacts on natural ecosystems and human activities. Ground water is one of the largest available resources of freshwater ensuring livelihood security across the universe as they supply 80% of domestic needs and more than 45% of total irrigation requirement. Due to climactic fluctuations there has been a decrease in surface water use and a continuous increase in ground water utilization for irrigation purposes. In India, the vulnerability is extremely high because of booming tube well irrigation resulting depletion/over-exploitation of ground water and reduced share of canal water. Central water development board's

latest assessment showed that the stage of ground water development was 62% at all India level during the year 2014 and the remaining 38% was available for future use, which was not sufficient for future security and sustainability. Some states like- Punjab, Haryana, Rajasthan, Delhi, Karnataka, Tamilnadu, Andhra Pradesh, Gujarat, Telangana and Uttar Pradesh have even reached a critical stage as ground water development was more than 100% showing that consumption was more than annual ground water recharge and the number of over-exploited units were also significantly high (15% of total accessed units). In these states the net draft of ground water was either in excess of or close to the net available resources, implying that these states were facing a situation of dangerous over-exploitation of their available ground water resources. In India, over a period of 15 years the number of safe districts was decreasing with 7.9% CGR and the number of over-exploited districts was increasing with 48% CGR. In addition to depletion, severe water quality problems too were being faced by the nearly 60% of all districts in India (GOI, 2012-17). Measures such as behavioural and structural adaptations, promoting ground water governance, defining ground water risk zones and climate change mapping, promoting afforestation, Co_2 sequestration can be adapted for the sustainable utilization of the ground water reserves.

Key words: Ground water development, livelihood security, net draft, over-exploitation, vulnerability.

P117A136

WEED MANAGEMENT OPTIONS TO MANAGE COMPLEX WEED FLORA IN ONION (*Alium Cepa* L.) NURSERY

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Abstract

An investigation was conducted at AICRP-Weed management farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *rabi* season of year 2014 to evaluate the different chemical weed management practices on growth, number of seedlings m^{-2} and weed spectrum in onion nursery. All the treatments significantly reduced weed growth over the weedy check. Hand weeding at 15 and 25 DAS was significantly reduced weed density (no. m^{-2}), lower weed persistence index and significantly highest number of transplantable seedlings m^{-2}. The most adverse effect of pendimethalin @ 800 g ha^{-1} was observed when applied as PE and PPI. However, partial control of weeds was observed in treatment oxyflurofen @ 100 g ha^{-1} as PPI and oxyflurofen @ 120 g ha^{-1} as POE (15-20 DAS). There was significant reduction of weight of 100 seedlings in treatment pendimethalin @ 800 g ha^{-1} as PE followed by PPI. The significantly highest number of transplantable seedlings (no. m^{-2}) was recorded in treatment oxyflurofen @ 120 g ha^{-1} as POE (15-20 DAS). So, in cultural practices HW at 15 and 25 DAS and considering the chemical weed control treatment oxyflurofen @ 120 g ha^{-1} POE (15-20 DAS), oxyflurofen @ 100 g ha^{-1} as POE (15-20 DAS) and oxadiargyl @ 70 g ha^{-1} as POE (15-20 DAS) was observed better weed management option and produced maximum number of healthy seedlings production in onion nursery. Application of oxyflurofen @ 120 g ha^{-1} as POE (15-20 DAS) recorded significant reduction of not only monocot weeds (*viz. Dactyloctenium aegyptium, Eleusin indica, Asphodelus tenuifolius* and *Chloris barbeta*) but also dicot weeds (*viz. Chenopodium album, Chenopodium murale, Digera arvensis, Melilotus indica* and *Trianthema monogyana*).

P118A138
BIOPHARMING: INNOVATIVE APPROACH TO NATURAL RESOURCES UTILIZATION

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Abstract
Biopharming is the production and use of genetically engineered transgenic plants to produce pharmaceutical substances for use in humans or animals via recombinant DNA technology. First recombinant protein avidin was expressed in transgenic maize for commercial purpose. Transgenic plants provide immense pliability in bioproduction platforms that differentially address production scale, cost, safety and regulatory issues. Plant based system provide the spectrum of production capacity ranging from plant/algal cell bioreactor systems using various stable and transient plant expression platforms. Biopharming promises more abundant and cheaper supplies of pharmaceutical drugs, including vaccines for infectious diseases and therapeutic proteins for treatment of various diseases. Vaccinating animals/humans with edible plants is a new emerging idea that appears to hold great pledge. Common food plants like banana, tomato, rice, carrot, etc. have been used to produce vaccines against certain diseases like hepatitis B, cholera, HIV, etc. Nutraceuticals define as a food or part of food or nutrient that provides health benefits including the prevention and treatment of diseases. Biopharming for nutraceuticals become progressively popular to improve health now days.

P119A150
IMPACT OF CATASTROPHIC HAILSTORMS ON MAHARASHTRA'S CROPS, LIVE STOCK AND HUMAN BEINGS

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Abstract
The hail storms developed as response to hot, damp air from Bay of Bengal as well as Arabian Sea, rising and meeting to the cold air coming from south from the Himalayas, which led to formation of use hail. Marathwada, Vidarbha, Northern Maharashtra and parts of Western Maharashtra reeling under, unprecedented hail storms and unseasonal rainfall. Hail storm in the end of February absolutely destroying the farmer. The damage included around 50,000 ha of fruit crops and food crops on 6.20 lakh ha has been destroyed including grapes, oranges and pomegranates. The crop of wheat, jowar and grams has been virtually raised while the cotton and summer onion has also been affected. Orchard which took years to grow are ridden to the ground. For many farmers the tragedy is unbearable as majority of crops were about to be harvested crops like water melon, cucumber and wheat, which were ready for harvest have also seen large scale damage. Turmeric was drying in sun, grapes were waiting to be graded have been damaged. The grape vines, trimmed preparation for the new coppices, which were bettered by the heavy rain and hail. The new leaves sprouting on these vines were ripped by the hail thus raising fears that orchards might not regenerate this year. Apart from agricultural thousand of loss live stock, animals and birds have succumbed to injuries and diseases, which threaten to spread around 21 people have lost their lives to the disasters. In many areas houses, lamp-posts and trees have been damaged due to the storm and hail. Several farmers have reported committed suicide in the state after their crops were damaged by the several hail storms. Maharashtra has suffered more than Rs 5000 crore of agricultural loss.

P120A154

EFFECT OF DIFFERENT IRRIGATION SCHEDULING ON SOIL MOISTURE, WATER PRODUCTION FUNCTION AND SIMULATED YIELD OF MUSTARD BY USING CROPWAT MODEL

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Abstract
The CROPWAT model developed by Food and Agricultural Organization is used for estimation of crop water requirement/ irrigation requirement based on climate, soil and crop data. This can also be used for irrigation scheduling under different management practices and to estimate the performance of crops under different irrigation scheduling. In order to provide input data to CROPWAT model, an field experiment was carried out on mustard crop during the *rabi* season of 2011-12 with four irrigation treatments (I_1: Irrigation at critical growth stages: Branching, flowering and siliqua formation, I_2: 0.3 IW: CPE ratio, I_3: 0.5 IW: CPE ratio, I_4: 0.7 IW: CPE ratio and I_5: 0.9 IW: CPE ratio) at Anand Agricultural University, Anand. The results showed that there was close relationship between actual soil moisture and that simulated by CROPWAT model. The actual water use and that simulated by CROPWAT model was observed higher under I_2 irrigation treatment with 11.94 kg mm^{-1} and 12.21 kg mm^{-1} and lowest was observed under I_5 irrigation treatment with 5.1 kg mm^{-1} and 5.34 kg mm^{-1}. Maximum grain yield was recorded under I_4 irrigation treatment with 2389 kg ha^{-1} and minimum yield was recorded under I_2 irrigation treatment. Water production function was 0 under I_4 irrigation treatment as there was no water stress. Lowest yield reduction was simulated as 0.1% when irrigation was given at 13, 26, 40, 59, 78, 94 and 106 days after sowing and highest cumulative yield reduction was simulated as 30.5% when irrigation was given at 40 and 95 days after sowing. CROPWAT model simulated I_5 as best irrigation treatment with lower yield reduction.
Key words: Irrigation, mustard, CROPWAT model, yield reduction.

P121A155

CHITOSAN: AN EMERGING TOOL FOR SUSTAINABLE AGRICULTURE

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Abstract
Chitosan is a deacetylated form of chitin, the chief component of exoskeleton of arthropods and cell wall of many fungi. It is a linear polymer of randomly distributed β-(1, 4)- linked D- glucosamine and N-acetyl-glucosamine units. Chitosan has excellent properties such as biodegradability, biocompatibility and non toxicity to mammals including humans. It has got a wide range of application in agriculture, water purification and in the pharmaceutical, cosmetics and food processing industries. In agriculture, it is being used as a biopesticide and growth promotant. It can be applied as seed treatment/ foliar spray or can be used as a soil amendment. Chitosan is believed to act by promoting the chitinolytic and other beneficial microbes associated with plants and also show toxicity towards many pests. It elicits plant's natural immune system against insects, nematodes and various fungal, bacterial and viral pathogens. It increases plant growth and vigour by enhancing photosynthesis and stimulating the absorption of nutrients from soil, ultimately leading to improved yield. Application of chitosan has also shown to improve plant's resistance to various abiotic stress like drought and nutritional deficiencies in soil. This review reiterates the role of chitosan as a tool for sustainable agriculture.
Key words: Chitosan, Biopesticide, Growth promotant, Sustainable agriculture

P122A160
HI-TECH PRE-HARVEST HORTICULTURE TECHNOLOGY IN BANANA CULTIVATION

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Abstract
Climate change may significantly alter both yields as well as vulnerability to diseases in banana crop, which would affect incomes of many farmers in India. Thus to mitigate its impact on banana cultivation, many hi-tech pre-harvest horticulture technology has been developed. It is defined as "Any horticultural technology, which is modern, less environment dependent, capital intensive and has the capacity to improve the productivity and quality of any horticultural crop." Banana is a high value crop grown in tropical and sub tropical zones of India. High tech banana cultivation by using Tissue Culture (TC), fertigation, High Density Planting (HDP), Integrated nutrient management, Integrated disease and pest management, plant growth regulators and micronutrients etc. gives very high yield and profit. Gujarat ranks 2nd in production (422.55 MT) and 1st in productivity (63.54 MT/ha) in India (NHB, 2015). There has been significant increase in productivity of banana due to use of quality planting material and adoption of hi- tech cultivation practices by farmers in Gujarat.
The effects of climate change on agriculture have been proposed in terms of both productivity and the risk of disruption of production, with implications for food security and income for millions of households worldwide. The increase in average temperature that characterizes climate change is likely to generate an increase in the frequency and severity of extreme and moderate weather events resulting in additional episodic losses. This converts into increased vulnerability in agriculture over the medium and long term unless measures are taken to strengthen the resilience of production systems (Calberto *et. al.* 2015). Thus, this review paper includes the summary of researches done by different scientists at different locations in India using hi tech horticulture technique to mitigate the effect of climate change on banana cultivation as well as increasing production with quality.

P123A177
EFFECT OF WEATHER ON FROG-EYE SPOT DISEASE IN BIDI TOBACCO NURSERY

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Abstract
Frog-eye spot (FES) caused by *Cercospora nicotianae* Ell. & Eve. is a dreadful disease of bidi tobacco. It is noticed at later part of the nursery and spreads in the field with infected seedlings. The disease is known to reduce 21 % cured leaf yield and 20 % nicotine content in field crop. Due to change in monsoon pattern and weather conditions since last few years, it is desirable to study the incidence and severity of the disease in relation to agro-meteorological parameters with ultimate goal to manage the disease in nursery. The study was based on eight years data (2008-2015) on occurrence of the disease and weather parameters (BSS, RF, RDAYS, WS, MAXT, MINT, RH1, RH2, VP1 and VP2) using logistic regression analysis. The results of logistic regression analysis indicated that weather parameters RDAY and MINT had positive and significant effect on FES whereas, weather parameter VP1 had negative and highly significant effect on FES. A predicted probability curve were produced for RDAY, MINT and VP1. It was estimated that probability of diseases FES initiation >0.5 when RDAY was >2.0 and MINT was round about 25 ^{0}C and VP1 was < 24.5. Further odd ratio indicated that every increase in 1 unit in RDAY and MINT the risk of FES increases 2.1 and 20.7, respectively, whereas increase in 1 unit in VP1the risk of FES reduces 0.13.

