

# Future Agriculture In Viksit Bharat

**“Women Farmers - New Farmers”**



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

# A New Era of Agricultural Management with the Power of Women

Hon'ble Prime Minister Shri Narendra Modi



- Women play a vital role in the agricultural sector. It is essential to introduce modern technology into farming to strengthen their capabilities. Agriculture must be viewed in three key segments—traditional farming, horticulture, and animal husbandry. If we can advance in these areas collectively, the contribution of women will increase significantly. When the poor, farmers, women, and youth become empowered, the nation becomes stronger.
- When women are economically empowered, they can support themselves and their families, contribute meaningfully to economic growth, and break free from the cycle of poverty.
- Women's empowerment is not solely a women's issue — it is a shared responsibility. It requires active participation and support from individuals, communities, governments, and institutions

# **Future Agriculture in Viksit Bharat “Women farmers - New Farmers”**

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First Edition : Dec – 2025

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Published by:

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Sustainable Development and Public Leadership**

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Ahmedabad – 380014 Phone: (0 91 79) 26421580

Website: [www.nccsindia.org](http://www.nccsindia.org)

**Printer:**

**Sahitya Mudranalaya Pvt. Ltd.**

Ahmedabad

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## Foreword

The last decade has witnessed huge increase in work participation rate of women in India. Actual numbers are revealed by periodic labour force survey conducted by the Ministry of Statistics and Programme Implementation, GOI, since 2017-18. This data shows that work participation rate of women was only 16.5 per cent in year 2017-18 and it reached 30.7 per cent in year 2023-24. As a result, women are catching up with men in work opportunities.

It is interesting to mention that most of the increase in women workers is recorded in agricultural activities. The number of women workers in agriculture and allied activities has increased from 604 lakh in year 2017-18 to 1365 lakh in year 2023-24. This has raised share of women in total workforce in agriculture from 30 per cent to 48.7 per cent in last six years. There is a big increase in feminization of agriculture. Further classification of women workers in agriculture reveals that majority of them are self-employed in agriculture and belong to category of farmers. This requires suitable development strategy in agriculture to absorb more labour and to make farm employment more female-friendly.

It is pertinent to mention that Government of India under the leadership of Hon'ble Prime Minister, Shri Narendra Modi has undertaken several initiatives to encourage and enable women to play a stronger role in agriculture, processing, and marketing. The NaMo Drone Didi initiative empowers women-led SHGs with drone technology, enabling them to offer precision agricultural services while boosting rural incomes. This inclusive model of rural growth strengthens both households and communities.

I am happy to note that NCCSD is working on the ground for economic empowerment of farm women in Gujarat and undertaking regular activities to develop capacity of women farmers to adapt to climate change and secure sustainable livelihood with appropriate technology. The guidebook prepared by NCCDS draws from their ground level experience and outlines a vision for harnessing potential of Nari Shakti as envisaged by our Prime Minister. The Guidebook offers lot of practical ideas and practices for capacity building of women farmers. I hope this guidebook will be very useful for policy makers, development practitioners and experts involved in women-led transformation of agriculture and securing their livelihood.

[Ramesh Chand]

New Delhi, 21<sup>st</sup> October, 2025



एक कदम स्वच्छता की ओर

# PREFACE

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The face of Indian agriculture is changing, and at the heart of this transformation is the woman farmer. She is the backbone of the rural economy, the steward of household nutrition, and an agent of change in a world grappling with climate unpredictability. Despite her pivotal role, her contributions have historically remained under-recognised, often lacking the necessary resources, training, and institutional support to thrive as a modern, Climate-Smart agriculturist.

This guidebook, **Women Farmers - New Farmers Capacity Building Program,** is a collaborative effort to bridge this gap. It documents the journey and impact of the capacity building program organised jointly by the **National Council for Climate Change Sustainable Development and Public Leadership (NCCSD INDIA)** and the **Oil and Natural Gas Corporation Ltd. (ONGC)**, a prime example of corporate social responsibility investing in sustainable rural development.

## **A Vision for the ‘New Farmer’**

The core philosophy of this program, and consequently, this book, is to redefine the traditional ‘farmer.’ The ‘New Farmer’ is a climate-smart, financially literate, and an entrepreneurial woman who is empowered to make informed decisions for her farm, family, and community.

This program was not merely a series of training sessions; it was an immersive experience focusing on a spectrum of modern agricultural practices, including:

- **Climate-Smart Agriculture (CSA) and Adaptation:** Equipping women with the knowledge to manage crop water quality, improve soil health, and adopt resilient farming practices against extreme weather.

- **Empowerment and Entrepreneurship:** Providing skills in post-harvest management, value-addition, collective marketing strategies, and financial management for small farm enterprises.
- **Good Agricultural Practices (GAPs):** Enhancing knowledge on farm sanitation, food safety, and the effective use of organic inputs.

## **The Journey Documented**

This volume is a collection of case studies, technical summaries, and field insights derived directly from the implementation of the program. It captures the spirit of the participating women—their challenges, their breakthroughs, and their emergence as **‘Aatmanirbhar’ (Self-Reliant) and climate-smart leaders** in their villages. It also reflects the commitment of NCCSD, with its focus on practical, scientific, and locally relevant climate adaptation strategies, and the sustained support from ONGC’s CSR initiative, which made this extensive outreach possible.

We believe the insights, methodologies, and success stories compiled here will serve as a crucial resource for policymakers, development organisations, agricultural extension professionals, and students of rural development. It is an evidence-based narrative demonstrating that investing in the capacity of women farmers is the most effective pathway toward achieving India’s Sustainable Development Goals (SDGs) related to gender equality, food security, and climate action. In VIKSIT BHARAT

To the indomitable women farmers who opened their fields and their lives to this program, we extend our deepest gratitude. Their diligence, quick learning, and leadership are the true measure of this project’s success, and their stories are the true essence of this book.

This guidebook will be of interest to all who have interest in agricultural and rural development.

JAY HIND

Date : 27/10/2025  
Place : Ahmedabad

Dr. Kirit Shelat  
Dr. A.R. Pathak

## ACKNOWLEDGEMENT

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This book is the outcome of the collective efforts, guidance, and support of numerous individuals and institutions. We express our deep appreciation to all who contributed to its successful completion.

- Our foremost gratitude goes to the women farmers (Mahila Khedut) from the five districts—Bhavnagar, Amreli, Kutch, Bharuch, and Navsari—who actively participated in the training programmes. Their enthusiasm and involvement form the foundation of this initiative.
- We are sincerely grateful to Hon. Minister of Agriculture, **Shri Raghavjibhai Patel; Dr. Anju Sharma**, Additional Chief Secretary, Department of Agriculture; **Shri Kharadi**, Commissioner, Department of Fisheries; the Vice Chancellors and Research Scientists of the State Agricultural Universities; and the Directors of the Department of Agriculture — **Dr. Rabari, Dr. Chavda, Dr. Falguni Thakar, and Dr. Joshi.**

We also extend heartfelt thanks to **CGM, NABARD, Dr. B.K. Singhal**, and to all District and Taluka Officers of the Department of Agriculture for their unwavering support in implementing this programme successfully.

- We acknowledge the significant contributions of scientists and experts from the six Agricultural Universities of Gujarat, as well as officers from the Departments of Agriculture, Animal Husbandry, Fisheries, ATMA, and KVKs, whose technical guidance enriched this initiative.

- Our institutional collaborators deserve special mention: **Shri Ashwinbhai Shroff**, Chairman, VRTI and Excel Industries; **Shri Dipeshbhai Shroff**, M.D., Agrocel Industries Pvt. Ltd.; **Smt. Chandrikaben** and **Smt. Nandini Ben** of Atapi Sanstha, Bharuch; **Shri Manubhai** and **Shri Vallabhbhai Hadia**, VRTI, Bhavnagar; **Shri Rohithbhai Trivedi**, VRTI, Amreli; **Shri Kamlendubhai** and **Shri Sendhabhai**, VRTI, Mundra, Kutch; and **Dr. Ramanbhai B. Patel**, Navsari, for their strong collaboration and field-level support.
- We are thankful to the distinguished Members of NITI Aayog, Government of India—**Dr. Saraswat** and **Dr. Ramesh Chand**—as well as Senior Advisor **Dr. Neelam Patel**; **Dr. Kinkini Das Gupta** from the Department of Science and Technology; Dr. Sadamate; **Dr. N.C. Patel**; and **Dr. Amrita Chatterjee** for their valuable insights and encouragement.
- We also appreciate the dedicated efforts of **Shri Satish Chhaya**, **Sunny Patel**, **Deepak Rana**, **Jay Patel**, and **Mohandas** of NCCSD, who played an important role in preparing this knowledge product.
- Our sincere thanks to **Dr. R. Gopichandran**, NTPC School of Business, for editing the text and providing a cohesive and comprehensive perspective.
- We gratefully acknowledge **Shri Dineshbhai Patel** of Sahitya Mudranalaya Pvt. Ltd. for printing the book with care and precision.

Finally, we extend our respectful gratitude to the Chairman and Board of Directors of ONGC—Director **Dr. Manish Patil**, **Shri Mukherjee**, and **Shri Atal Srivastava**—whose vision, support, and commitment lie at the core of this initiative’s success. Their leadership made this programme a reality.

Pranam

Jai Hind



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# **Future Agriculture in Viksit Bharat**

## **Women Farmers – New Farmers**

### **In the Arena of Climate Change Sustainable Livelihood with Technology**

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#### **Introduction:**

The present Guidebook is a vital resource designed to empower the emerging generation of agricultural producers, with a special focus on addressing the unique needs and challenges faced by women farmers and all those who here interested in agriculture sector. It is prepared, based on practical experience of capacity building and upskilling nearly 2500 women farmers in five districts of Gujarat. This was part of the ONGC NCCSD project on WOMEN FARMERS -NEW FARMERS CAPACITY BUILDING PROGRAM.

#### **Purpose and Vision**

This program is rooted in the belief that strengthening the capacities of women and new entrants in agriculture is crucial for household food security, economic growth, and sustainable farming practices. The primary mission is to facilitate transitions in agriculture driven Indian rural economy. This has to evolve as a profitable and entrepreneurial agri-business duly responding to challenging posed by in climate change. An important constraint is the fact men are increasingly going out for work. As a consequence, greater responsibilities are imposed on

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women for on farm decisions. It is therefore absolutely essential build the latter's capacities to deliver optimally.

### **Key Focus Areas**

The present publication serves as a comprehensive manual, offering structured training insights and information to enhance skills to overcome systemic barriers. It typically covers:

- Development of skills to use modern, climate-resilient agricultural techniques, post-harvest management, and value addition.
- Knowledge enrichment especially about business planning, financial literacy, market linkages, and access to credit and government schemes for economic empowerment; procedures for securing critical aspects, such as land registration, quality inputs and agricultural extension service &
- Leadership and Governance to foster leadership skills, particularly in women, to enable meaningful participation in farmer cooperatives and decision-making bodies.

This is in response to a felt need, reflected in the fact that:

- Agriculture contributes 16% to India's GDP; increasingly so as a women-centric activity.
- 70–80% of rural women workers are engaged in farming or allied agricultural activities. They play a key role in sowing, weeding, harvesting, threshing, grain storage, fisheries, animal husbandry, and at times marketing too.
- In rural India, women form the most productive workforce, especially in developing regions.
- Male outmigration for jobs and youth leaving villages for education shifts responsibility entirely to women.
- Women are now decision-makers, not just helpers and must therefore be recognized as "New Farmers. Yet, most are officially identified as "Workers" (in census report) and not as "farmer."

## Status of Women Farmers in the Agricultural domain: A snapshot

### Indicator Status

- Rural women engaged in agriculture >73%
- Women with legal land ownership 12.80%
- Women with Kisan Credit Card <7%
- Women members in FPOs/PACS <10%
- Women with access to crop insurance <5%
- Women receiving agriculture training <10%

Source: NSSO, NABARD, Agriculture Census, FAO

### Honorable Prime Minister Shri Narendra Modi envisions “Nari Shakti – Foundation of New India”

Women are not just helpers — they can lead the **next agricultural revolution** as **independent farmers**, even without land ownership. This invaluable word view reflects equity and justice; calling for action on seven focal areas indicated in the following:

1. Recognition as ‘Farmer’ – Ensure Policy support for women without land titles.
2. Promote SHGs & FPOs – Strengthen women-led producer groups.
3. Enable Easy access to credit & insurance – Simplify KCC & PMFBY for women.
4. Acknowledge Women as agri-entrepreneurs provide support for organic farming, value addition, food processing.
5. Enhance skills in machinery, animal husbandry, climate-smart agriculture.
6. Enable Access to technology including Women-friendly tools, solar devices, mobile apps, drones.
7. Enhance Inclusion in schemes through direct participation in PM-Kisan, Digital India, etc.

### These are essential to help women farmers tackle challenges due also to:

- Lack of land rights and related women-centric approach in agricultural systems

- Limited access to schemes, support, and information and financial facilities / subsidies / schemes / agri machinery on rent
- Growing household responsibilities
- Lower wages
- Lack of participation in decision-making
- High impact of climate change
- Low participation in the agricultural value chain (e.g., packaging, marketing)
- Inadequate women-friendliness in agricultural universities and research centers &
- Lack of gender-sensitive extension literature for women.

**The ONGC NCCSD Model for New Farmers – Women Farmers demonstrated the success of need-based interventions**

- In 05 districts, 10 villages each, 50 women per village; thus, for the benefit of 2,500 beneficiaries.
- Through Three-stage training / guidebooks and follow-up visits.
- Partnered with local NGOs/SHGs for implementation.
- Integrated Feedback & enhanced experiential learning and Tracked progress through structured reporting.

**The Status of Women Farmers (Before the Program) was quite complex due to**

- Lack of awareness about sustainable farming practices and market opportunities.
- Minimal contact with agricultural extension/ administration, limiting access to knowledge and schemes.
- Limited family support, restricting their participation in decision-making.
- Additional responsibilities such as animal husbandry, family care, and household chores, leaving little time for skill development.

- Exclusion from agricultural decision-making, despite active involvement in farming activities.

NCCSD Approach embedded eight Unique Features for women – empowerment. Local level planning meant “Discuss together, plan together”. Meetings were held with agriculture, horticulture, animal husbandry, industry departments, national/international experts, and women before the capacity building program. Training topics and approach were decided with women’s participation; further manifest as:

1. Training at periods of time suitable for them aligned with their household schedules. These were in their own villages, balancing labour and domestic responsibilities and follow up visits at their at doorstep.
2. Direct presence of experts from government departments and industry officials dealing with agriculture and animal husbandry
3. Three topic-based manuals to support continuous learning after training. Women are commendably literate, so manuals help them self-learn and adopt new ideas and peer – sharing. Each manual is linked to a specific training session, written in simple language with practical information pictures, and local features.
4. Free meals were provided during training to ensure full participation.
5. Review meetings were held before and after sessions with experts to refine content.
6. These translated into three separate trainings per woman and did not stop as just one-day events. Feedback and field visits for continuous contact included forms collected after each training. Such regular field visits by NCCSD officials resolved queries.
6. Each woman accordingly received 3 topic-specific trainings.
7. Proper coordination and participation through a model of collaboration ensured success. This included the role of NITI Aayog, agriculture, animal husbandry, industry departments, national/international experts, and local organizations.

## **Two technically enriching interventions included the:**

- I) The Drone Demonstration Program: Organized in collaboration with Optimus Unmanned Systems (Delhi based company) in four districts. The team visited each district thrice to provide live demonstrations of the use of drones for agriculture. It is through these drone demonstrations, women participants got to know about the Drone Didi scheme and related new technologies.
- II) Financial Literacy Program guided them about accessing financial assistance and support schemes for farming and entrepreneurship.

125 women leaders were trained in 50 villages. In addition to the above stated, SHGs & FPO participation was strengthened. This also enhanced adoption of solar, drip irrigation, food processing, dairy tech. Women launched new enterprises e.g., khakhra, agro businesses. The overall impact was seen as Empowered rural women, sustainable livelihoods and resilient communities.

## **Key Partners and Contributors Supporting the Program included the following:**

- Institutions & Departments
- Optimus Unmanned Systems
- Panchayats
- Krishi Vigyan Kendra (KVK)
- District Agriculture Department
- ATMA (Agricultural Technology Management Agency)
- NABARD
- Horticulture Department
- Agricultural Universities (Vice Chancellors & Scientists)
- CED Department
- Government Leaders & Policy Makers
- Shri Raghavji Patel – Hon'ble Minister, Agriculture, Animal Husbandry, Cow Breeding and Fisheries, Government of Gujarat

- Hon'ble Shri Parshottam Rupala – Hon'ble MP (Lok Sabha) & Former Union Minister, Department of Fisheries, Animal Husbandry & Dairying, Government of India
- Hon'ble Shri Dileep Sanghani – Chairman, IFFCO & GUJCOMASOL and Former Agriculture Minister, State of Gujarat
- Dr. Anju Sharma, IAS – Additional Chief Secretary, Agriculture, Government of Gujarat
- Shri Sandeep Kumar, IAS - Secretary (Co-operation, Animal Husbandry, Cow Breeding & Fisheries)
- Dr. V. P. Chovatia -Vice Chancellor,Junagadh Agricultural University.
- National & International Experts
- Prof. Ramesh Chand – Hon'ble Member, NITI Aayog, Government of India
- Dr. V. K. Saraswat – Member, NITI Aayog & Chancellor, Jawaharlal Nehru University
- Dr. Neelam Patel – Senior Adviser (Agriculture), NITI Aayog
- V. V. Sadamate – Former Advisor (Agriculture), Planning Commission, Government of India
- Prof Sanjay Deshmukh – Professor & Head, Life Sciences, Mumbai University
- Prof. O. S. Mbuya – Director, Center for Water & Climate Institute, Florida A&M University,USA
- Mr. Geoffrey Kirenga – CEO, SAGCOT Centre Ltd., Tanzania
- Dr. Keshav Nayak – Former Director General, DRDO, Bangalore
- Dr. S. S. Kalamkar – Director & Professor, Agro-Economic Research Centre for Gujarat
- These were logical extensions of Ongoing Efforts by NCCSD. These include
- Guidebooks in Gujarati for Women Farmers; covering 3 crop seasons with season-specific practices. Work is in progress on the English version.)

- 06 Success Stories uploaded digitally on Atmanirbhar SELF RELIENT NCCSD GUJARAT INDIA YouTube channel. More are being curated
- Continual handholding for adoption, innovation, awareness, and confidence in decision-making
- Outcomes as
  - i. 2,761 women trained in sustainable farming & entrepreneurship.
  - ii. 350+ women join in FPOs
  - iii. 15+ home-based enterprises started.
  - iv. Adoption of Pakrutik kheti, animal husbandry innovations, drones, soil kits
  - v. enabled an average 10% income increase along with 15% reduction in farming costs through natural inputs.
  - vi. Increased decision-making roles and outcomes in market engagement.