P124A178
ROLE OF ENTOMOPHAGE BIO-DIVERSITY PARK IN TOBACCO BASED AGRO ECOSYSTEM

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Abstract
Entomophage Biodiversity Park was raised in the year 2015 at Bidi Tobacco Research Station, Anand Agricultural University, Anand to establish and increase the population of natural enemies in tobacco based agro ecosystem. Five lines of 5 m length and 0.90 m. apart from each other were sown / transplanted with seven different crops *viz.*, tobacco, marigold, sena, cotton, kuvadio (*Cassia* sp.), maize and lucern. Results revealed that activity of various natural enemies like spider, coccinellids, *Nesidiocoris tenuis*, *Geocoris ochropeterus* and *Rhinocoris* sp, were found on different crops raised under entomophage park. Out of various bio agents maximum activity of *N. tenuis* was found in tobacco. Spider had highly negative significant correlation with WD_2 and VP_2, while negative significant association was established with WD_1, WS, MinT, RH_2 and VP_1. Coccinaelids showed highly negative significant correlation with WD_1, WS, RH_2 and Mean RH. A predatory bug, *Nesidicoris tenuis* had highly negative significant correlation with Mean T, RH_1, RH_2, Mean RH, VP_1, VP_2 and Mean VP while significant negative correlation with WD_1, WD_2, Max T and Min T exerted highly positive significant correlation. A larval predatory bug, *Rhinocoris* sp. established significant negative correlation with EP, WD_1, WD_2 and RH_2 while highly significant negative correlation with MinT, VP_1 and Mean VP and highly positive correlation with VP_2. To minimize indiscriminate use of insecticide farmers may raise entomophage park which is safe alternate of sustainable agriculture.

P125A179
HERBICIDES COMBINATIONS FOR CONTROL OF COMPLEX WEED FLORA IN WHEAT

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Abstract
Weeds are reported to causes upto 66% reduction in wheat grain yield if not timely controlled (Kumar *et al*., 2011). To overcome the problems of weed shift due to continuous use of 2,4-D, pendimethalin or metsulfuron-methyl, tank mix or pre-mix herbicides mixture have been recommended by Chhokar and Malik, 2002. A field experiment was conducted during *rabi* 2014 to study the bioefficacy of herbicides/mixtures as tank mix or pre-mix for the management of complex weed flora in wheat. Significantly the lowest total weed dry biomass at 60 DAS were recorded in hand weeding carried out at 30 and 60 DAS and application of pendimethalin 1.0 kg/ha PE *fb* sulfosulfuron 0.018 kg/ha PoE, but it was closely followed by post emergence application of clodinafop + metsulfuron methyl (0.06 + 0.04 kg/ha), pinoxaden 0.06 kg/ha + metsulfuron methyl 0.004 kg/ha, mesosulfuron + iodosulfuron (0.012 + 0.0024 kg/ha) and sulfosulfuron + metsulfuron (0.03 + 0.002 kg/ha) as tank mix or pre-mix. This indicated that combinations of herbicides were found more effective for control of complex weed flora in wheat. Among the weed management practices, HW carried out at 30 & 60 DAS recorded significantly higher grain and straw yield, but it was remained at par with post emergence application of clodinafop + metsulfuron methyl (0.06 + 0.04 kg/ha) and sulfosulfuron + metsulfuron methyl (0.03 + 0.002 kg/ha) with higher B:C ratio. Significantly the lowest grain and straw yield were recorded in weedy check due to higher density and vigorous growth of weeds created more competition with crop. The growth parameters of succeeding crops viz; greengram, maize and pearlmillet were not significantly influenced due to different herbicides applied in preceding wheat crop as individual or as mixtures at 30 DAS in bioassay study indicated that there was no any carry over/residual effect of herbicide applied in wheat noticed on succeeding crops.

P126A180

DIVERSITY AND EFFICACY STUDY OF NATIVE *Rhizobium* SP. ON SUMMER GROUNDNUT FROM SUKHI RIVER COMMAND AREA OF MIDDLE GUJARAT

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Abstract

Nitrogen is one of the major nutrients required for groundnut (*Arachis hypogaea*) growth and productivity. Unfortunately, Nitrogen is most commonly deficient in soil to meet the demand and thereby reducing yields. Groundnut can form N fixing symbiotic association with root nodule bacteria '*Rhizobium*'; in a process that can supply sufficient N for the crop. Due to lack of information on the diversity of indigenous *Rhizobium* populations of summer groundnut growing Sukhi river command area of middle Gujarat, the study was undertaken to find out efficient isolate, which can enhance groundnut production in eco-friendly manner. In answer to that, groundnut nodule and soil samples were collected from 100 locations of the *Delta* and processed for isolation of *Rhizobium*. Total 138 isolates grew on CRYEMA media were selected showing typical mucilaginous *Rhizobium* type colonies. Selected 5 isolates out of 138 were further characterized for different PGP traits *viz*. *nif* gene detection, P solubilization, siderophore production, different enzyme production etc. The 16S ribosomal DNA sequencing of both the isolates was carried out, from NCBI blast results it is conformed that both the native isolates are *Rhizobium* with NCBI genebank accession numbers KU836508 & KU836509, respectively. Based on the result from different plant growth promotion trait characterization, isolates C 10 and J 14 were selected for further studies in field and designated as GNR1 & GNR2, respectively. The result of efficacy testing of isolates in the field (factorial RBD & control *vs* rest) revealed that different yield and growth attributes of summer groundnut were not differed significantly due to the different levels of FYM, Nitrogen and Biofertilizers (*Rhizobium* isolates). Interactions were found non-significant for pod and haulm yield. However, treatment F1 (10 t FYM/ha) gave numerically maximum pod (3,313 kg/ha) and haulm (5,371 kg/ha) yield of groundnut. But, in comparison to controls (100% & Absolute) the treatments having *Rhizobium* application shown significantly difference in pod and haulm yield.

P127A199

EFFICACY OF ORGANIC AMENDMENTS EXTRACT AGAINST DAMPING-OFF (*Pythium Aphanidermatum)* OF TOMATO *IN VITRO* AND *IN VIVO*

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Abstract

To find out antifungal effects of organic amendments extract on the pathogen *Pythium aphanidermatum,* six different amendments extract *viz.,* Farm yard manure (FYM), vermi compost, poultry manure, mustard cake, castor cake and neem cake was evaluated at two different concentrations. All the organic amendments significantly reduced mycelial growth of the pathogen as compared to control. Significantly minimum mycelia growth of pathogen and maximum inhibition was obtained with castor cake followed by poultry manure at 5 percent concentration. The next best treatments in order of merits were mustard cake, vermi compost and FYM at 5 percent concentrations, respectively. Poor inhibition of mycelial growth was recorded in neem cake at 5 percent concentration. All the organic amendments were found effective at 2 percent concentration as compared to control. The higher concentration (5%) was more effective than lower concentration (2%) in each treatment. Dry mycelia weight was also significantly reduced in all the organic amendments applied at 5 and 2 percent concentrations. The

organic amendments were further evaluated for the management of damping-off disease under pot conditions. The significantly higher seed germination was recorded in the treatment of castor cake as compared to other organic amendments and control. Significantly minimum number of damped-off seedlings per pot and maximum percent disease control was obtained with castor cake which was followed by poultry manure and both were at par with each other. The next best treatments in order of merits were mustard cake, FYM and vermi compost while neem cake found least effective in controlling the disease. The study results suggest that the minimum redial growth, dry weight of the pathogen, maximum inhibition of mycelial growth, minimum damped-off seedlings and maximum per cent disease control was obtained with castor cake followed by poultry manure.

P128A201

WEATHER BASED RELATIONSHIP OF ADULT MOTH CATCHES OF PINK BOLLWORM AND LEAF EATING CATERPILLAR IN COTTON GROWING CROP AREA

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Abstract

The data pertaining to adult moth catches of pink bollworm (*Pectinophora gossypiella*) (PG) and leaf eating caterpillar (*Spodoptera litura*) (SL) were recorded for nine years (2006-2014) using the light trap installed at College Agronomy farm, B. A. college of Agriculture, Anand Agricultural University, Anand. The standard week wise (SW) weather data for the study period were collected from the agro meteorology observatory of AAU, Anand and correlated with adult moth catches. Adult moth catches (AMC) of PG were observed during the period of 1st SW to 25th SW and 37th SW to 52nd SW. AMC of *Spodoptera litura* showed two peaks during the period under study and it remain active throughout the years. The correlation analysis results indicated that the most of the weather parameters had negative and significant association with AMC while, BSS had positive association with AMC in both the pest. The stepwise regression analysis was employed and results showed that partial regression coefficient of WS was found positive and significant whereas, for VP1, it was negative and significant. The model explained 87 per cent variation in AMC. WS had negative and significant effect on AMC whereas, VP2 had positive and significant effect on AMC in case of leaf eating caterpillar. The coefficient of determination (R^2) indicated 65 per cent variation could be explained by this model.

Key words :*Pectinophora gossypiella*, *Spodoptera litura*, Adult moth catches, Light trap.

P129A233

CURRENT SYSTEM FOR MEETING CHALLENGES IN FARMING SUGGESTIONS OFFERED BY NEEM TREE OWNER FARMERS TO POPULARISE NEEM-AN INDIAN PERSPECTIVE

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Abstract

Neem is accredited today as an ecological alternative to many unhealth practices followed by farmers. With climate change farm adversities like pest resurgences, disease incidences and crop losses are escalating. Role of neem is well established and it has much to offer in solving global agricultural, environmental and public health problems. The natural properties of neem do not have any toxic reactions, so they are helpful in plant protection and eco-friendly management for sustainable agricultural development. Neem products make insecticide, pesticide, fumigant, fertilizer, manures, compost, urea coating agent and soil conditioner. Due to swelling public concerns about the harmful effects of toxic synthetic pesticides, neem based

products have virtually taken the center stage as an imminent alternative. Neem oil, neem fruit and its different by-products make efficient biopesticides, fungicides and organic manures. These products can help to construct a sustainable agricultural back bone to low income group and developing countries with reasonably lower costs and ecological damages. In past many efforts have been undertaken by agricultural scientists to encourage such organic alternative neem based products among farmers for the control of various harmful pests. The present study is aimed to understand the extend of usage of neem based biopesticides by practising farmers and suggestions offered by neem tree owner farmers to popularise neem as system for meeting challenges in farming and presenting it as an Indian perspective. The data were collected through personal interview using structured interview schedule. The collected data were classified, tabulated, analysed and interpreted in order to make the findings meaningful. The suitable statistical tools were used to analyse data in the study. The most important suggestions given by neem tree owner farmers to popularize neem in agriculture in order of their importance were; create awareness about ill effects of chemical pesticides right from school level, need to give proper advertisement for various commercial formulations made of neem, need to promote environment friendly pest control measures, need to arrange special training at KVKs and universities and other training institutes to demonstrate the use of neem-based biopesticides to farmers and need to create awareness through mass media and SMS to popularise use of neem-based biopesticides.
Key words: Neem, Neem based bio- pesticides, Suggestions by neem tree owners, Indian perspective.