**District-Specific Focus & Achievements establish the diversity that should be addressed.**

District	Focus Area	Key Outcomes
Bhavnagar	Soil health, drone tech	30% cost savings, better fertility, increased natural farming
Bharuch	Value addition, Natural farming	6 enterprises started-products sold in local markets
Kutch	Animal husbandry, drought crops	Improved livestock health, reduced costs, climate-resilient crops
Amreli	FPO, home industries	300+ women members in FPO, 20+ enterprises (papad, wafers, khakhra), higher incomes
Navsari	Horticulture, market access	Direct-to-market sales (pickles, Mango pulp, papad, tutty-fruity)

**District-Level Variations & Need substantiate the above stated.**

- Navsari & Bharuch – Higher awareness and greater adoption.

- Bhavnagar & Amreli – Awareness exists, but more desire for adoption.
- Kutch – Lack of awareness, need for capacity-building.

**Action: District-specific strategies + cross-learning from high achievers.**

An important reality is that while Women & Agriculture related systems exist , access is Limited. These pertain to the

- MKSP (NRLM) – Direct SHG support
- Women SHG Loan Scheme – Local & easy access
- Cow/Goat Assistance Scheme – Linked with animal husbandry
- Ujjwala Yojana – Household-level gas connection in woman’s name
- Widow/Old Age Pension – Social security support
- Mukhyamantri Mahila Kisan Sashaktikaran Yojana – State-level scheme for training & tools
- Schemes Difficult for Women to Access
- PM-KISAN – Land must be in women’s name
- PMFBY Crop Insurance – Awareness & registration barriers
- KCC – Banking complexities, spousal consent
- Solar Pump (PM-KUSUM) – High cost & online hurdles
- Agri-Startup Subsidy – Certification & IT filing required
- Drone/Fisheries Schemes – Digital & registration gaps.

**Policy Suggestions: Empowering Women in Agriculture (Gujarat) therefore cover ten domains.**

They must be viewed with respect to the Changing Face of Agriculture. In Gujarat, women’s participation in the agricultural sector is steadily increasing. Today, women are not just support workers but are moving forward as farmers, entrepreneurs, and leaders. State policies and agricultural diversity are providing them with opportunities for empowerment. However, there are still many challenges in this journey of growth – lack of financial support, technology, market access, and information.

1. **Financial Support and Awareness:** Special scheme for women – Under the Mukhyamantri Mahila Kisan Sashaktikaran Yojana (MMKSY), assistance of up to ₹50,000 per year can be provided for improvements. The Central government is also trying to include women in schemes like PM-KISAN and the Agriculture Infrastructure Fund (AIF). Often, women cannot get loans due to lack of land ownership papers. Therefore, government camps and SHGs/FPOs should spread information about alternative arrangements.
2. **Appropriate Tools and Technology:** Labor-saving tools such as groundnut decorticators, dibblers, drum seeders, cono weeders, maize shellers, egg incubators etc., should be specially designed for women. The State government should establish agricultural tool banks from which SHGs or FPOs can rent equipment.
3. **Market and Climate Linkages:** It is essential to promote natural farming, carbon credits, and online platforms/apps to sell agricultural produce quickly and directly in the market. It is equally important to devise arrangements for delivering market-related information in the local dialect for better understanding.
4. **Technology for Animal Husbandry:** Integrate use of AI, IoT-based devices, digital vaccination, and record-keeping apps for livestock health management. Enhance government incentives for women-run dairy cooperatives.
5. **Climate Advisory and Updates** should be enhanced using SMS, WhatsApp, community radio, online apps, and audio-visual advisories in local language. Young women should be trained as “Agro Advisory Champions” to spread information to rural women.
6. **Home-based Industries and Benefits** should be highlighted aligned with the PMFME scheme with training for making papad, pickles, and other small-scale products with low-cost machinery, along with branding development. Encourage SHGs and rural producer groups for direct market entry.
7. **Market Logistics:** “Gati Shakti” and e-NAM platform to be

made useful for small farmers. Provide cold booths, cold storage, and artificial market yards with transport assistance for distribution systems.

8. Time-Saving Household Tools: To improve efficiency, provide subsidies under small schemes for mini washing machines, infra-light stoves, solar panels, water purifiers, and food processors.
9. Inclusive Policy and Stakeholders centre on the main Nari Gaurav Policy 2024 about needs of women farmers. Some primary thrusts include Flexibility in land ownership rules, Comprehensive, integrated scheme design and Digital inclusion.

### **Key Stakeholders:**

- o State Government: Agriculture, Rural Development, Women Welfare, Animal Husbandry Departments.
- o Central Government: Ministry of Agriculture, Ministry of Food Processing.
- o Local Level: Panchayats, SHGs, FPOs, KVKs.
- o Private & NGOs: Tech companies, marketing platforms, training organizations.

### **Department-wise Policy Suggestions**

#### **1. Agriculture Department**

Goal: Increase women farmers' participation in agriculture and improve productivity.

- Simplify the application process for schemes (MMKSY, etc.).
- Provide subsidies for women-friendly agricultural tools.
- Establish a "Women Farmer Support Center" in every taluka.
- Run awareness campaigns about schemes through SHGs and FPOs.
- Organize special training programs for women in collaboration with agricultural universities.

## 2. Animal Husbandry Department

Goal: Use technology in animal husbandry and empower women.

- Conduct special digital animal husbandry training camps for women.
  - Provide subsidies for artificial insemination, livestock health services, and feed management.
  - Assist in setting up women-run dairy cooperatives.
  - Promote affordable IoT-based devices for livestock.
3. Rural Development Department: The goal is to Increase women's participation in agriculture through SHGs and village-level enterprises.
- Create Women Farmer Producer Organizations (WFPOs) for SHGs.
  - Provide packaging and branding training for home-based food products.
  - Support agriculture-based activities (e.g., machinery rental) for alternative income.
  - Launch a "Time-Saving Tool Kits" distribution program.
4. Women & Child Development Department should Strengthen the link between women empowerment and agriculture.
- Introduce agriculture-focused acts under Nari Gaurav Policy 2024.
  - Run agriculture-based life skills training programs for women.
  - Develop schemes for assistance or alternative work for pregnant or lactating women in farming.
5. Industries & MSME Department should Promote value addition in agriculture and develop home-based industries.
- Create a special subsidy structure for women under the PMFME scheme.
  - Provide minimum machinery packages for home-based industries at subsidised rates.

- Develop a market platform for storage, packaging, and sale of agricultural products.
- 6. IT Department / Digital Inclusion Cell should provide tech-based information and services to women farmers.
  - Develop a “Women Farmer Mobile Application” (with local language support for market rates, weather updates, and schemes).
  - Launch digital literacy programs (Digital Sakhi) for SHGs.
  - Start mobile tech centers (Digital Vans) in villages.
- 7. Meteorology Department / AMFU / KVKs should Reduce crop loss through weather-based
  - Start weather-based SMS/WhatsApp services specifically for women farmers.
  - Appoint local women as “Women Weather Assistants”.
  - Expand local language weather forecasting and farmer advisory programs.
- 8. Agricultural Marketing & Transport Department must Improve direct market access and supply chains.

### **Policy Suggestions:**

- Connect women directly to customers through a “Market-Milap” digital platform.
- Provide subsidized vehicle services/cold storage facilities for SHGs/FPOs.
- Establish storage centers and transport pooling units at the village level.

## **CONCLUSION**

**Six important thrust areas dominate the interfaces of Women Farmers – New Farmers Future Agriculture in Viksit Bharat. They include :**

### **1. Structural Change at the Family Level in Rural Areas**

- Traditionally, men take all farming decisions while women contribute labour – treated as workers.

- With men increasingly migrating to semi-urban and urban areas for work and youth for studies, in many areas, women are now emerging as the 'New Farmers' and have to become responsible for day-to-day agricultural decisions.
- Women are not well-informed about current agricultural practices – technology and assistance available.
- Extension Administration does not contact them.
- Their mobility outside village is limited.
- Majority of them do not have smart phones.

## **2. Structural Change in Agriculture Sector**

- Climate change and unpredictable intense adverse weather events need continuous guidance and farmer-specific contingency planning – productivity is under challenge – so is livelihood.
- Shrinking farm size make viability a challenge; while technologies for tiny farms exist, it remains inaccessible to most farmers.
- Increasingly “Sharecroppers” are growing in peripheral areas of Urban – Semi Urban towns which is a major challenge to productivity. This is different from sugar cane farming. Land is sold – but not developed by speculators and hence sharecroppers.
- Salinity ingress and water contamination - in tubewells and canal water further aggravates the situation, threatening both crops' livestock and drinking water – productivity and health. Ocean areas already face serious challenges.
- Adaption of Prakrutik Kheti is need of time – due to soil degradation and increasing cost of chemical inputs.

## **3. Support Women farmers for VIKSIT BHARAT.**

- In VIKSIT BHARAT, Agriculture Sector is a major strength. India, with world's second largest arable land and adaptive farmers can supply World Food and Food Security as it already did during arena of COVID.
- But to make this happen Agricultural Administration and

Universities have to make a paradigm shift in their focus.