P130A236

MORPHOLOGICAL AND BIOCHEMICAL SCREENING OF GUAVA (*Psidium Guajava* L.) HYBRIDS

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Abstract

Guava (*Psidium guajava* L.) 2n= 2x= 22 belonging to *Myrtaceae* family is native from the America; It is an important tropical commercial fruit crop of India. It is also known as "Apple of the Tropics", *amarood,* ***jamphal*** or *jamrukh in Hindi* in India. It provides lot of vitamins and minerals. Guava is the fourth most important fruit crop in India after Mango, Banana and Citrus. In India it occupies a cultivated area of 268.2 thousand hectare with annual production of 3667.9 thousand MT with average productivity of 13.7 MT ha^{-1}. The fruit is extensively grown in various states of India, mainly in UP, Bihar, MP. However, UP is an important guava producing state and Allahabad has the reputation of growing the best guava in the world. Guava is the hardiest among tropical fruit trees and excels most of the other fruit crops in productivity and adaptability. Moreover, guava scores over other fruits in ascorbic acid, pectin and other mineral contents. Guava cultivars however, display a greater diversity in tree size, bearing habit and yield, fruit size, shape, quality and ripening season. Genus *Psidium* contains about 150 species. All cultivated varieties of guava are either diploid 2n=2x =22 or triploid 2n=3x =33. In guava, most of the commercial varieties are reported to be diploids, except the seedless types which are triploids. The various morphological parameters of different genotypes and hybrids of guava and characters such as plant height, plant spread, leaf area, fruit diameter, fruit length, fruit weight, pulp thickness, pulp weight, weight of seeds per fruit, and number of fruit per plant and fruit yield are correlated with genotypic factors. Such as the various biochemical parameters of different genotypes have different characters such as TSS, acidity, vitamin-C, minerals, reducing sugar, non- reducing sugar and total sugar are correlated with genotypic factors. Sometimes characters are moderate influenced by environmental factors along with genotypic factors.
Keywords: Guava, Genotypes, Morphological characters, Biochemical characters.

P131A241
DISSIPATION OF IMIDACLOPRID, ACETAMIPRID AND FENPYROXIMATE ON CHILLI FRUITS

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Abstract
Dissipation and residue of Imidacloprid, Acetamiprid and Fenpyroximate was carried out on chilli fruits at Pesticide Residue Laboratory, following field trial conducted at Main Vegetable Research Station, Anand Agricultural University, Anand (Gujarat) during *Rabi* 2013. Imidacloprid 17.8 SL 0.005 % @ 25 g a.i./ha, Acetamiprid 20 SP 0.004 % @ 20 g a.i./ha and Fenpyroximate 5 EC 0.005 % @ 25 g a.i./ha were sprayed on chilli crop as per need. Initial deposit of imidacloprid recorded at 0 day was 0.06 ± 0.0215 µg g^{-1} which dissipated to 0.05 ± 0.007, 0.04 ± 0.0125, 0.04 ± 0.0094 and 0.03 ± 0.0084 µg g^{-1} at 1, 3, 5 and 7 days after treatment (DAT), respectively. In case of acetamiprid, initial deposit was 0.01 ± 0.0011µg g^{-1} at 0 day which was degraded very fast and found below determination limit (BDL) within 24 hours. Similarly, initial deposit of fenpyroximate was 0.06 ± 0.0147 µg g^{-1} which dissipated to 0.06 ± 0.0030, 0.05 ± 0.0078, 0.02 ± 0.0037 and 0.01 ± 0.0048 µg g^{-1} at 1, 3, 5 and 7 DAT, respectively. The half-life of imidacloprid and fenpyroximate was 7.67 and 5.24 days, respectively. Pesticide residues determined in chilli samples collected revealed that green chilli collected from Anand, Nadiad and Ankleshwar taluka of Gujarat did not reveal any pesticide, whereas samples collected from Dakor and Khambhat exhibited presence of profenophos and ethion in green chilli fruits. Highest residue (1.58 ppm) of profenophos was detected from red chilli collected from Ankleshwar followed by Dakor and Khambhat. Ethion was in the range of 0.70 to 1.25 ppm being highest in Nadiad and lowest in Khambhat.

P132A249
IMPACT OF CLIMATE CHANGE ON FRUIT PRODUCTION

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Abstract
Weather is the day-to-day state of the atmosphere, and is a chaotic non-linear dynamic system.“Climate is the average state of weather”. What is ‘climate change’? Climate change is a shift in ‘climate’ relative to a given reference time period. Changes in the sun (Global Warming) and Changes in the gases in the atmosphere (Green house Effect). The amount of energy coming off the Sun is not constant but keeps changing with the Earth’s distance from the Sun affect the amount of energy received from the Sun. Those variations are believed to be one of the causes that start ice ages. when a volcano erupts it throws out large amounts of SO_2, water vapor, dust, and ash into the atmosphere. The climate system is made up of many components that all affect climate: this includes ocean currents, atmospheric circulation, sea ice and land covers (trees, grass…). What is Global warming ?. Global warming is the increase in the average measured temperature of the Earth’s near-surface air and oceans, its projected continuation. The average global air temperature near the Earth’s surface increased **0.74 ± 0.18 °C** (1.33 ± 0.32 °F). In mango it reduces pollen viability, fruit set and parthenocarpy and decreases the number of perfect flowers, delay panicle emergence, pollentube growth, early flowering in sub tropics, affect germination, mango malformation. In case of banana, climate change results dessication of leaves, poor pollination, deformed fruit, chilling injury and reduce the yield. Unfavourable climate condition in grape effects number of flower per cluster, loss of ovule viability, reduce in concentration of starch, skin cracking, tasteless fruit. It impact on horticultural crops, due to erratic rainfall, more demand for water and enhanced biotic and abiotic stresses. Ability to adjust to the effects of climate change will be a key adaptive measure in the horticultural sector. Innovative methods are thus required to develop simulation models for important horticultural crops like mango, citrus, banana, apple, guava, and coconut. As a matter of fact no systematic studies have been carried out to elucidate into the effects climate change on fruits growing in India There fore, detailed investigation on impact of climate on fruit growing is necessary.
Keywords: Climate, Climate change, Global warming, Fruit production.

P133A267
BIODIVERSITY OF ARTHROPOD PREDATORS OF INSECT PESTS AND THEIR ENHANCEMENT STRATEGIES IN AGRO ECOSYSTEM

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Abstract
Biological control is the beneficial action of predators, parasites and pathogens in managing insect pests and their damage collectively called “natural enemies”. The predatory fauna biodiversity distributed in more than 167 families and 14 orders of class insecta, which include beetles (coccinelids), lacewings (chrysopids), flies, true bugs, odonates, mantids, ants, wasps and universal predator spiders which feed on various insect pests. With regards to diversity and significance of biological control coccinelids, chrysopids and spiders having outstanding performance in management of crop pests. But this biological control by predators is often harder to recognize, less well understood and/or more difficult to manage. Several agro ecosystems are unfavorable for natural enemies due to high levels of disturbance.
Habitat management/manipulation, a form of conservation, is an ecologically based approach aimed at favoring natural enemies and enhancing biological control in agricultural systems. Plant diversification of agro-ecosystems can result in increased environmental opportunities for predators and subsequently improves biological pest suppression. Increasing plant diversity includes intercropping, cover cropping, mixed-cropping, trap cropping, relay-cropping, wind breakers, farm escaping and interspersing of plants which can act as reservoir for predators of crop pests. Such habitat manipulation has great potential to enhance the functional bio-diversity which in turn helps in conservation as well as to encourage the activity of entomophagous insects. These resources must be integrated into the landscape in a way that is spatially and temporally favorable to predators and practical for producers to implement through transforming the physical environment including micro climatic and local climatic changes.

P134A270
INCIDENCE OF LEAF REDDENING IN *BT* COTTON GROWN IN VADODARA DISTRICT

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Cotton is an important cash crop grown in Gujarat. Year after year, the incidence of leaf reddening showed increasing trend due to the physiological disorder or deficiency of micronutrients or feeding of the sucking pests. NCIPM (ICAR), New Delhi sponsored one project to monitor insect pests along with incidence of leaf reddening in *Bt* cotton in Vadodara district during 2008-09 to 2012-13. Under this project, 49 villages of Vadodara district had been covered during this period. The red leaf infested plants were recorded at weekly interval from the two selected *Bt* cotton fields at weekly interval throughout the study period. For the purpose, 20 plants were randomly selected in select fields of each villages and number leaf reddening plants counted. Looking to the average data of leaf reddening plants were observed during the fruiting stage. In different villages of Vadodara district, it was observed to the tune of 0.44 to 74.50 per cent. However, higher infested plants was recorded during 46^{th} to 8^{th} SMW *i.e.* 60.60 to 74.50 per cent.

P135A271
STUDY OF SUCKING INSECT PESTS INFESTING *BT* COTTON IN VADODARA DISTRICT

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To know the activity of major sucking insect pests infesting *Bt* cotton, National Centre for Integrated Pest Management (NCIPM, ICAR) sponsored a project "National Information System for Pest Management (*Bt* cotton)" during 2008-09 to 2012-13. Pest survey and surveillance was carried in 49 villages of different talukas of Vadodara district during this period. The observations on major sucking insect pests *viz.* aphid, *Aphis gossypii* Glover; leafhopper, *Amrasca biguttula biguttula* (Ishida); whitefly, *Bemisia tabaci* (Gennadius); thrips, *Thrips tabaci* Lindeman and mealybug, *Phenacoccus solenopsis* (Tinsley) were recorded at weekly interval during the crop seasons. The activity of these pests was recorded in two selected cotton field in each villages during 2008-09 to 2012-13. Aphid infested plants were observed to the tune of 0.31 to 36.79 per cent with the higher activity during 44th Standard Meteorological Week (SMW). As far as leafhopper in concerned, the highest (7.20/3 leaves) population was recorded in 52nd SMW with a range of 0.29 to 7.20 per 3 leaves. The higher activity of whitefly was recorded 41st to 3rd SMW (4.59 to 8.64/3 leaves). Incidence of thrips was recorded throughout the study period to the tune of 0.74 to 6.86 per 3 leaves. However, higher activity of this pest recorded during 51st to 4th SMW. The incidence of mealybug was remained comparatively lower *i.e.* 0.02 to 0.46 (scale: 0 – 4) in studied villages of Vadodara district.

P136A272
EFFECT OF MAGNESIUM SULPHATE AGAINST LEAF REDDENING IN *BT* COTTON

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Due to the deficiency of micronutrients and changing in climate, incidence of leaf reddening is observed in *Bt* cotton grown in Vadodara district. To see the effect of Magnesium sulphate ($MgSO_4$), demonstration trials were conducted on farmers' fields in Vadodara district under the project " NISPM (*Bt* cotton)" sponsored by NCIPM (ICAR), New Delhi during 2012-13. On all 10 *Bt* cotton fields were selected in different villages of Vadodara district. Total four spray of $MgSO_{4\ @}$ 1 % (1 kg per 100 litre of water) was given at an interval of 10 days. One plot in each village was also selected as farmer's practices (without application of $Mgso_4$). The observations on leaf reddening plants were recorded from the 50 randomly selected plants in each demonstration plot. Per cent leaf reddening plants was observed in the range of 27.00 to 70.75 and 37.50 to 82.50 in demonstration field and farmer's practices fields, respectively. There was significant reduction in plants infested with leaf reddening under demonstration plots. The seed cotton yield and economic of the treatments were also carried out.

P137A273
GENETIC RESOURCES OF FRUIT CROPS IN INDIA, THEIR CONSERVATION AND UTILIZATION

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India is endowed with presence of rich diversity in large number of fruit crops and their wild relatives especially citrus, mango, banana in North Eastern region. Today, the existing genetic diversity is often seriously endangered. In nature, biodiversity has been reduced due to the industrial development, climatic changes and agricultural practices. Often valuable original resources of many crops were lost. Genetic resources comprising cultivars, land races, wild relatives, special genetic stocks *etc*. are not only the pre- requisite but key ingredients for genetic improvement of fruit and nut crops, therefore the exploration, collection and maintenance of perennial crop germplasm is the need of the hour, to preserve highly desirable genes and gene recombination. In India national active germplasm conservation sites for tropical fruits IARI, New Delhi and IIHR, Bangalore with 13118 accessions, for subtropical CISH, Lucknow with 587 accessions, for temperate NBPGR regional research station Phagali, Shimla with 454 accessions and for arid and semiarid fruits CIAH, Bikaner with 698 accessions. While, in Gujarat state germplasm collection centers for different fruits are located at CHES, Godhra, Anand, Junagadh, Navsari, S.K.Nagar, Paria, Gandevi and Vasda .

P138A275
ROLE OF BIOTECH CROPS IN RELATION TO MITIGATING EFFECTS ON CLIMATE CHANGE

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Biotechnology is a platform technology that may significantly contribute to climate change mitigation and adaptation. Yet biotechnology is hardly ever referred to as a ‘clean technology’. The continuing increase in greenhouse gas emissions raises the temperature of the earth’s atmosphere. This results to melting of glaciers, unpredictable rainfall patterns, and extreme weather events. The accelerating pace of climate change, combined with global population and depletion of agricultural resources threatens food security globally. Green biotechnology offers a solution to decrease green house gases and therefore mitigates climate change. Commercialization biotech crops have been contributing to the reduction of CO_2 emissions. Crops can be modified faster through biotechnology than conventional crops, thus hastening implementation of strategies to meet rapid and severe climatic changes. Pest and disease resistant biotech crops have continuously developed as new pests and diseases emerge with changes in climate. Resistant varieties will also reduce pesticide application and hence CO_2 emission. Crops tolerant to various abiotic stresses have been developed in response to climatic changes. The results of a perception pattern analysis show that the majority of stakeholder representatives had a neutral or positive attitude towards the use of biotechnology and regarded its potential to address climate change problems as significant. To a considerable extent, a person’s background appears to determine whether biotechnology is framed as a risk or an opportunity for sustainable development. Biotech research to mitigate global warming should also be initiated to sustain the utilization of new products. Among these are: the induction of nodular structures on the roots of non-leguminous cereal crops to fix nitrogen. This will reduce farmers’ reliance on inorganic fertilizers. Another is the utilization of excess CO_2 in the air by staple crop rice by converting its CO_2 harnessing capability from C_3 to C_4 pathway. C_4 plants like maize can efficiently assimilate and convert CO_2 to carbon products during photosynthesis.

P139A277
IMPACT OF CLIMATE CHANGE ON YIELD OF PIGEONPEA

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Abstract
Pulses, the poor man's meat and rich man's vegetable are the most important source of protein in a vegeterian food basket and are integral part of diet of many people in India. Apart from serving as an important source of protein, the crop is highly beneficial for the health of soil and being a leguminous crop through its nitrogen fixing properties it has a great impact on climate also. India is the largest producer, consumer and importer of pulses in the world accounting for about 25 percent production, about 33 percent acreage and about 27 percent consumption of total pulses of the world. Gram and Tur are the most important pulse crops having a share of around 40 per cent and 15- 20 percent respectively in the total production. Gujarat is one the important pulse growing states in India contributing 3.84 percent in total production and 3.22 percent(2013-14). The pigeonpea grown in Gujarat contributes 10.65 percent in total production of pulse crops and 2.65 percent of total area under pulse crops in India respectively (2013-14). In the past few decades there has been a lot of changes in climate and these changes have resulted in the decline of agricultural output. Climate change poses risk and this risk is higher for developing country like India due to lack of technological and financial resources. Increase in temperature, erratic rainfalls, drought, floods etc. has severely affected agriculture. The impact of climate change can be seen as increase in temperature, decrease in yield, increase incidence of disease and pest attack, lower availability of water etc. Pulses are mainly rainfed crops. Distribution and intensity of rainfall affects the productivity of crop. Back-to-back drought years for the first time in three decades has eroded India's output of pulses and boosted imports. These changes has been gearing attention across the globe. The study aims to find out the impact of changes in climatic variables on the yield of pigeonpea over a series of time by using panel data approach.

P140A284
ACTIVITY OF PINK BOLLWORM IN *BT* COTTON GROWN IN VADODARA DISTRICT THROUGH PHEROMONE TRAPS

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Recent post, the incidence of pink bollworm, *Pectinophora gossypiella* (Sounders) was observed in *Bt* cotton grown in Gujarat. Activity of this pests was carried out in the project "Online Pest Monitoring and Advisory Services (OPMAS)" sponsored by NCIPM (ICAR), New Delhi during 2014-15 and 2015-16 in Vadodara district through pheromone traps. In Vadodara district in all nine villages were selected from the different talukas. In each village, pheromone traps were installed in one fixed plots and moth catches were recorded at weekly interval. The data on catches were also uploaded in websites "ncipm.org.in". During 2014-15, 0.11 to 4.33 moths per trap was recorded during the study period. The highest catches was recorded during December and January. During 2015-16, the activity of pink bollworm was recorded throughout the study period *i.e.* August to January (1.00 to 5.33 catches/trap/week). The higher activity was noted during August and December-January.

P141A285
INCIDENCE OF BOLLWORMS IN *BT* COTTON GROWN IN VADODARA DISTRICT

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Under the project "National Information System for Pest Management (NISPM) *Bt* cotton" sponsored by NCIPM (ICAR), New Delhi, incidence of major bollworms were recorded in 49 villages of different talukas of Vadodara district during 2008-09 to 2012-13. For the purpose, two fields were selected as fixed plots and two as random in each villages. Twenty plants were selected randomly and observation on bollworms were recorded at weekly interval. The data on the infestation was also uploaded in websites "ncipm.org.in" regularly and the advisory issued accordingly. The observations on larval population of spotted bollworm, *Earias vittella* (Fabricius); Leaf eating caterpillar, *Spodoptera litura* (Fabricius); American bollworm, *Helicoverpa armigera* (Hubner) Hardwick and pink bollworm, *Pectinophora gossypiella* (Sounders) were recorded from the each selected plants. Population of bollworms was recorded lower and sporadic in different villages of Vadodara district during 2008-09 to 2012-13. However, larval population of *H. armigera* was recorded during 46^{th} to 50^{th} SMW (0.03 to 0.05 larva/plant), *E. vittella* during 46^{th} to 48^{th}, 51^{st} to 1^{st} and 40^{th} SMW (0.01 to 0.03 larva/plant) and *P. gossypiella* during 42^{nd} to 46^{th}, 49^{th} to 1^{st} SMW and *S. litura* during 35^{th} to 6^{th} SMW (0.01 to 0.18 larva/plant).

P142A286
WASTE LAND MANAGEMENT THROUGH PLANTING OF FRUIT PLANTS

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WADI is also known as **Wasteland Agriculture Development Initiative** (Orchard Development on uncultivable land and providing the beneficiaries the basic knowledge and advantages of orchard farming, providing organic manures, organic fertilizers, organic certification, identifying viable & sustainable micro enterprises). The main outputs of our WADI programme are productive utilization of wasteland and marginal lands, increased area under fruit crops, conservation of natural resource like water and soil, reduced migration, improved social status, generation of self employment for rural mass, strengthened community participation in decision making process. WADI plantations have several benefits even on small plots, fruit trees produce high yields, both quantity and money wise; fruit trees provide the tribal's with healthy supplementary nutrition to their otherwise non nutritive diet; and the fruit trees also serve to improve the environment in terms of checking soil erosion, carbon dioxide sequestration, providing shed, increasing growth of fodder plants *etc*. New orchards developed this year are inter-cultivated with different vegetables as a result the earnings have gone up than those for traditional crops. In waste land those fruit crops are selected for cultivation *i.e.* hardy in nature and resistant to different abiotic stress conditions of waste soil *e.g*. In sandy wastelands ber, kair, guava, custard apple *etc.* and in waterlogged condition date palm, banana, jamun, kokum, coconut and arecanut are can cultivated. In saline and alkaline soil datepalm, ber, jamun, guava, karonda, mulberry, phalsa, grape, tamarind and wood apple successfully cultivation can do with high production due to proper management practices.

P143A292

IMPACT ASSESSMENT OF CLIMATE CHANGE ON GROUNDNUT IN NORTH-SAURASHTRA AGRO-CLIMATIC ZONE OF GUJARAT

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Abstract

The impact of projected climate change on groundnut (cv. GG-2 and GG-20) yield have been studied for Rajkot station of north-Saurashtra Agro-climatic region using PRECIS output of A_2 scenario and base line data. Yield simulation study was performed by PNUTGRO (DSSAT v4.5) model. The field experiment data on groundnut cv. GG-2 and GG-20 during the year 2007 to 2009 have been used to calibrate and validate the model. The weather condition as projected by PRECIS model under A_2 scenario (2071-2100) showed that there will be 63 % higher rainfall as compared to base line (1961-90). The mean maximum and minimum temperature will be higher to the tune of 3.9 and 3.6 ^{0}C as compared to their base line temperature 33.7 and 20.1 ^{0}C respectively. Nearly 28 and 30 % pod yield reduction was noted as compared to baseline in D_1 sowing (Onset of monsoon) of groundnut cv. GG-20 and GG-2 while, it was 29 and 31 % for D_2 sowing (15 days after D_1), respectively under projected period. Nearly 11 to 16 % yield benefited by adaptation strategies such as fifteen days earlier shifting of sowing with one pre sowing irrigation and application of organic manure instead of chemical fertilizer respectively.

P144A293

A REVIEW ON STUDY THE IMPACT OF CLIMATE CHANGE ON CEREAL CROP PRODUCTION BY USING DSSAT MODEL

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Abstract

Agriculture is highly dependent on weather, and therefore, changes in global climate could have major effects on crop yields, and thus food supply. In DSSAT system, CERES family model generally used to study of cereal family crop, through these model it possible to evaluate the effect of various climate parameters like $CO_{2,}$ temperature, solar radiation etc on growth, development and production of cereal crop. A lot of research works was done on study of climate change and its effects on crop through DSSAT model during the past and recent decades. The objective of this paper is to review those research results.

P145A005
MANAGEMENT OF CROPPING SYSTEMS FOR RESOURCE CONSERVATION AND CLIMATE CHANGE

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Abstract
The field experiment was conducted on loamy sand soils of Centre for Research on Integrated farming Systems, SDAU, Sardarkrushinagar for North Gujarat region during the years 2009-10 to 2014-15 to study effect of management of cropping systems for resource conservation. The soil of the experimental plot was low in organic carbon and available nitrogen, medium in available phosphorus and potash. The experiment was laid out in split plot design with three replications. Twenty four treatment combinations (Table 1) were evaluated in the study. The pooled results (6 years) were analyses by calculating PMEY. Interaction effect of different factors of main plot and sub plot treatment were found to be non significant, while looking to the individual effects of the factors over a year it is observed that among the tillage treatments (minimum and conventional tillage) conventional tillage, among the cropping systems (Pearlmillet – Mustard, Castor + Greengram – Summer Greengram, Greengram - Mustard – Summer Pearlmillet) Castor + Greengram – Summer Greengram cropping systems in sub plot mulch treatments (No mulch and Mulch/Residue incorporation) Mulch/Residue incorporation and among the fertilizer treatments (RDF and 25 % higher RDF) 25 % higher RDF individually recorded higher PMEY, net return, system productivity and system profitability.

P147A129
MONITORING OF RESISTANCE IN FIELD POPULATIONS OF *Aphis gossypii* Glover TO CONVENTIONAL INSECTICIDES

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Abstract
The present investigations were undertaken in the Section of Entomology, College of Agriculture, Dr.PDKV, Akola (MS) during the year 2010-11 to assess the insecticide resistance in cotton aphids *Aphis gossypii* Glover to conventionally used insecticides. The insecticide resistance was assayed for field collected *Aphis gossypii* populations from Yavatmal, Amravati, Akola, Wardha and Buldhana districts of Vidarbha (MS) by leaf dip method on agar bed and as prescribed by IRAC for cotton aphids. The results indicated that the three insecticides tested viz., Acetamiprid 20 SP, Methyl demeton 25 EC and Dimethoate 30 EC were less toxic to Yavatmal and Amravati populations of *Aphis gossypii* recording higher LC_{50} and LC_{90} values. The relative toxicity studies amongst insecticides reveled that Dimethoate 30 EC was highly toxic to aphid population from five districts with RT values of 1.00 followed by Methyl demeton (0.49 to 0.53) and Acetamiprid (0.31 to 0.39) indicating that the resistance to these insecticides not varied much amongst the five geographical regions. The studies on relative degree of resistance revealed that the *Aphis gossypii* populations from Yavatmal district registered highest degree of resistance with resistance ratios (RR) ranging 1.05 to 1.48 fold against Acetamiprid 1.26 to 1.53 against Dimethoate and 1.24 to 1.47 against Methyl demeton as compared with aphid populations from Buldhana, Wardha, Akola and Amravati districts. The aphid populations from Buldhana district seems to be more susceptible against all the three insecticides tested as compared to aphids populations from other four districts.

P149A164
EFFECT OF TYPE OF CUTTING AND GROWTH REGULATORS ON ROOTING OF 'WAX APPLE'(*Syzygium samarangense* L.)