- Women already look after livestock and understand its use and more adaptive and willing to pick up new ideas. But they need to be informed and guided by demonstration an up-skilled for New Technologies and emerging climate change situation and market trends – more particularly:
- Water Resilient Agriculture
- Smart use of Water and Solar System.
- Digital use – For application for Subsidy and Loan and Market & Procuring inputs.
- Soil & Water analysis-based Crop Selection
- Weather Advisory based farming and climate smart agriculture.
- Use of Drone
- Precision Agriculture
- Tissue Culture
- Contingency plan in case of severe adverse weather events.

#### **4. Women Farmers need Attention and Support:**

- Extension Administration and Agricultural Universities must reach out to them at village level.
- Financial support by Bank.
- In village records – form VII – XII; they should be recorded as farmers and in census as well in succession – VARSAL entries.
- Support for smart phones and setting up of cooperatives / FPO

#### **Guidance for –**

- o Selection of inputs
- o Weather events & Climate Smart Agriculture
- o Harvesting and Storage
- o Marketing & Value addition

#### **5. Social Transformation – Ease of doing Business for Women:**

- Structural change in family in Decision-taking process needs to be facilitated – by appropriate social media messages in TV, Newspapers, Radio and social media. Family must realise that they have to support and make it easy for them to work and decide.
- Technology – tools and equipments are men-centric. They have to be Women-centric also – but more importantly made available at village – block level.
- Rotation system exists in Local bodies Gram Panchayat for chairperson – same need to be introduced in Cooperative and APMC by statutory amendments.
- In Viksit Bharat approach is to have increasing income of rural family on par with their urban counterparts -This will need of male member to work in non-agriculture farm work - within or outside villages.

## **6. Learning from Gujarat's Experience**

- Under the Krishi Mahotsav Approach, initiated by Hon'ble Prime Minister Shri Narendra Modi (then Chief Minister of Gujarat), the state successfully overcame the challenges of low productivity.
- Today, Gujarat stands as a leading Agricultural, Animal Husbandry & Fisheries state, demonstrating how structured interventions can turn adversity into opportunity.
- Gujarat Women have already made successful AMUL model. They look after 100 per cent livestock management and are adaptable but need to be up-skilled and supported.

### **Way Forward towards Viksit Bharat – Atmanirbhar Farmers**

Our Hon'ble Prime Minister has laid a roadmap for agriculture in his Independence Day address as part of Viksit Bharat. With women farmers at the centre, a comprehensive national program is needed to address emerging challenges. The Krishi Mahotsav model can be adapted for mass communication, awareness creation, and implementation.

# Agriculture Status

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## Gujarat

Gujarat's agriculture sector plays a crucial role in the State's economy. The State is a prominent producer of various crops, including cotton, castor, groundnuts, dates, sugarcane, and a range of spices (cumin, fennel, coriander, isabgul, chilli). It also holds a leading position in the production of milk and is a significant player in the dairy industry.

Recent years have seen a strategic shift towards horticulture and high-value crops, with substantial increases in crop area and production for fruits like mango, banana, citrus, pomegranate, and sapota. The State has also diversified into new fruit crops like tissue culture banana, date palm, dragon fruit (Kamalam), and strawberries. Some of the strengths and positive developments include:

- **Progressive Adoption of Micro-Irrigation:** Gujarat has been a frontrunner in adopting drip and sprinkler irrigation systems. This is critical for water-sensitive agriculture in the state, with significant areas brought under micro-irrigation in 2024-25. Gujarat green Revolution company (GGRC) is the nodal government company to guide and provide subsidies to farmer.
- **Technological Integration and Digital Initiatives** like the "Farmer Registry" streamline access to government services and support, including crop insurance and subsidies. The

“iKhedut Portal” and “Smartphone Support Scheme” empower farmers with real-time information on weather, crop diseases, modern techniques, and scheme applications. Precision farming, utilizing IoT and data analytics for optimized irrigation and input application, is also gaining traction. Drone technology is being employed for digital crop surveys and targeted fertilizer/pesticide spraying.

- Focus on Value Addition and Agro-Processing is through boosting agro and food processing, storage, and value-added exports.
- Government Support and Schemes for the benefit of farmers includes power subsidies for agriculture (a significant allocation in the 2024-25 budget), financial aid for interest subvention, and support for agricultural mechanization. Schemes like “Kisan Suryodaya Yojana” (16 hours power supply for irrigation) and “Saat Pagla Khedut Kalyanna” (encompassing various aspects of farmer welfare) are notable.

**Despite the progress, the Gujarat agriculture sector faces several persistent challenges:**

- Water Scarcity and Groundwater Depletion;
- Climate Change Vulnerability including variations in monsoon rainfall and extreme weather events, which can lead to crop losses Dust storm and wind with high velocity often damage crops and plantation
- Market Price Volatility and Remuneration disrupt fair and remunerative prices for their produce. Issues related to market access and efficient marketing channels persist, despite efforts like the implementation of the Model APMC Act.
- Initial Investment for Diversified Crops call for experimentation and initial high investments.
- Lack of Awareness and low Adoption of Sustainable Practices including natural farming
- Land Acquisition Concerns and,
- Data and Research Gaps: Agricultural institutions maintain

a cautious stance on the long-term viability of some newly introduced diversified crops, highlighting the need for more extensive research on their suitability to local weather and soil conditions.

Gujarat's agriculture sector is on a path of modernization and diversification, driven by government initiatives and farmer adoption of new technologies. However, addressing the fundamental challenges related to water scarcity, market stability, and climate resilience will be crucial for ensuring sustainable growth and enhancing farmer livelihoods in the long term. Continued investment in research, infrastructure, and farmer education will be key to overcoming these hurdles. Importantly the number of women taking over is increasing as is farming farm mechanisation.

### **The backdrop of the Status of Indian Agriculture:**

Indian agriculture continues to be the backbone of the nation's economy, providing livelihoods to nearly 60% of the population and contributing a significant portion (around 17-18%) to the national GDP. While its share in GDP has seen a gradual decline with the growth of other sectors, its socio-economic importance remains paramount. The sector is undergoing a significant transformation, driven by technological advancements and policy support, yet it grapples with persistent challenges.

### **Key Status and Positive Trends:**

- The Indian agricultural sector has demonstrated remarkable resilience, especially in recent years, with consistent growth rates. The Gross Value Added (GVA) of agriculture and allied sectors has shown improvement, highlighting a robust trajectory.
- There is a strong push towards modernizing agriculture through technology. This includes Precision Farming and Digital Tools: leveraging IoT sensors, satellite imagery, drones, and data analytics. Farmers are increasingly using smartphone apps for instant market access, weather advisories, and scheme information. AI and machine learning are being used for predictive insights on weather, crop yield, and

disease detection. Smart irrigation, micro-irrigation, and remote monitoring systems is growing to address water scarcity. Innovations in biotechnology, genome editing for crop improvement, and the use of robots for repetitive tasks are emerging trends.

- Efforts are being made to encourage farmers to diversify into high-value crops, horticulture, and allied sectors like animal husbandry, which are contributing significantly to agricultural growth.

**Despite these advancements, Indian agriculture faces several significant challenges:**

- A large proportion of farmers are small and marginal, with fragmented landholdings, which hinders mechanization, economies of scale, and adoption of modern technologies. India is a water-stressed country, and agriculture is the largest consumer of water. Over-reliance on groundwater, inefficient irrigation practices, and declining water tables pose a severe threat.
- Indian agriculture is highly susceptible to the adverse impacts of climate change, including erratic monsoons, droughts, floods, heatwaves, and changing pest and disease patterns, leading to significant crop losses and financial distress for farmers. Compared to global averages, crop yields in India remain relatively low, largely due to traditional farming practices, inadequate access to technology, and insufficient infrastructure.
- Farmers often face challenges in accessing efficient markets, leading to distressed sales and price volatility. Lack of adequate storage and processing facilities contributes to post-harvest losses. While schemes exist, many small and marginal farmers still face difficulties in accessing formal credit and adopting expensive modern equipment and technologies.
- Overuse of chemical fertilizers and pesticides has led to declining soil fertility and health in many regions, impacting long-term sustainability. Despite efforts, the

level of mechanization, particularly among smallholders, remains low, increasing labor costs and reducing efficiency.

Indian agriculture is at a critical juncture, balancing the need for increased production to feed a growing population with the imperative of sustainable and climate-resilient practices. The ongoing technological revolution, coupled with sustained government support, holds immense potential. However, addressing the structural issues of land fragmentation, water management, market inefficiencies, and the pervasive threat of climate change will be crucial for ensuring a prosperous and sustainable future for Indian farmers.

## The case of Women Farmers in Gujarat

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Five interesting features of women farmer's growing roles are presented in the following. These include:

"Feminization of Agriculture" in Gujarat, out of necessity as men migrate to urban areas for other employment. While their hours in the field may increase, this does not always translate to improved wages or control over resources.

Limited Land Ownership and Control is perhaps the most significant challenge. Despite their critical involvement, women's land ownership in Gujarat remains low. The agricultural census of 2015-16 showed that only 16.4% of women were operators of land holdings in Gujarat, a marginal increase from previous years. Even when women technically own land (often through inheritance or specific schemes), men often retain de facto control over it. This lack of formal land titles severely limits their performance. Their work is often perceived as "household work" rather than formal agricultural labour, leading to underestimation of their economic contribution and a lack of recognition as "farmers."

Banks and financial institutions often require land as collateral, making it difficult for women to secure loans for agricultural inputs, machinery, or improvements. Many government schemes and benefits for farmers are linked to land ownership, effectively excluding a large proportion of women who work the land but

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don't own it. Without formal recognition as landowners, their ability to negotiate prices and engage effectively in agricultural markets (APMCs) is diminished. Studies show very few women farmers in Gujarat have direct access to mandis.

On the other hand: Gujarat's agricultural universities are witnessing a significant increase in female enrolment, particularly in horticulture courses (nearing 50%) and agriculture courses (more than 35%). This is a crucial shift in a traditionally male-dominated field, driven by government initiatives like tuition and hostel fee exemptions for girls, and changing perceptions about career opportunities. Gujarat has a robust network of SHGs, predominantly led by women. These groups offer a powerful collective platform for accessing credit, resources, training, and market linkages, demonstrating the potential for collective action. There are inspiring examples of women farmers in Gujarat who have adopted natural farming, diversified crops, and successfully marketed their produce, demonstrating their entrepreneurial spirit and capacity for innovation.

### **Policies and related Initiatives in Gujarat:**

The Government of Gujarat has introduced several policies and schemes to support women farmers. The Government acknowledges the fact that fundamental issue of land ownership, enhancing access to credit and technology, and breaking down societal barrier will be critical to truly empower them and unlock their full potential for sustainable agricultural growth and rural development in Gujarat.

NCCSD with support of ONGC organised Capacity Building program for 2500 women farmers in five districts of Gujarat. There were three programs. Women farmers were given guidebooks after each program. In foregoing pages there is narration of Agriculture, Animal Husbandry, Fisheries and allied activities being undertaken by Women Farmers but not efficiently. The narration gives them guidance how to adapt. It was revealed that there was information gap, technology gap [right tools], access to finance [land titles] so on and so forth. But what is most important to know, and satisfying that Women Farmers

are willing to learn, adapt and very keen to increase their income. They of course need support and attention at village level. It is equally important to define the various facets of the persona of women and therefore their invaluable eminence in the society. Accordingly:

The family unit is the most immediate and influential circle for a woman farmer. The husband's main role is to acknowledge and respect the wife's role as a farmer and economic contributor, not just as a labourer. This is foundational and so actively participate in farm tasks and, crucially, share household chores (childcare, cooking, fetching water/fuel) to reduce the wife's immense dual burden. This frees up her time and energy for productive farm work or skill development. Additionally,

- Include the wife in significant farming decisions (what to grow, when to sell, how to invest, managing finances)
- Support her access to land rights (joint titling), credit, government schemes, training, and technology. If she needs to attend a training session, he can manage the farm or children
- Provide encouragement, listen to her challenges, and support her aspiration
- Shield her from social pressures or discrimination when she tries to assert her rights or adopt new practices.

Even small children can help with non-strenuous household chores, freeing up the mother's time. Older children can take on more significant responsibilities. Also, provide age – appropriate weeding, planting, harvesting, or tending to livestock, without compromising their education. Tech-savvy children, can help their mothers learn to use smartphones, agricultural apps (like Meghdoot), and online market platforms. Understand the hard work their mother puts into farming and appreciate her contribution to the family's well-being.

An encouragement from mother-in-law can be a huge asset. She can guide the daughter-in-law in farming practices, share traditional knowledge, and help navigate village dynamics. Other

female in-laws too can often be the primary support system for domestic chores and childcare, allowing the younger woman more time for farming. Studies show that mothers-in-law can free up time for their daughters-in-law, even while sometimes imposing social norms. They advocate for the daughter-in-law's right to participate in decision-making, access resources, and be recognized as a farmer within the wider family structure. A supportive relationship with in-laws can provide a sense of security and belonging, which is crucial, particularly for women who marry into a new village. It is equally important to being open to the daughter-in-law adopting new farming techniques or using technology.

The wider community, including neighbors, local leaders, and community organizations, also plays a crucial role. They could:

- Challenge Gender Norms and publicly acknowledge and celebrate women's contributions to agriculture, changing societal perceptions that farming is exclusively a male domain
- Encourage equal access for women to local resources, common property lands, and participation in village decision-making bodies (Gram Sabha).
- Support Networks and Collective Action through Farmer Producer Organizations (FPOs) for Collective bargaining power (for inputs and markets); access to micro-credit and savings, peer learning and knowledge sharing, mutual support during crises.

Local Leaders (Sarpanch, Village Elders) can ensure fair access to common property resources (e.g., grazing land, water bodies), mediate disputes, and advocate for women's access to government services. Such extensions Services and KVKs should be leveraged to work closely with women's groups to provide gender-sensitive training, demonstrations, and advisories that are relevant to their needs and time constraints. They should also help women farmers connect with local buyers, organize farmers' markets, or facilitate direct sales to consumers in addition to creating a Safe and Enabling Environment:

In Gujarat, with its strong tradition of community participation (e.g., cooperatives, SHGs), the role of family and community support becomes even more vital. When families and communities collectively recognize, value, and actively support women farmers, it not only transforms the lives of individual women but also strengthens rural economies, improves food security, and fosters more equitable and sustainable agricultural development.

Women health and well-being are at the core of their development. They must be fostered for real life equity and justice; and importantly note unique and magnified health challenges they face due to climate change. These include

**Heat Stress and Dehydration due to Increased Workload.** Erratic rainfall, droughts, and changes in crop cycles often mean longer hours of physically demanding work in the fields under extreme heat. Women are primarily responsible for fetching water for household and often agricultural needs. Longer distances and increased effort to collect water lead to severe dehydration, heat exhaustion, heat stroke, kidney issues, increased risk during pregnancy, and general fatigue.

**Nutritional deficiencies and food insecurity:** Extreme weather events (droughts, floods, unseasonal rains) lead to crop failures, directly impacting food availability nutritional security and household income. In times of scarcity, women often prioritize feeding children and other family members, sacrificing their own nutritional needs, leading to increased rates of anemia, malnutrition, and weakened immune systems. Increased susceptibility to infections, impaired physical and cognitive function, and adverse pregnancy outcomes (low birth weight, maternal mortality) set in. They are subject to Water-Borne and Vector-Borne Diseases, breathing problems and mental health stresses due to these challenges.

Gender-Sensitive Climate Policies should be supported with localized research on the specific health impacts of climate change on women farmers in different agro-climatic zones. This could build on the context set by the Legal Framework for Women's Rights. Gujarat, like other states in India, is primarily

governed by central laws concerning property and inheritance, along with some state-specific rules and policies. These include the:

- Hindu Succession Act, 1956 (Amended in 2005) as the most significant piece of legislation. The 2005 amendment granted daughters equal coparcenary rights in ancestral property as sons. This means daughters have the same birthright to family property as sons, including agricultural land. A wife is a man's first legal heir for self-acquired property. If a man wants to bequeath inherited land to his children, he typically has to make his wife a joint owner first. This act covers Hindus, Sikhs, Jains, and Buddhists.
- Muslim Personal Law (Shariat) Application Act, 1937: wherein daughters and widows have prescribed shares in property, including agricultural land. However, their shares are generally less than those of male heirs.
- The Indian Succession Act, 1925 that applies to Christians and others who are not covered by the Hindu or Muslim personal laws. It provides for equal inheritance rights for sons and daughters; an,
- The Forest Rights Act (FRA), 2006 on the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over forest land. It explicitly mandates mandatory joint titling for husband and wife, or titles in the name of single women, for land recognized under the Act. This is a crucial provision for tribal women's land rights in forest areas of Gujarat.

### **Some Gujarat - specific policies and provisions include the**

- Nari Gaurav Niti (Gender Equity Policy): Gujarat has adopted a Gender Equity Policy (Nari Gaurav Niti - 2006, updated in 2024) which emphasizes ensuring gender equality in access to resources, including land. This policy provides impetus to efforts aimed at increasing women's control and ownership of land and other common property resources.
- Reduced Stamp Duty: Some states (and potentially Gujarat

in specific contexts) offer reduced stamp duty for property registered in the name of women, providing a financial incentive for transferring titles to women.

- **Government Land Distribution Schemes:** When government land is distributed (e.g., to landless poor), there are often provisions to give joint titles to husband and wife or to prioritize women beneficiaries.
- **“Hayaati ma Haq” (Rights during Lifetime):** This is a unique social practice in parts of Gujarat where a woman’s name might be added to land records during her husband’s lifetime, often motivated by access to government benefits. However, as discussed below, this doesn’t always translate to actual control.

## **Challenges Rural Women Face in Securing and Exercising Land Rights in Gujarat**

Despite the progressive legal framework, significant challenges persist for rural women in Gujarat:

### **1. Patriarchal Social Norms and Customs:**

- o **Cultural Resistance:** Deep-rooted patriarchal norms often lead to families, particularly male relatives (fathers, brothers, in-laws), resisting the idea of women owning land or having their names on land titles.
- o **Daughters’ Exclusion:** Daughters are frequently excluded from ancestral property records despite legal rights, often through informal family settlements or societal pressure.
- o **Widow’s Vulnerability:** While widows often have stronger societal claims, they can still face immense pressure, harassment, and even violence from in-laws to relinquish their claims, especially if they don’t have male children.
- o **“Hayaati ma Haq” vs. Control:** Even when a woman’s name is on the title (e.g., for government benefits), the actual control over the land, its produce, and decisions related to it often remains with the men in the family.

## **2. Lack of Awareness and Legal Literacy:**

- o Many rural women are unaware of their legal rights to inheritance and property ownership.
- o The procedures for mutation (transfer of title), accessing land records, and asserting rights can be complex and intimidating.