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Abstract
The present study was carried out at the Agriculture Experimental Station, Navsari Agricultural University, At & Po. Paria, Ta: Pardi, District- Valsad, Gujarat, India during the year 2015-16 to investigate the "Effect of type of cutting and growth regulators on rooting of wax apple (*Syzygium samarangense* L.)". The experiment was laid out in Completely Randomized Design with Factorial concept having eighteen treatment combinations, comprising with two factors (1) types of cutting (hardwood cutting and semi-hardwood cutting) and (2) growth regulators (IBA 5000 ppm, IBA 7500 ppm, NAA 5000 ppm, NAA 7500 ppm, IBA 5000 + NAA 5000 ppm , IBA 5000 + NAA 7500 ppm, IBA 7500 + NAA 5000 ppm and IBA 7500 + NAA 7500 ppm). The treatments were repeated thrice. The effect of these treatments on sprouting, shoot and root growth parameters, and survival percentage were studied. The results of present investigation revealed that among the different types of cuttings, growth regulators and their interactions exerted significant influences on different parameters studied. The results regarding different type of cuttings indicated that propagation of wax apple through hardwood cutting. whereas among the growth regulators IBA 5000 ppm + NAA 5000 ppm found superior in terms of significantly less days taken for sprouting of cuttings and maximum sprouting percentage. Similar trend were observed on the growth parameters of shoot and root such as number of leaves and shoots, leaf area, diameter of longest shoot, length of longest shoot and root, fresh and dry weight of root and shoot, and survival percentage. The interaction of type of cuttings and different growth regulators concentrations revealed that hardwood cutting treated with IBA 5000 ppm + NAA 5000 ppm recorded maximum sprouting, superior growth rate of root and shoot at different intervals with higher survival percentage. On the basis of the results obtained under the study, it was concluded that hardwood cuttings of wax apple treated with IBA 5000 ppm + NAA 5000 ppm shoot growth and survival cutting. found most useful for obtained healthy and vigour planting material of wax apple (*Syzygium samarangense* L.).

P150A195
PERFORMANCE OF MUSTARD (*Brassica juncea* L.) TO DIFFERENT PLANTING METHODS AND WEED MANAGEMENT UNDER SOUTH GUJARAT CONDITION

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Abstract
A field experiment was conducted during *rabi* season of 2014-15 at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the "Performance of mustard (*Brassica juncea* L.) to different planting methods and weed management under south Gujarat condition". Significantly higher values of all growth and yield attributes such as plant height, number of branches plant^{-1}, dry matter production (g plant^{-1}), siliqua plant^{-1}, length of siliqua and number of seed siliqua^{-1} were recorded with row spacing of 45 cm x 10 cm with normal planting followed by 30/60 cm x 10 cm with paired row planting. The treatment of 45 cm x 10 cm with normal planting gave significantly higher seed, stover and oil yield (1851, 3808 and 742 kg ha^{-1}, respectively) and maximum net realization of ₹ 52874 ha^{-1} with BCR of 3.29 but it was at par with the treatment of 30/60 cm x 10 cm with paired row planting. Significantly higher seed, stover and oil yield (2085 and 4230 and 866 kg ha^{-1}, respectively) and maximum net realization of ₹ 60458 ha^{-1} with BCR of 3.41 were obtained with the application of Pendimethalin @ 1.0 kg ha^{-1} as PE + Quizalofop - P - ethyl @ 0.04 kg ha^{-1} at 20 DAS + HW and IC at 40 DAS but it was at par with treatments of Pendimethalin @ 1.0 kg ha^{-1} as PE + HW and IC at 40 DAS and Pendimethalin @ 1.0 kg ha^{-1} as PE + Quizalofop - P - ethyl @ 0.04 kg ha^{-1} at 20 DAS for seed yield, stover yield and net realization, while for oil yield it was at par with treatment Pendimethalin @ 1.0 kg ha^{-1} as PE + HW and IC at 40 DAS only. Similar trend was also found in growth and yield attributes of mustard mainly due to effective control of weed population and weed biomass. Total weed population

and dry weight of total weeds were significantly lowest under narrow row spacing of 30 cm x 10 cm with normal planting and markedly lower under the treatment of Pendimethalin @ 1.0 kg ha^{-1} as PE + Quizalofop - P - ethyl @ 0.04 kg ha^{-1} at 20 DAS + HW and IC at 40 DAS. Interaction effect between different planting methods and weed management treatments was found to be significant with respect to monocots and total weed population.

Keywords: *Planting method, weed management, Pendimethalin, Quizalofop - P - ethyl, net realization.*

P152A235

BANANAS AND CLIMATE CHANGE: WHAT IS GOING TO HAPPEN TO ONE OF THE WORLD'S FAVOURITE FRUITS?

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Bananas are a key crop for millions of households in developing countries, providing food, nutrition and income. Grown throughout the tropics and subtropics, bananas are a source of food, nutrition and income for millions of rural and urban households. The most recent reports on the impact of climate change on agricultural production show that, especially in the tropical regions, yields of certain crops will decline. Projections vary for different crops, but what is going to happen to bananas in a climate scenario of rising temperatures and alteration of rainfall amount and patterns? In the arena of the climate change, one important factor is increase in the temperature, it means increase in water demand of the crop, which is projected to increase by 12-15% and higher temperatures may also threaten those crops, such as coffee, that are often grown with bananas. Farmers who grow banana as a secondary crop, may abandon banana when climate change makes coffee cultivation less viable. Another big challenge for banana cultivation with warmer temperatures is the spread of pests and diseases. The scientists reviewed the potential impact of climate change on the incidence and severity of the most important banana leaf disease, black leaf streak. Preliminary results suggest that the increased temperatures will accelerate disease development. However, rainfall distribution has a much larger impact on disease severity. Since rainfall distribution is less affected by climate change, black leaf streak management will continue to be linked more to rainfall than temperature. We know that warmer climates will be accompanied by increased extreme weather events. We need more research to quantify the effects of these events and their implications for banana productivity and management. The genetic diversity of bananas, there are more than 500 varieties around the world, is also a key resource for climate change adaptation that needs to be further studied and used.

P153A257

ASSESSMENT OF SOIL MICROBIAL ACTIVITY AND BIODIVERSITY IN SOIL

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Soil microbial activity and their diversity play a significant role in the transformations of nutrients and their availability to plants. Soil enzyme activities dictates the biological indicators of soil health and microbial biomass and soil respiration and microbial population is key points to dictates soil biological quality as well as soil fertility. In previous studies it was observed that cropping system and soil types having an impact on soil biological activity and soil processes. The results showed that this study has clearly brought out the seedling stage of cotton (30 days after sowing) showed more microbial activity dehydrogenase, acid phosphatase, alkaline phosphatase, FDA as compare to harvest stage of cotton. This revealed that growing stage of cotton having an impact on enzyme activity due to its rhizosphere effect of the cotton plants. The improved variety performed better for all soil enzymes stated above than the wild varieties. Also the similar to enzyme activity soil respiration and microbial biomass also more in seedling stage than harvest stage of cotton and improved variety showed better effect in increasing this microbial parameter than wild varieties. The microbial population diversity also more in improved variety and wild varieties this in terns dictates the activity. In general more diversity includes different types of micro flora influences different microbial function which is important for nutrient cycling point of view. There was a positive relation between microbial diversity and microbial activity in our study that is more importance for soil biological health assessment.

The differences of microbial activity and diversity caused by growing cotton and variety have a great impact on as per as soil health is concern especially with reference to biological properties.

P154A278
DEVELOPMENT OF STATISTICAL MODEL FOR SUCKING PEST FORECASTING IN RAINFED BT COTTON

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Abstract
Investigation was carried on to develop a multiple regression model for forecasting of sucking pest *viz;* aphid (*Aphis gossypii* Glover) and jassid (*Amrasca biguttula biguttula* Ishida) incidence in cotton based on abiotic factors (*i.e.* weather factors) by its validation with real time pest data. The experiment was conducted at experimental farm of Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani and observations of sucking pest incidence was recorded for *kharif* 2013 for validation of model. The pest incidence data (2001-2012) were taken from Department of Agriculture Entomology and abiotic factor data (2001-2013) of Department of Agricultural Meteorology, VNMKV, Parbhani was used. The model was developed from the analysis is $Y= a+ b_1x_1+b_2x_2+\dots b_n x_n$ on the basis of data (2001-2012) for aphid and jassid and validated. The aphid incidence was observed from 29th Meteorological Week (MW) (16-22 July) and continued up to 52nd MW (25-31 Dec.) during the study period (2001-2012). The highest incidence was observed in 34th MW (20-26 Aug.) and aphid populations were above ETL during 30th to 39th MW. Hence, for development of multiple regression model, pest population data and previous week weather data from 29th MW to 52nd MW was used and developed model is $Y= 62.54-0.6250X_1+2.2499X_2-4.3211X_3+1.8939\ X_4+0.2624\ X_5+1.1586\ X_6-13.53\ X_7+5.5109\ X_8+1.7977\ X_9$ ($R^2 = 0.80$) Where, X_1= Rainfall, X_2= Rainy day, $X_3= T_{max}$, $X_4= T_{min}$, X_5= RH-I, X_6= RH-II, X_7= EVP, X_8= BSS, X_9= WS and R^2= Regression coefficient. This model was found best fit for 34th MW to 52nd MW expect to 38, 40, 41, 43 to 45 and 49th MW. This model worked better and found best fit for the week in which pest population was observed above ETL. The jassid incidences were recorded from 28th MW (9-15 July) to 52nd MW (25-31 Dec.) and highest incidence was observed in 37th MW (10-16 Sept.) during the study period (2001-2012). The jassid populations were found similar to aphids. On similar line to aphid, multiple regression model was developed for jassid *i.e.* $Y= -12.69-0.027\ X_1+1.441\ X_2-0.2861\ X_3+0.2956\ X_4-0.2634\ X_5+0.4565\ X_6+0.2725\ X_7+2.5791\ X_8-0.6310\ X_9$ (R^2 =0. 91). Whereas, $X_1, X_2 \dots X_9$ and R^2 is similar as in aphid model. This model was validated with jassid population data and previous one week weather data of 2013. The results of model were found significant, error was less and it is useful for forecasting. The model was found best fit for the most of week and more or less similar to aphid model. It might be due to variation of weather prevailed at experimental plot and weather at agromet observatory. Therefore, model needs improvement for more accurate forecasting of aphid and jassid population by recording the pest data and weather data based on micro climatic observations within same experimental field.

P155A279
PREDICTION OF WHITEFLY AND THRIPS INCIDENCE BY USING MULTIPLE REGRESSION MODEL

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Abstract
In order to develop a multiple regression model for prediction of whitefly (*Bemicia tabaci* Gennadius) and thrips (*Thrips tabaci* Lindeman) incidence in cotton based on abiotic factors (*i.e.* weather factors) by its validation with real time pest data. The experiment was conducted at experimental farm, Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani and observations of whitefly and thrips incidence was recorded in *kharif* 2013 for validation

of model. The pest incidence data (2001- 2012) was collected from Department of Agriculture Entomology and abiotic factor data (2001- 2013) of Department of Agricultural Meteorology, VNMKV, Parbhani was used. The model developed for the whitefly and thrips from the analysis is $Y= a+ b_1x_1+b_2x_2+\ldots b_n x_n$ and it was validated. The whitefly incidence was observed from 30th Meteorological Week (MW) (23-29 July) to 52th (25-31 Dec) MW and highest population was noticed in 43th MW (22-28 Oct) during 2001-2012. Hence, pest population data and weather data from 29th MW to 52nd MW was used to develop multiple regression model *i.e.* $Y=31.68-0.0164X_1+1.6888X_2-0.7367X_3+1.0036X_4-0.7395\ X_5+0.3181X_6-0.0055\ X_7+ 2.9606\ X_8-0.5599\ X_9$ ($R^2 = 0.78$) Where, X_1= Rainfall, X_2= Rainy day, X_3= Tmax, X_4= Tmin, X_5= RH-I, X_6= RH-II, X_7= EVP, X_8= BSS, X_9= WS and R^2= Regression coefficient. This model was found best fit for 37th MW to 50th MW, specially to 37, 38, 40 to 42, 45 and 50th MW, considering previous one week weather data. This model worked better and found best fit for the week which showed above ETL population. The thrips incidence was observed from 28th MW to 52th MW and highest population was noticed in 35th MW during 2001-2012. On similar line to whitefly, multiple regression model was developed for thrips *i.e.* $Y= 53.09-0.1594\ X_1+4.5989\ X_2- .5185\ X_3+ 2.2039X_4+0.1941\ X_5+0.3903\ X_6+4.6860\ X_7+ 5.2905X_8-2.0869\ X_9$ (R^2 =0. 81). Whereas, $X_1, X_2 \ldots X_9$ and R^2 is same as used in whitefly model. This model was validated with thrips population data and previous one week weather data. The results of model were found less significant and error was observed more in many MW, due to which this model was not applicable to give accurate prediction for incidence of thrips. It might be due to variation of weather prevailed at experimental plot and weather at agromet observatory where data was recorded. Therefore, model needs to improve for more accurate prediction of thrips population by recording the pest data and weather data based on micro climatic observations within same experimental field.