## **3. Administrative Hurdles and Systemic Bias:**

- o Revenue Officials: Village-level revenue officials (Talatis) may sometimes be unsupportive or perpetuate existing biases, making it difficult for women to navigate the bureaucratic process.
- o Lack of Disaggregated Data: The absence of gender-disaggregated data on land ownership at the state and national levels makes it difficult to accurately assess the situation and formulate targeted policies.
- o Corruption: Women, particularly those from marginalized communities, can be vulnerable to exploitation or demand for bribes.

## **4. Economic Dependency and Mobility:**

- o Women's economic dependency often makes them reluctant to assert their rights, fearing social backlash or losing family support.
- o Limited mobility and access to transportation can hinder their ability to visit revenue offices or legal aid centers.

## **5. Impact of Land Use Change:**

- o Large-scale land acquisition for industrialization, SEZs, and urban expansion in Gujarat has led to the displacement of rural communities. Women, often not recognized as landowners, lose their livelihood base without adequate compensation or rehabilitation.

## **Impact of Securing Land Rights for Rural Women**

When rural women secure land rights, the positive impacts are profound and extend beyond mere ownership:

## **1. Economic Empowerment:**

- o Access to Credit: Land title serves as collateral, enabling women to access institutional credit, bank loans, and Kisan Credit Cards (KCCs), which are often denied without land ownership.
- o Access to Government Schemes: Recognition as a landowner allows women to directly benefit from agricultural subsidies for seeds, fertilizers, farm equipment, and schemes like PM-KISAN.
- o Increased Productivity: Studies show that women with secure land rights are more likely to invest in land improvement, adopt sustainable farming practices, and increase farm productivity.
- o Enhanced Income: Direct control over land and its produce leads to higher income realization.

## **2. Improved Household Well-being:**

- o Food Security and Nutrition: Women's control over resources often translates into increased expenditure on food, better nutrition for children, and improved household food security.
- o Education and Health: Higher income controlled by women tends to be invested more in children's education and family healthcare.
- o Poverty Reduction: Land ownership is a critical factor in lifting households out of poverty.

## **3. Enhanced Bargaining Power and Decision-Making:**

- o Within the Household: Owning land significantly increases a woman's bargaining power and decision-making authority within her household, giving her greater agency.
- o In the Community: Land ownership elevates a woman's social standing and voice in community matters, including Gram Sabhas.

#### **4. Increased Security and Resilience:**

- o Protection against Eviction: Secure tenure protects women from arbitrary eviction, especially in cases of widowhood or marital breakdown.
- o Climate Change Adaptation: Women with land rights are better positioned to adopt climate-smart agricultural practices and access government support for climate resilience. Land ownership can act as a shield, allowing them to access government compensation and relief measures for crop loss due to climate shocks.

#### **5. Reduced Gender-Based Violence:**

- o Economic independence and enhanced social status often correlate with a reduction in domestic violence and greater personal safety.

While legal provisions exist, the actual realization of land rights for rural women depends heavily on continued awareness, strong community support, persistent advocacy, and responsive administrative mechanisms to overcome deep-seated patriarchal barriers.

# Prakrutik Kheti

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Prakrutik Kheti refers to an agricultural system that aims to cultivate crops without the use of any synthetic chemical fertilizers, pesticides, or other external inputs. It relies entirely on natural processes and locally available resources, primarily focusing on the cow-based ecosystem.

## Key Principles

- Absolutely no synthetic fertilizers, pesticides, herbicides, or genetically modified organisms (GMOs).
- Emphasizes the crucial role of indigenous cow dung and cow urine as the primary inputs. These are used to create beneficial microbial concoctions.

## Four Pillars of SPNF:

1. **Jeevamrut:** A fermented microbial concoction made from cow dung, cow urine, jaggery (gud), pulse flour, and soil from virgin forest/farm soil. It's applied to the soil to enhance microbial activity and nutrient availability.
  2. **Ghana Jeevamrut:** A solid form of Jeevamrut, made by mixing cow dung, to be decomposed by jeevamrut for 30-40 days, then allowing it to dry. Used as a soil amendment.
  3. **Beejamrut:** A seed treatment solution made from cow dung, cow urine, lime, and soil. It protects seeds from soil-borne diseases and improves germination.
  4. **Mulching:** Covering the soil with organic matter (crop
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residues, dry leaves, straw) to conserve moisture, suppress weeds, and promote soil life. It can be live mulching (cover crops) or dead mulching.

- **Vaapsa** : The concept of maintaining continuous moisture in the soil, essential for microbial activity, by providing vapor rather than direct flood irrigation.
- **Diversification and Intercropping**: Encouraging multi-cropping, intercropping, and growing diverse plant species to promote biodiversity and natural pest control.
- **No Tilling**: Minimizing soil disturbance (ploughing, tilling) to preserve soil structure and microbial life.

### Usefulness for Farmers

Prakrutik Kheti offers significant benefits for farmers, particularly small and marginal farmers, hence the Gujarat government is strongly promoting it.

1. **Reduced Input Costs (Zero Budget)** is the biggest benefit. Farmers don't need to buy from markets expensive chemical fertilizers, pesticides, or even certified organic inputs. This dramatically reduces the cost of cultivation, leading to higher net profits.
2. **Improved Soil Health and Fertility**: Over time, the continuous addition of organic matter and microbial activity regenerates soil health, increases organic carbon content, improves water retention capacity, and enhances nutrient availability. This makes the soil more resilient.
3. **Enhanced Water Conservation**: Mulching significantly reduces evaporation, meaning fields require less irrigation. This is crucial in water-scarce regions of Gujarat.
4. **Environmental Benefits**:
  - o **Reduced Pollution**: No chemical run-off into water bodies or soil contamination.
  - o **Increased Biodiversity**: Promotes beneficial insects, earthworms, and microbial life in the soil.
  - o **Climate Change Mitigation**: Healthier soil sequesters

more carbon, and reduced use of energy-intensive chemical fertilizers lowers greenhouse gas emissions.

5. **Healthier Produce:** Food grown without chemicals is safer for consumption, leading to better human health.
6. **Farmer Independence and Resilience:** Reduces dependence on external markets for inputs, making farmers more self-reliant and resilient to market fluctuations in input prices.
7. **Increased Income:** While yields might initially see a slight less during transition, the drastic reduction in input costs often leads to higher net profits. Over time, as soil health improves, yields can stabilize or even increase.

### **Schemes for Prakruti Kheti in Gujarat**

Gujarat has been at the forefront of promoting natural farming in India. The state has launched specific initiatives and integrates natural farming into broader agricultural programs.

1. **Gau Adharit Prakruti Krushi Yojana (Cow-Based Natural Farming Scheme):**
    - o **Direct Financial Incentive:** The Gujarat government provides direct financial assistance of ₹900 per month (or ₹10,800 annually) to farmers who adopt cow-based natural farming, specifically for the maintenance of an indigenous cow. This is a powerful incentive to encourage the use of cow dung and urine.
    - o **Training:** Extensive training programs are conducted across the state, often involving agricultural universities and KVKs (Krishi Vigyan Kendras), to educate farmers on the principles and practices of natural farming (especially SPNF). Governor Acharya Devvrat himself has held numerous large-scale training camps.
    - o **Demonstration Farms:** Establishment of demonstration plots and model farms to showcase successful natural farming practices.
    - o **Farmer Outreach:** Village-level “Prakruti Krushi Chintan Bethaks” (discussions/meetings) are regularly organized to spread awareness.
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2. Integration with other Schemes:
  - o Natural farming is often promoted within the framework of larger schemes like the Paramparagat Krishi Vikas Yojana (PKVY) by the Central Government, which supports organic and natural farming through cluster approaches.
  - o Agricultural Universities: Gujrat has established Natural Farming science university first in world as well as four SAUS of Gujrat have abo research and extension activities to guide farmers.
3. Target for Expansion: The Gujarat government has an ambitious target to bring a significant portion of its agricultural land under natural farming in the coming years. Governor Devvrat has set a target of 20 lakh farmers practicing Natural Farming by Gujarat Foundation Day in 2025, and aims for Gujarat to fully adopt Natural Farming within the next 5 years.

**Source: From the book Natural Agriculture  
Five-Day Training Program for Agricultural Assistants**

# **Agricultural Calendar is an important information augment for the benefit of farmers**

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A month-wise calendar for agricultural activities in Gujarat is presented, focusing on major crops and for general guidelines to farmers

## **Key Crop Seasons in Gujarat:**

- Kharif (Monsoon Crop): Sowing from June-July, Harvesting from September-October/November.
  - o Major Crops: Groundnut, Cotton, Bajra (Pearl Millet), Maize, Paddy (Rice), Pulses (Tur/Pigeon pea, Moong, Urad), Sesamum (Sesame). Vegetables like brinjal, okra, tomato, bottle guard, cluster bean
- Rabi (Winter Crop): Sowing from October-November, Harvesting from February-March.
- Major Crops: Wheat, Gram (Chickpea), Cumin, Coriander, fennel, val, maize Mustard, Garlic, Onion, Potato, Isabgul. Vegetables Brinjal, Colliflower
- Zaid (Summer Crop): Sowing from February-March, Harvesting from May-June.
  - o Major Crops: Moong, Urad, Groundnut, Sesamum, paddy, cluster bean vegetables, cucurbits, okra. Primarily grown in irrigated areas.

## Month-wise Agricultural Calendar for Gujarat

### July (Current Month: Mid-Kharif)

- **Kharif:**

- Sowing: Continuous sowing of groundnut, cotton, bajra, maize, paddy (rice), tur, moong, urad, sesame, cluster bean etc.
- Weeding: First round of weeding and intercultural operations for early-sown Kharif crops.
- Fertilization: Basal application of fertilizers for Kharif crops.
- Pest & Disease Watch: Vigilance for early pests and diseases as humidity rises.

- **General:**

- Monsoon rains are typically strong. Ensure proper drainage in fields to prevent waterlogging.
- Repairing bunds (embankments) and irrigation channels.

### August (Late Kharif Sowing / Early Growth)

- **Kharif:**

- Sowing: Late sowing of some Kharif pulses, castor (late July to mid-August).
- Weeding & Inter-culturing: Continuous weeding and intercultural operations.
- Top Dressing: Second dose of fertilizers (top dressing) for actively growing Kharif crops.
- Pest & Disease Management: Intensive scouting and management for pests (e.g., bollworms in cotton, sucking pests) and diseases (e.g., leaf spot in groundnut, downy mildew in bajra).

- **General:**

- Managing excess rainfall and drainage if monsoon is heavy.
- Preparing nurseries for Rabi vegetable transplants.

## September (Kharif Maturation / Harvest Prep)

- **Kharif:**
  - Maturity: Early Kharif crops like moong, urad, and early varieties of bajra and groundnut start maturing.
  - Harvesting: Harvesting of early-sown moong, urad, and fodder crops begins.
  - Water Management: Careful water management; reduce irrigation as crops approach maturity.
  - Pest & Disease: Continue monitoring for late-season pests and diseases.
- **Rabi Preparation:**
  - Land Preparation: start land preparation for Rabi crops in areas where Kharif harvest is early or in fallow fields.
  - Seed Procurement: Procure seeds for Rabi crops (wheat, gram, cumin, coriander, mustard).
- **General:**
  - Monsoon typically starts withdrawing towards the end of the month.
  - Cleaning and storing harvested produce.

## October (Kharif Harvest / Rabi Sowing)

- **Kharif:**
  - Harvesting: Peak harvesting period for major Kharif crops: groundnut, cotton, bajra, maize, paddy, sesame, tur (continues into November/December for long-duration varieties) cluster bean.
  - Post-Harvest Operations: Threshing, cleaning, drying, and storage of harvested produce.
- **Rabi:**
  - Sowing: Primary sowing month for most Rabi crops: Wheat, gram, cumin, coriander, mustard, garlic, onion, potato, fenugreek, maize
  - Land Preparation: Intensive land preparation (ploughing, harrowing) after Kharif harvest.

- o Fertilization: Basal application of fertilizers for Rabi crops.
- **General:**
  - o Weather starts getting cooler and drier.
  - o Managing stubble and crop residue.

### **November (Rabi Sowing / Early Growth)**

- **Rabi:**
  - o Sowing: Continues for late-sown Rabi crops like some varieties of wheat, gram, and spices.
  - o Weeding & Inter-culturing: First weeding and intercultural operations for early-sown Rabi crops.
  - o Irrigation: First irrigation for Rabi crops, especially wheat and gram, which are highly sensitive to water stress at critical stages irrigation to castor, fennel, vegetables.
  - o Pest & Disease Watch: Vigilance for initial pest and disease attacks in Rabi crops.
- **Kharif (Long-duration):**

Harvesting of long-duration cotton and tur continues.
- **General:**
  - o Cooler weather sets in.
  - o Preparing cold storage for potatoes and onions.

### **December (Rabi Growth / Mid-Season Management)**

- **Rabi:**
  - o Growth: Rabi crops are in active vegetative growth.
  - o Top Dressing: Second dose of fertilizers for crops like wheat.
  - o Irrigation: Critical irrigation for wheat (tillering to flowering stage), gram, and other Rabi crops.
  - o Pest & Disease Management: Monitoring and managing pests (e.g., aphids in mustard, pod borer in gram) and diseases (e.g., rust in wheat).

- **Kharif (Long-duration):**
  - o Final harvesting of long-duration cotton and tur.
- **General:**
  - o Coldest month. Frost might be a concern in some regions; measures like light irrigation or smoke generation might be used.

### **January (Rabi Maturation / Harvest Prep)**

- **Rabi:**
  - o Maturity: Early Rabi crops like some varieties of gram, mustard, and fenugreek start maturing.
  - o Fertilizer: Nitrogen application to castor, fennel.
  - o Irrigation: Last irrigation for some crops as they approach maturity.
  - o Harvest Prep: Preparing for harvesting of early Rabi crops, castor, cotton harvesting.
  - o Zaid- Summer crops
  - o Land Preparation: Begin preparing land for summer (Zaid) crops in irrigated areas.
  - o Seed Procurement: Procure seeds for Zaid crops (moong, urad, groundnut, sesame, summer vegetables).
- **General:**

Continued cold weather.

### **February (Rabi Harvest / Zaid Sowing)**

- **Rabi:**
  - o Harvesting: Peak harvesting period for Rabi crops: Wheat(rainfed), gram, cumin, coriander, mustard, garlic, onion, potato.
  - o Post-Harvest Operations: Threshing, cleaning, drying, and storage of Rabi produce.
  - o Zaid - Summer crops
  - o Sowing: Primary sowing month for Zaid (Summer) crops like moong, urad, groundnut, sesame, and various vegetables (cucurbits like bottle gourd, bitter gourd, watermelon, muskmelon, okra).

- o Irrigation: Regular irrigation is critical for Zaid crops due to rising temperatures.

**General:**

- o Temperatures start rising.
- o Preparing storage for harvested Rabi crops.
- o March (Zaid Growth / Perennial Crop Management)
- o Zaid- Summer crops
- o Growth: Zaid crops are in active vegetative growth.
- o Irrigation: Continuous and ample irrigation is essential.
- o Weeding & Management: Weeding and pest/disease management for Zaid crops.
- o Horticulture & Perennial Crops (Mango, Banana, Citrus, Sapota):
- o Flowering/Fruiting: Mango trees are typically in flowering/early fruiting stages.
- o Maintenance: Irrigation, nutrient management, and pest/disease control for perennial fruit crops.

**Harvesting castor**

• **General:**

- o Temperatures continue to rise, moving towards summer.

**April (Zaid Maturation / Summer Heat)**

• **Zaid- Summer crops**

- o Maturity: Zaid crops like moong, urad, and summer vegetables start maturing.
- o Harvest Prep: Preparing for harvesting of Zaid crops.
- o Irrigation: Crucial for maintaining Zaid crops till harvest.

• **Horticulture:**

- o Mangoes are typically ripening or ready for harvest (Kesar Mango from Gir region).
- o Harvesting of other summer fruits.

• **General:**

- o Peak summer heat.
- o Water management and conservation become paramount.
- o Preparations for the upcoming monsoon (Kharif) season (repairing farm machinery, cleaning sheds, purchasing seeds).

### **May (Zaid Harvest / Pre-Monsoon Prep)**

- **Zaid- Summer crops**

- o Early sowing of cotton and of rice by end of May.
- o Harvesting: Harvesting of Zaid crops continues and concludes.
- o Post-Harvest: Drying and storage of summer pulses and oilseeds.

- **Horticulture:**

- o Harvesting of summer fruits like mangoes continues.

- **General:**

- o Intense heat.
- o Major land preparation activities for Kharif begin, especially dry ploughing after any pre-monsoon showers.
- o Cleaning and maintenance of farm equipment.
- o Procurement of seeds and fertilizers for the upcoming Kharif season.
- o Repairing bunds and field boundaries.

### **June (Monsoon Onset / Kharif Sowing)**

- **Kharif:**

- o Sowing: The most critical month as the monsoon arrives. Sowing of major Kharif crops (Groundnut, Cotton, Bajra, Maize, Paddy, Pulses) begins immediately after the first good monsoon showers.
- o Nursery Raising: For crops like paddy (rice) nagali, brinjal, chillies that are transplanted.
- o Fertilization: Basal fertilizer application.

- **General:**
  - Relief from summer heat with the onset of monsoon.
  - Monitoring rainfall patterns closely to decide sowing dates.
  - Ensuring good drainage in low-lying areas.

### **Important Considerations for Gujarat:**

- **Rainfall Variability:** Gujarat experiences significant spatial and temporal variation in rainfall. North Gujarat and Kutch are more arid, while South Gujarat receives heavy rainfall. This dictates crop choices and irrigation needs.
- **Irrigation Facilities:** The availability of irrigation (canal, borewell, well) significantly influences the ability to grow Rabi and Zaid crops.
- **Specific Regions:**
  - Saurashtra: Known for Groundnut and Cotton.
  - North Gujarat: Major producer of Bajra, Castor, Cumin, Isabgul, Mustard, Potato.
  - South Gujarat: Major for Rice, Nagali, Sugarcane, Banana, Mango, sapota, Vegetables.
  - Central Gujarat: Cotton, Rice, Paddy, Maize, Pulses, Banana, Potato, Vegetables.
  - Bhal Region: Famous for Bhalia (duram) Wheat (rain-fed, unique variety, gram

**Government Advisories:** Farmers should always refer to the latest agro-advisories issued by IMD (Ahmedabad Centre), Gujarat Agricultural Universities (AAU, JAU, NAU, SDAU), and the i-Khedut portal for precise, localized, and real-time guidance based on weather forecasts and crop conditions.

This calendar provides a general overview. Local conditions, specific crop varieties, and prevailing weather patterns will always influence the exact timing of agricultural operations.