P156A291

EFFECT OF PHYTOHERB *WITHANIA SOMNIFERA* (ASHWAGANDHA) ON HAEMATOLOGICAL PARAMETERS IN NORMAL AND SYNBIOTIC SUPPLEMENTED BROILER CHICKENS UNDER SEMI-ARID CLIMATIC CONDITIONS

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The present study was carried out in semi arid condition of Bikaner (Rajasthan) in the transition month of March-April to observe the haematinic effect of phytoherb *Withania somnifera* (Ashwagandha) either alone or in combination with growth promoter substance 'synbiotic' in broilers. A 42 day feeding trial was conducted under standard feeding and managemental conditions with broiler starter (0-21 days) and finisher (21-42 days) ration on 360, day old Vencobb broiler chicks randomly divided into 8 treatment groups (T_1-T_8) with three replicates of 15 chicks each. The T_1 group was kept as control whereas T_2, T_3 and T_4 were supplemented with 0.5%, 1% and 1.5% *Withania* root powder; T_5 and T_6 were supplemented with 0.025% and 0.050% synbiotic and T_7 and T_8 were fed on diet containing 0.25% *Withania*+0.025% synbiotic and 0.50% *Withania*+0.05% synbiotic, respectively. Blood (2 ml) was collected aseptically from brachial vein of six chicks from each treatment (two chick/ replicate) after 28 days of trial. Total erythrocyte counts (TEC), haemoglobin, packed cell volume (PCV) were estimated as per Benjamin (1978). The TEC, haemoglobin, and PCV ranged from 1.75 (T_1) to 2.05 (T_8) million/ cumm; 6.9 (T_5) to 7.96 (T_4) gm % and 22.08 (T_1) to 27.36 (T_8) percent, respectively. Significant increase in TEC was observed with the supplementation of 0.05% synbiotic or its combination with 0.5% Withania root powder. Haemoglobin level was significantly higher in 0.5% and 1.5% Withania supplemented group. PCV values were significantly higher in all treatment groups except T_5 as compared with control. The study concluded that optimum performance could be achieved at 0.5% level of Withania in the presence of o.o5% synbiotic.

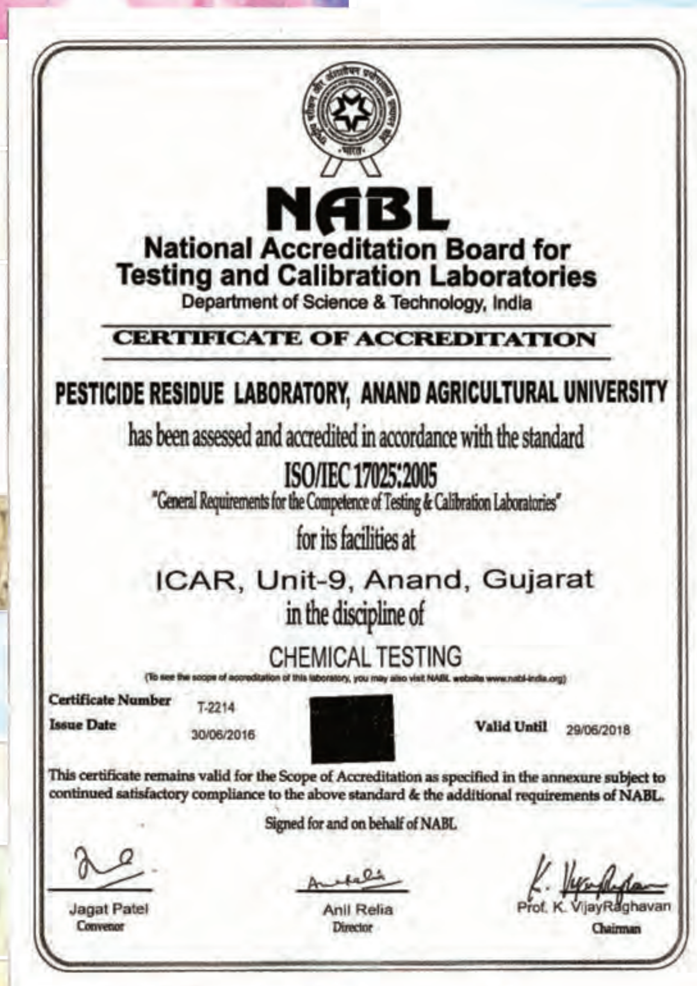
Keywords: Broiler, Withania, Synbiotics, Haemoglobin, PCV

SPONSORERS

PESTICIDE RESIDUE LABORATORY
ANAND AGRICULTURAL UNIVERSITY, ANAND

The only laboratory of the State Government with NABL 17025:200 5 in the field of Pesticide Residues.

The laboratory is actively involved in analysis of market samples like vegetables, fruits, cereals, pulses, animal feed and milk for consumer exposure.



NABL

National Accreditation Board for Testing and Calibration Laboratories

Department of Science & Technology, India

CERTIFICATE OF ACCREDITATION

PESTICIDE RESIDUE LABORATORY, ANAND AGRICULTURAL UNIVERSITY

has been assessed and accredited in accordance with the standard

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"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

ICAR, Unit-9, Anand, Gujarat

in the discipline of

CHEMICAL TESTING

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Certificate Number T-2214

Issue Date 30/06/2016 [redacted] **Valid Until** 29/06/2018

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the additional requirements of NABL.

Signed for and on behalf of NABL

Jagat Patel, Convenor — Anil Relia, Director — Prof. K. VijayRaghavan, Chairman

The scope includes vegetables, fruits, cereals, pulses, milk and water.

Core laboratory of the western region of the country under Monitoring of pesticide residues at National level, sponsored by Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India

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Department of Agricultural Microbiology, BACA, AAU, Anand

Anubhav Liquid biofertilizes (plant probiotics)

Contact: Phone & Fax: 02692 260211, Ext 813, Email: rvvyas@aau.in, rajababuvyas@gmail.com

More Information : http://www.aau.in/college-menu/department/765~815

Success story AAU's LBF on ICAR web site : http://www.icar.org.in/node/5667

https://www.youtube.com/watch?v=m8hxJqR_3UI

AAU Liquid Biofertilizer Products

Nitrogen Fixers: *Rhizobium, Azotobacter, Azospirillum*

Phosphate and Potash Solubilizer/Mobilizer *Bacillus/ Enterobacter*

Bio NP/ Bio NPK Consortium Indian Patent-2014

Liquid Bio-fertilizers

- Shelf life more than 1 year
- $5x10^8$ CFU /ml
- Easy use & transport
- Better efficiency, Acceptable by farmers
- Seed/ seedling/ soil treatment
- Suitable for drip irrigation & green house
- Save N, P & K chemical fertilizers
- Increase crop production up to 8 - 10 %
- Eco friendly and non polluting
- Highly useful in Organic farming

Krushimaotsav, Gujarat (2012) Liquid Biofertilizer in opinion of Shri Narendra Modiji

Liquid biofertilizers comprising useful indigenous soil bacteria maintains soil health and productiveness with reduction of costly chemical fertilizers

Liquid Biofertilizer Technology and its Commercialization

Liquid Biofertilizer Production & Bottling Plant

Launching of BIO NPK consortium by Smt. Aanadiben Patel, Chief Minister of Gujarat and MOU with GAIC, Gandhinagar

અનુભવ ટ્રાયકોડર્મા

ANUBHAV TRICHODERMA

A potential bioagent in plant disease management

- It is a formulation of CIB & RC, New Delhi registered Trichoderma viride (TNAU) isolate.
- The product Anubhav Trichoderma 1 % WP is talc based formulation.
- Minimum colony count: 2×10^{8} cfu / g.
- Useful in management of seed and soil borne diseases viz., wilt, root rot, collar rot, damping off, etc. in pulses, oilseeds, vegetables, etc.

Applications:

- Seed Treatment: Treat the seeds with Anubhav Trichoderma @ 10 g/ kg seed at the time of sowing.
- Soil Application: Apply in furrow @ 1.25 kg in 125 kg of castor cake/ha at the time of sowing.
- Seedling dip: 1 or 1.5 kg of Anubhav Trichoderma in 10 litre of water and dip the roots for 15 minutes.
- Enrich FYM and cakes @1kg / 50kg of materials.

Packaging:

- Packing size: 1 Kilogram
- Shelf life: 6 months

CONTACT:

CENTRE FOR RESEARCH ON BIOAGENTS
DEPARTMENT OF PLANT PATHOLOGY
B. A. COLLEGE OF AGRICULTURE
ANAND AGRICULTURAL UNIVERSITY,
ANAND- 388 110, GUJARAT, INDIA
TELEPHONE: (02692) 262435

NAVSARI AGRICULTURAL UNIVERSITY
NAVSARI -396450, GUJARAT, INDIA


Dr. C. J. Dangaria
Vice Chancellor


Hon'ble Chief Minister Visit


Hon'ble Agri. Union Minister Visit


G.Cot.Hybrid-6 (BG II)

MISSION

Attain excellence in education, relevance in research and outreach in extension education.

VISION

Transform Navsari Agricultural University in to a Knowledge Power Centre by the year 2020

ACCREDITATION

ICAR accredited Colleges:

1. N.M. College of Agriculture
2. ASPEE College of Horticulture
3. ASPEE Agri-business Management Institute

ICFRE accredited College:

1. College of Forestry

VCI recognized College:

1. Vanbandhu College of Veterinary Science & A. H.

Our Products:

Seeds: More than 5000 q/ annum

Tissue Culture Plantlets: More than 3.0 lakh/ annum (sugarcane/banana)

Liquid Bio-fertilizers: About 1.0 lakh/annum

Novel Sap: About 25000 litres/annum

Seedlings/saplings: More than 9.0 lakh/annum

The agricultural education in South Gujarat region started way back in 1965 with the establishment of N.M. College of Agriculture at Navsari. Another milestone was the establishment of ASPEE College of Horticulture and Forestry in the year 1988 at Navsari. Navsari zone of erstwhile GAU had attained the status of independent State Agricultural University (SAU) with the promulgation of Gujarat Agricultural University Act 2004 on 1st May, 2004 heralding formation of Navsari Agricultural University (NAU) with Navsari as the head quarter. After formation of NAU, new colleges like Aspee Institute of Agri-Business Management (2007), Vanbandhu College of Veterinary Science and Animal Husbandry (2008) at Navsari, College of Agriculture at Bharuch and Waghai and ASPEE SHAKILAM Agricultural Biotechnology Institute at Surat have been established during the year 2012. Further, the College of Agricultural Engineering at Dediyapada (2013) and College of Fisheries Science (2015) were also established at NAU, Navsari.

University offers courses for developing medium skilled manpower in the field of agriculture to work at grass root level through seven Polytechnics located at different stations. NAU offers Polytechnic in Agriculture (Bharuch, Vyara and Waghai), Polytechnic in Horticulture (Navsari and Paria), Polytechnic in Animal Husbandry (Navsari) and Polytechnic in Agricultural Engineering at Dediyapada. Besides, University also offers Certificate courses in Turf-grass management, Wild-life photography, Landscaping and Gardening, Agro ITI and Bakery etc.

Degree Programmes of NAU

Bachelors	Masters'	Doctoral
B.Sc. (Hons.) Agriculture, B.Sc.(Hons.) Horticulture, B.Sc. (Hons.) Forestry, B.V.Sc.&A.H., B.Sc.(Agril. Biotechnology), B.Tech.(Agril. Engineering) B.F.Sc.	M.Sc. (Agri.) M.Sc. (Horti.) M.Sc. (Forestry) M.V.Sc. M.B.A. (Agri-business Management) M.Sc. (ICT in Agriculture) M.Tech. (Agril. Engineering)	Ph.D. (Agriculture) Ph.D. (Horticulture) Ph.D. (Forestry) Ph.D. (Veterinary)

* For admission & other details please visit University Website : www.nau.in

E-Mail: registrar@nau.in **Ph:** 02637-282823

Technologies Developed :

- Precision Farming
- Protected Cultivation
- Organic Farming
- Waste Management
- High Density Farming
- Rejuvenation of Mango Orchards
- Bio-fertilizer & bio-pesticides
- Integrated Nutrient Management
- Fruit Fly Traps
- MIS and Mulching
- Closed Sub-surface Drainage
- Integrated Pest Management
- Vertical Cultivation
- Value Addition of Banana Pseudo-stem/ various fruits
- Brackish Water Aquaculture

Varieties Released: 45

Cotton (9) including 3 *Bt* hybrids, Sugarcane (6), Rice (8),Pulses (6), Nagli (4), Vari (2), Sorghum (3), Turmeric (2), Vegetable(3), Castor(1), Niger(1)

Extension Activities:

Extension wing of NAU disseminates useful technologies to farmers by organizing more than 5000 extension programmes including FLDS, on-campus/ off-campus trainings, farmers' Day, *Kisan Gosthi*, Agriculture exhibition, seminars and educational tour, mass communication programmes like *Krushi Mahotsav*,release of press notes, SMS, Video shows and radio/TV talks etc. every year. These programmes benefit more than 1.60 lakh farmers every year.


Guj. Navsari Sugarcane-8


Bio-fortified Rice (GNR-4)


Gujarat Navsari Nagli -6


G.Cot.Hybrid-8 (BG II)

NAUROJI BIOFERTILIZERS

ઉચ્ચ ગુણવત્તા ધરાવતા સંશોધિત નૌરોજી જૈવિક ખાતરો

Azotobacter | Rhizobium | Acetobacter | Azospirillum | PSB | KMB

Benefits of Biofertilizers

- ✓ 50% reduction in chemical fertilizers
- ✓ 20% increase in production
- ✓ 20-40 kg/ha increase phosphorous solubilization
- ✓ Improve soil texture and Increase soil fertility
- ✓ Eco-friendly
- ✓ Increase seed germination
- ✓ Improve plant growth by vitamins and growth hormones

જૈવિક ખાતરો થી થતા ફાયદા

- ✓ ૫૦% રાસાયણીક ખાતરો ની બચત
- ✓ ઉત્પાદન માં ૨૦% વધારો
- ✓ પ્રતિ હેકટર ૨૦–૪૦ કિ.ગ્રા રાસાયણીક ફોસ્ફરસ ખાતરની લભ્યતા વધારે
- ✓ જમીનનું બંધારણ સુધારે અને તેની ફળદ્રુપતામાં વધારો
- ✓ કિફાયતી તેમજ પર્યાવરણ માટે સુરક્ષિત
- ✓ છોડના ઉગાવાના દરને વધારે
- ✓ વિટામીન તેમજ વૃધ્ધિ વર્ધકો બનાવી છોડને પોષણ પુરુ પાડે

Manufactured and Marketed by

Biofertilizers Production Unit
Department of Plant Pathology, N.M. College of Agricutlrue
Navsari Agricultural University, Navsari-396450
Contact No.: +91 9537294343

ઉત્પાદન કર્તા તેમજ વિક્રેતા

બાયોફર્ટીલાઈઝર્સ પ્રોડકશન યુનિટ
વનસ્પતિ રોગશાસ્ત્ર વિભાગ, ન.મ.કૃષિ મહાવિદ્યાલય
નવસારી કૃષિ યુનિવર્સિટી, નવસારી–૩૯૬ ૪૫૦
સંપર્ક: +૯૧ ૯૫૩૭૨૯૪૩૪૩

NAVSARI AGRICULTURAL UNIVERSITY

NAUROJI STONEHOUSE FRUITFLY TRAP

નૌરોજી સ્ટોન હાઉસ ફળમાખી ટ્રેપ

- ❖ To control the Fruit flies in mango, sapota and other fruits and in climber vegetables
- ❖ It prevents yield loss up to 85% and eco-friendly in nature
- ❖ Fruit Crops- Methryl Eugenol Block Vegetables- Cuelure Block
- ❖ 10 Traps/ha
- ❖ Hang above 5 to 6 feet from the ground

- ❖ કેરી,ચીકુ અન્ય ફળોમાં તથા વેલાવાળા શાકભાજીમાંફળ-માખીના નિયંત્રણ માટે
- ❖ ઉત્પાદનમાં ૮૫% સુધીના નુકશાન અટકાવે છે
- ❖ ફળ પાકો માટે- મિથાઈલ યુજીનોલ બ્લોક અને વેલવાળા શાકભાજી માટે - ક્યુલુર બ્લોક
- ❖ ૧૦ ટ્રેપ પ્રતિ હેક્ટર
- ❖ જમીનથી ૫ થી ૬ ફૂટ ઊંચે લટકાવો

ઉત્પાદક અને વિક્રેતા:

ફૂડ ક્વોલિટી ટેસ્ટિંગ લેબોરેટરી
ન. મ. કૃષિ મહાવિદ્યાલય
નવસારી કૃષિ યુનિવર્સિટી
નવસારી- ૩૯૬ ૪૫૦
સંપર્ક. ફોન. નં. ૦૨૬૩૭ ૨૮૨૯૭૮

Dr. A. R. Pathak
Vice Chancellor

Junagadh Agricultural University

Junagadh 362 001 (Gujarat, India)

Phone: (O) +91-285-2672080-90, PBX: 322
Fax: +91-285-2674064




Introduction

Junagadh Agricultural University is among the four different Agricultural Universities in the State carved out of Gujarat Agricultural University under GAU Act-2004 and came in to existence from 1st May, 2004. University's jurisdiction is spread over the districts of Junagadh, Jamnagar, Rajkot, Porbandar, Surendranagar, Bhavnagar, Amreli, DevbhumiDwarka, GirSomnath and Morbi of the Saurashtra region, comprising of 32.74% (6.43 mha) area of the Gujarat state (19.60 mha).

Mission

Play pivotal role in teaching, research and extension education related to agriculture and allied sciences.

Vision

Junagadh Agricultural University intends to be one of the nation’s leading universities in terms of its academic quality, advancement in technological research and enhancement of farmers’ knowledge for sustainable agriculture as well as ensuring food and nutritional security to the people.

Education

Junagadh Agricultural University offers education (UG & PG) in the faculties of Agriculture, Agril. Engg.& Tech., Fisheries Sci., Veterinary Sci. & A.H., Horticulture and MBA in Agri-Business Mgmt. University also offer Diploma Courses in the field of Agriculture, Horticulture, Agro Processing, Agril. Engg., Animal Husbandry and Home Science.

Research

Junagadh Agricultural Universityhas **31 research stations** including multidisciplinary main research stations, sub centres on various crops and testing centres spread over in whole North Saurashtra& South Saurashtra Agro-climatic Zones. The research activities have been carried out in Crop Improvement, Crop Production, Horticulture and Agro forestry, Plant Protection, Basic Science, Social Science, Agril. Engg.,Animal Sci. and Fisheries Sci..As an outcome of the research 48 varieties of different crops were released and 403 technologies / package of practices recommended by JAU for the benefits of the farmers.

Extension

Extension activities through SSK, six KVKs, CoC, Farm Advisory Service Center, T&V Scheme, ATIC, Agriculture Diploma course, Agro based ITI, Bakery, Mali and Fisheries Training are carried out for the benefit of farmers. Community Radio Station **"Janvani 91.2"**isbroadcasting extension programmes.

Products of Junagadh Agricultural University, Junagadh

Gir Kesar Mango

SAWAJ Kesar Mango Pulp

Cocnut D x T (Mahuva)

Banana Tissue Culture

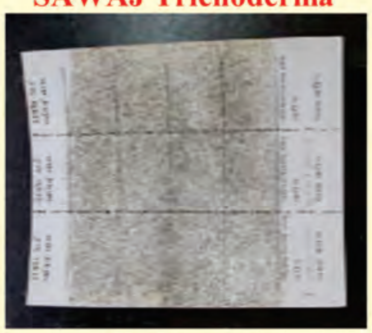
SAWAJ Beauveria

SAWAJ Trichoderma

SAWAJ HNPV & SNPV

SAWAJ PSB, Azotobacter and Rhizobium

Pheromone Trap



Trichocard

Seaweed

Fruit Fly Trap & Lure

Sesame G. Til-3

SARDARKRUSHINAGAR DANTIWADA AGRICULTURAL UNIVERSITY
SARDARKRUSHINAGAR-385 506 Dist: Banaskantha, Gujarat, India
web site: sdau.edu.in


Dr.(Prof.) Ashok A. Patel
Vice chancellor


Hon'ble Chief Minister visit


Wheat variety GW 451


Gujarat Rajgira-3

Expertise of SDAU

- Versatile varieties like GCH 7 in castor and GC 4 in cumin to solve insurmountable field problems.
- Nutritionally fortified varieties like GW 451 in wheat and GDLC 1 in leafy coriander.
- GD Cot 1 BG II, a cotton hybrid with state of art technologies to counter menace of American and Pink Boll Worms.
- Varieties like GW 1255 in wheat and GDM 4 in mustard amenable to value addition and industrial requirements.
- Varieties like GW 11 adaptable to limited irrigation.
- Varieties like Isabgul GI 4 to counter abiotic stresses like shattering.
- Proven versatility of varieties beyond the boundaries of Gujarat; 2 of the 10 most indented varieties of wheat at national level, castor, cumin are from SDAU
- Handy technologies of water harvesting, conservation and utilization; which is reflected in district Banaskantha as *numerouno* in adoption of MIS at the national level.
- Animal breeds' maintenance; milk yield / lactation increased from 910 L in 1978-85 to 2944 L in 2015-16 in Kankrej with lactation length increased from 225 days to 305 days.
- Different models of agro forestry on 86 ha land.
- Different models of arid horticulture.
- Integrated Farming System with models developed for daily income of Rs 990/ha with maintenance of sustainable health of farmer's family, environment and above all otherwise depleting natural resource base entailing soil, water and biodiversity.
- Richest in situ biodiversity of date palm.
- Maintenance of local biodiversity; identification of new breed Banni buffalo.
- Zoonotic Diseases: First time reported serotypes 23 and 24 of Blue Tongue Virus in camel. 15 isolates of *Brucella* deposited to national repository. Confirmed zoonotic pox in buffalo, testing of vaccination of dreaded Johne's disease. Diagnostic facilities for haemoprotozoon diseases.
- Technologies in environmental engineering including solar energy

Extension Activities

The wing of Extension Education is functioning with T & V system, Sardar Smruti Kendra, Krishi Vigyan Kendra, ATIC etc and organizing various programmes viz; Krishi mahostav, training, FLDs, Kisan gosthy, farmers-scientist interaction, field day, training for extension functionary, diagnostic visit, exhibition, exposure visit etc. Reaching more than 2.5 lac farmers to disseminate latest technologies.

Educational course offered:

Under Graduate	Post Graduate & Ph.D	Diploma
B.Sc.(Hons.) Agri.	M.Sc. (Agri)	Horticulture
B.V.Sc & A.H	M.V.Sc.	Agriculture
B.Sc.(Hons.) Home science & Nutrition	M.Sc. (Home Science)	Home science
B.Tech (Dairy & Food Technology)	M.Sc. (Basic Science)	Veterinary
B.Sc.(Hons.) Horticulture	Ph.D (Agri., Veterinary, Home Science)	
B.Tech (Renewable & Env.Engg)	P.G. Diploma in Plant Tissue Culture	
B.Sc.(Food Quality Assurance)	MBA in Agribusiness	
Basic Science (Biotech/ Micro/ Biochem)		

Kamdhenu University

Our Motto: Welfare of all living beings

(Established by Government of Gujarat vide Gujarat Act No.9 of 2009)

Karmyogi Bhavan, Block No-1, 4th Floor, B-1 Wing, Sector 10A, Gandhinagar 382010
Phone No: 079-65726668, E-mail: registrar.kamdhenuuniversity@gmail.com,
Website: www.ku-guj.org

The Kamdhenu University is established and incorporated by the State Government vide Kamdhenu University Act, 2009 (Gujarat Act No.9 of 2009) as a teaching and affiliated University for the development of veterinary and animal sciences and for furthering the advancement of learning, conducting of research and dissemination of findings of research and other technical information in veterinary and animal sciences including dairy, fisheries and allied sciences in the state of Gujarat.

Prof. M.C. Varshneya, Vice-Chancellor

Vision

- To be the National Leader in Education and Research in the fields of Veterinary and Allied Sciences.

Mission

- To excel in Education and Research and make advancement in all the fields of learning leading to welfare of all living beings
- To shape the student into compassionate Professionals
- To Promote productivity of animal Livestock and Aquaculture through dissemination of knowledge empowering the owners.

Post Graduate Programmes

Sr. No.	Name of Institute	Programme Offered
1	Post Graduate Institute for Veterinary Education and Research,Gandhinagar	M.V.Scin Animal Genetics & Breeding , Livestock Production and Management, Veterinary Gynaecology Animal Nutrition
2	Post Graduate Institute for Dairy Education and Research, Amreli	M.Tech(Dairy) in Dairy Microbiology, Dairy Chemistry
3	Post Graduate Institute for Fisheries Education and Research, Gandhinagar	M.F.Sc (Fisheries) in Aquaculture
4*	Post Graduate Institute for Dairy Education and Research, Mansinhbhai Institute of Dairy & Food Technology, Mehsana	M.Tech Dairy Technology, Dairy Microbiology, Dairy Chemistry

Bachelor degree Programmes: B.Tech(Dairy Technology)

Constituent College

- College of Dairy Science, Opp.Balbhavan, Library Road, Amreli-365601

Affiliated College

Mansinhbhai Institute of Dairy & Food Technology, DoodhSagar Dairy Campus, Highway, Mehsana-384002

Diploma Programme: 3-year Diploma in Animal Husbandry

Sr. No.	Name of Institute
1	Polytechnic in Animal Husbandry, Mehtapura, Nr. Government Poultry Farm, Himmatnagar-383001 **Constituent**
2*	Polytechnic in Animal Husbandry,Shree Gram seva Kendra, Khadsali,Ta.Savarkundala, Dist.Amreli-364530
3*	Keshavam Polytechnic in Animal Husbandry,At& PO & At. Chhapi, Ta.Idar-383230
4*	Navsarjan Polytechnic in Animal Husbandry,At.Ranchhodpura, Po.Devpura, Ta.Vijapur,Dist.Mehsana-382870
5*	Riddhi Polytechnic in Animal Husbandry,Shree Riddhi Education Campus, Chandra Nagar Society,Motipura, Ta. Himmatnagar, Dist.Sabarkantha-383001
6*	Vrundavan Polytechnic in Animal Husbandry,Tower Chowk, At.,Po-Jasdan, Dist.Rajkot-360050
7*	GVM Polytechnic in Animal Husbandry, Gopalak Vikas Mandal, At & Po. Aniyad, Ta. Shahera, Dist. Panchmahals- 389210

*** Affiliated College & Polytechnic**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विद्या डेरी Vidya Dairy

AAU CAMPUS, ANAND – 388 110

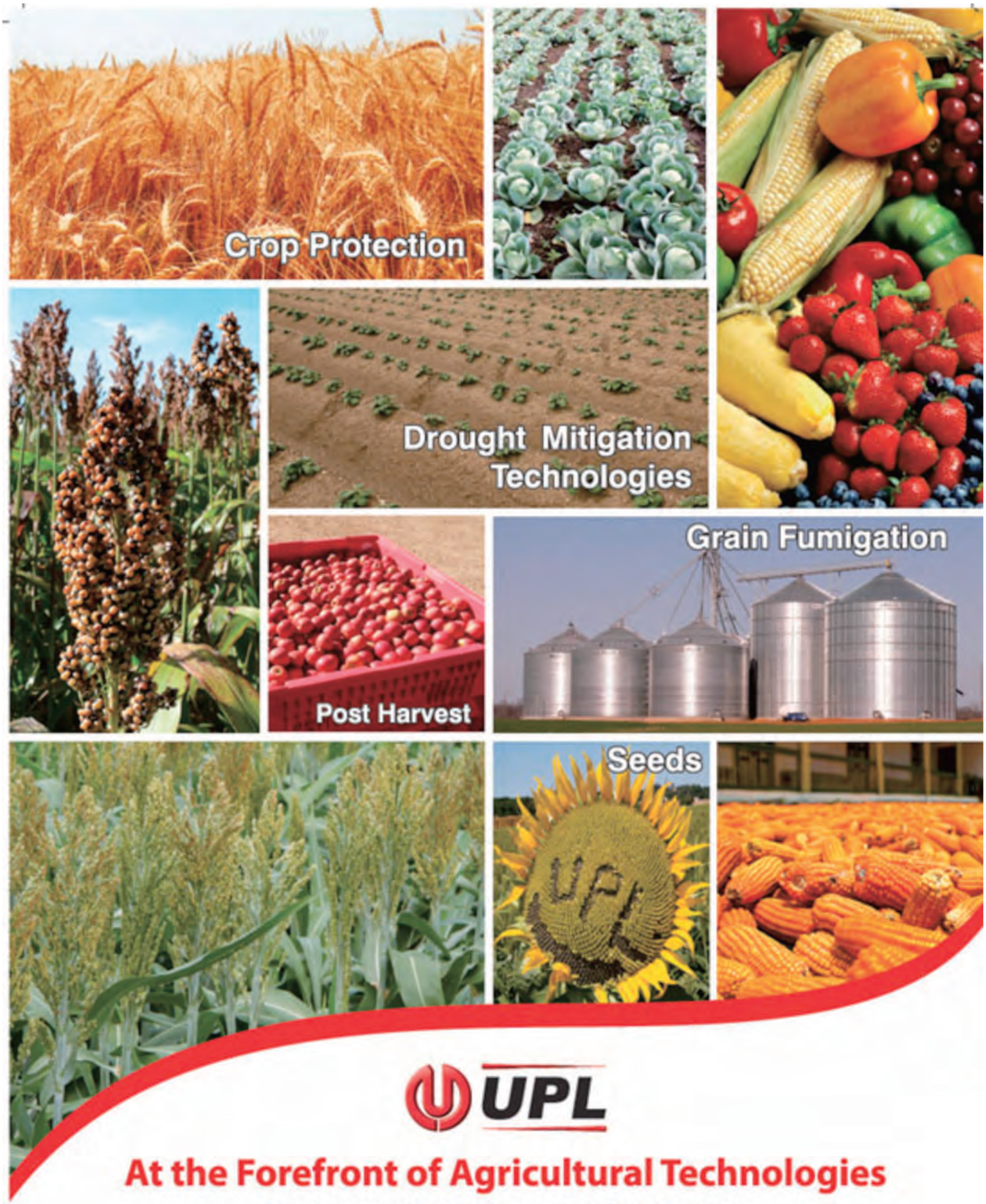
TRAINING PROGRAMME SCHEDULE FROM NOVEMBER 2016 TO MARCH 2017

Vidya Dairy a Student training Institute imparts hands-on-experience to the B. Tech (Dairy Technology) students of SMC college of Dairy Science-Anand. Besides imparting regular training to B. Tech (DT) students, the dairy also organizes Short-Term Training Programmes for the benefit of the industry in association with the Faculty of Dairy Science, Anand. These programmes are aimed at giving broad orientation of technological and analytical aspects of milk and major milk products along with hands – on – experience to the dairy / non-dairy personnel working in plant and laboratory areas. This helps the organization to improve efficiency, reduce cycle time and cost.

Month	Schedule	Course Name	Fee* (INR)
Nov-16	03.11.2016 to 05.11.2016	Detection of Adulterants in Milk	6000/-
	07.11.2016 to 10.11.2016	Dairy Supervisor Training	7000/-
	21.11.2016 to 23.11.2016	Technology of Fermented and Probiotic Dairy Products	7000/-
Dec-16	05.12.2016 to 10.12.2016	Technological and Engineering aspects of Ice Cream Plant	12000/-
	15.12.2016 to 17.12.2016	Management of Bulk Milk Cooling System (Guj)	5500/-
Jan-17	02.01.2017 to 07.01.2017	Dairy Technology for Non-Dairy Technologists (Eng)	12000/-
	18.01.2017 to 21.01.2017	Sensory Evaluation of Milk and Milk Products	9000/-
	23.01.2017 to 28.01.2017	Laboratory Practices in Dairy and Food Plant	12000/-
Feb-17	06.02.2017 to 11.02.2017	Dairy Technology for Non-Dairy Technologists (Guj)	12000/-
	13.02.2017 to 17.02.2017	Management of Bulk Milk Cooling System and Clean Milk Production (Hindi)	10000/-
	20.02.2017 to 22.02.2017	Detection of Adulterants in Milk	7000/-
Mar-17	02.03.2017 to 04.03.2017	Technology of fermented and probiotic dairy products	7000/-
	06.03.2017 to 08.03.2017	Management of Bulk Milk Cooling system (Guj)	6000/-

Fee* to be paid by DD in favour of VIDYA DAIRY payable at Anand, is inclusive of food, accommodation (double occupancy, A/C rooms) and service tax. Due to unforeseen circumstances, programme dates may change / get cancelled in some cases. Prior confirmation is therefore, a must before participating in any program. Contact: Training Co-ordinator 09377211866 / 09377925124, 02692-221504, 02692-262501 Email: trainings@vidyadairy.in paoffice@vidyadairy.in Website : www.vidyadairy.in


સહકારથી સમગ્ર સમાજની સેવા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Each work has to pass through three stages
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Hon. Chief Minister,
Gujarat

"Role of GIDC in Gujarat's and India's economic growth is pivotal and decisive. Apart from facilitation National and International iconic manufacturing units, GIDC must be credited for its fast-track development of industrial estates and MSME Units. GIDC's constant focus on providing world class infrastructure facilities comes for its visionary outlook for the future."

GIDC Vision

"To make GIDC an effective, vibrant and timely provider of quality industrial infrastructure with easy, quick and transparent delivery mechanism at competitive pricing and without losing sight of its social responsibilities."

Set up under the Gujarat Industrial Development Act. 1962 as a Statutory Board

Identifies and develops locations suited for Industrial purposes

GIDC offers developed industrial zone/estates, approved & well developed chemical estate, speedy land aggregation, clear land titles, cluster benefits, flexible payment options, waste disposal system & up-gradation of industrial estates

Nodal agency of the Government of Gujarat for providing Industrial backbone of the state

GIDC has an inventory of 202 Estates comprising of over 63,000 Units across the State

1 Identification & **Aggregation of land**

2 Development of Core & Support Infrastructure

3 Allotment of Industrial Plots

Core Infrastructure	Support Infrastructure
✓ Developed Industrial Plots ✓ Water Supply ✓ Power Supply ✓ Corridor for amenities-gas, telecom, pipeline etc. ✓ Effluent collection conveyance, treatment & disposal	✓ Skill Up-gradation Centers ✓ Environmental Conservation Initiatives-green space, parks, etc. ✓ Space for public amenities-banks, hospitals, school, police station, etc. ✓ Housing Plots ✓ Commercial spaces

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Development of **MSME Industrial Park**

Development of **Women Industrial Park**

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Training & Skill up-gradation programs

202 GIDC Estates across Gujarat

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ASSOCIATION OF AGROMETEOROLOGISTS

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Journal of Agrometeorology

(ISSN:0972-1665)

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on
Climate-driven Food Production Systems, Agrometeorological Interventions

Coimbatore, 20–22 December 2016

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Agrometeorological Interventions
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8	Presenting the paper in the Conference	:	Yes / No
9	Preference of presentation	:	Oral / Poster
10	If yes, title of the Paper	:	
11	Theme Number and title	:	
12	Registration Category	:	
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13	Do you require accommodation	:	
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