**Source: Shri Nitin Shukla Joint Director, Agriculture Department -  
Government of Gujarat,  
Dr. A.R. Pathak, Former Vice Chancellor, JAU & NAU**

# Good Agricultural Practices for Better Value of Crops and Climate Smart Agriculture

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Good Agricultural Practices (GAP) is practical, efficient on-farm and off-farm processes aimed towards sustainability and equity for small-scale farmers in arena of climate change it is climate smart agricultural. As high quality and healthy food are becoming more important for consumers have concerns about the control of food production and demand more information along the food chain. GAP is based on the principles of risk prevention, risk analysis, sustainable agriculture (by means of Integrated Pest Management (IPM) and Integrated Crop Management (ICM)) to continuously improve farming systems. GAP is of utmost importance in protecting consumer health. GAP provides important advantages for India, not only for the domestic market but also export markets.

Existing GAP followed by farmers	Practices Suggested	Benefits
<p>GAP are not well followed by Women farmers.</p> <p>Farmers are not well versed on how to improve productivity and the quality of their produce.</p>	<p>Four GAP practices advocated:</p> <p><b>Clean Soil</b></p> <ul style="list-style-type: none"> <li>• Involves taking steps to reduce soil contamination via manure and vermi-compost.</li> <li>• Improve soil health through use of well decomposed FYM, well prepared composting materials and green manuring.</li> </ul>	<p>1. It provides safe, hygienically and nutritive food to the consumer.</p> <p>This adds to value of food produce and such the produce gets higher market price.</p>

<p>Traditional methods result into getting produce graded as low quality and hence low market price.</p>	<ul style="list-style-type: none"> <li>• Mulching practices also help to prevent the infestation of weed, pest and can prevent or minimize soil borne diseases. Mulching practices can be adopted with the use of plastic sheets and crop residues.</li> <li>• Mulching can reduce soil salinity due to reduced evaporation. Evaporation will concentrate salts in the soil.</li> </ul> <p><b>Clean Water</b></p> <ul style="list-style-type: none"> <li>• Making sure all water used in washing, cooling and processing agricultural produce is potable.</li> <li>• Water used for irrigation and foliar applications must also be tested to ensure it is safe for the intended purpose (e.g. salinity, free of pathogenic bacteria, harmful chemicals, acidic or alkaline).</li> </ul> <p><b>Clean hands</b></p> <ul style="list-style-type: none"> <li>• The practice of good personal hygiene in the field and while packing.</li> </ul>	
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**1. Soil Management Practices:**

<b>Existing Soil Management practices followed by farmers</b>	<b>Soil Management Practices</b>	<b>Benefits</b>
<ul style="list-style-type: none"> <li>• Soil Management Practices followed by farmers are inadequate.</li> <li>• Farmers have insufficient know-ledge about zero tillage and benefits of zero tillage.</li> <li>• Farmers do not apply sufficient quantities of organic manures like FYM, green manuring, use of compost and incorporation of crop residues and use of biofertilizer.</li> </ul>	<p>[A] Reducing soil erosion by wind and water with the following technology:</p> <ul style="list-style-type: none"> <li>• By using organic and inorganic mulching practices and restoring of soil organic content in the soil: Incorporation of crop residues like paddy straw, paddy husk bran, wheat bhusa, chatting material of cotton stalks and other plants and incorporate with sufficient quantity of FYM and green manuring of crops in the soil.</li> <li>• Use inorganic mulching practices like plastic mulching.</li> </ul>	<ul style="list-style-type: none"> <li>• By preventing soil erosion due to wind and water, that can control the topsoils which is highly enriched with inorganic carbon total nitrogen, available phosphors, potassium with important minerals and full of micro-organisms which can fix the nitrogen from the atmosphere and convert the unavailable form into the available form.</li> </ul>

<ul style="list-style-type: none"> <li>• Farmers have inadequate knowledge about use of biofertilizer and their application in the soil.</li> <li>• Farmers have insufficient knowledge about the use of Azolla (water fern), blue and green algae in transplanted paddy cultivation. Use of organic and inorganic mulching practices not practised by the farmers in large area of the state due to inadequate knowledge about the mulching practices.</li> <li>• Crop residues like wheat, bhusha, sugar cane trash, rice bran husk and paddy straw, cotton stalks are being burnt at present in the field by the farmers due to lack of scientific knowledge.</li> </ul>	<ul style="list-style-type: none"> <li>• Establish the living hedge/ trees around the boundary of the fields to bring down the speed of wind.</li> <li>• Sowing of crop in the field in opposition of wind direction.</li> </ul> <p>[B] Application/ incorporation of fertilizer/manure in the soil.</p> <ul style="list-style-type: none"> <li>• Apply chemical fertilizer in root zone area of the plant through the drip irrigation system (fertigation) which can increase the fertilizer use efficiency and reduce the cost of fertilizer.</li> </ul> <p>[C] Reduce Soil Compaction to maintain soil structure: Avoid heavy tillage operations like deep ploughing, frequent use of Rotovator and use of heavy machinery for field operations which can affect the soil properties like soil aeration infiltration, microbial activities, uptake of nutrients, etc., which in turn can reduce plant growth and yield.</p>	<p>Moreover, good microbial activity facilitates congenial environment for better aeration in the soil.</p> <ul style="list-style-type: none"> <li>• By maintaining organic content/ organic matter or by providing the soil ideal crop rotation which can improve the chemical, physical and biological properties of the soil.</li> </ul>
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<b>2. Water</b>		
<b>Existing Water Management Practices</b>	<b>Advocated Management Practices</b>	<b>Benefits</b>
<p>Existing water management technology followed by the farmers.</p> <ul style="list-style-type: none"> <li>• Integrated water management practices are not being followed by the farmers.</li> <li>• Farmers are not following the improved method of irrigation.</li> </ul>	<p>Practice scheduled irrigation with monitoring of plant needs.</p> <ul style="list-style-type: none"> <li>• Prevent soil salinization by limiting water input to needs.</li> <li>• Avoid crops with high water requirement in a low availability region.</li> <li>• Use mulch to minimize water evaporation from the soil surface. Evaporation will increase soil salinity.</li> </ul>	<p>Scheduling of irrigation based on climatological requirement, type of crop (short duration, long duration) Shallow rooted crop or deep rooted crop and biological stages of crop growth which monitors the water requirement of plant.</p>

<ul style="list-style-type: none"> <li>• Farmers do not irrigate their crops at critical stage of irrigation because they have not knowledge about the critical stage of crop growth and water requirement.</li> <li>• Farmers have not adapted practices of mulching because they do not have sufficient knowledge of application of mulching in Agriculture.</li> <li>• Farmers not utilize sufficient quantity of organic manure like FYM and green manure compost and incorporation of crop residue like straw of paddy and wheat, cotton stalks etc.</li> <li>• Farmers do not have sufficient irrigation facility. Hardly 40- 45% area covered under irrigation - 50-60% area under rain fed Condition.</li> </ul>	<ul style="list-style-type: none"> <li>• Water should be applied through different methods of irrigation. Use of micro irrigation system [drip and sprinkler]</li> <li>• Alternate furrow irrigation</li> <li>• Broad bed and furrow system with mulching practices.</li> <li>• Use good quality of water for irrigation. It must be analyzed for use.</li> <li>• Select the crop variety as per agro climatic conditions i.e. for irrigated region and rainfed region.</li> </ul>	<ul style="list-style-type: none"> <li>• Advance technology of irrigation system like.</li> <li>• Drip irrigation system facilitates to apply the liquid fertilizer and pesticide thus increases the Efficiency of water &amp; fertilizer &amp; reduces the cost of application and leaching losses of fertilizers. Drip can increase 35 to 45% more irrigation area for cultivation with the same quantity of irrigation water.</li> <li>• Problem of soil salinization can be prevented through the use of mulching practices and suitable methods of planting.</li> <li>• Mulching can maintain the soil health.</li> </ul>
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### 3. Livestock Management

Existing Practices for Animals followed by the farmers	Practices suggested	Benefits
<p>Most of the farmers keep their animals nearby the farm and residential area. and providing in Digenis</p> <ul style="list-style-type: none"> <li>• Farmers are not providing a balanced feeding practice.</li> <li>• Farmers are not providing pure water around the year to the animals in sufficient quantity.</li> </ul>	<p>Animals:</p> <ul style="list-style-type: none"> <li>• Provide a balanced feeding practice to the animals i.e. green fodder, dry fodder; concentrate feed and mineral mixture as recommended.</li> <li>• Select the animal breed based on Climatic conditions e.g. Gir Cow and Jafra badi buffalo for Saurashtra Region.</li> </ul>	<p>By adopting scientific management practices, farmers can earn good return from animal husbandry.</p> <p>2. He can efficiently utilize byproduct like dry fodder, hey, straw and green forage as cattle feed and reduce the cost of products.</p>

<ul style="list-style-type: none"> <li>• Proper veterinary services are not provided by the farmers round the year.</li> <li>• Artificial insemination not properly handled by the farmers when animals are in peak/heat period.</li> </ul>	<ul style="list-style-type: none"> <li>• Provide better cattle sheds with full ventilation to have congenial environment to the animals.</li> <li>• Timely veterinary services / vaccination should be provided to the animals around the years to maintain good health of the animals.</li> <li>• Provide good quality of drinking water to the animals throughout the year.</li> </ul>	
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<b>4. Crop Management</b>		
<b>Existing crop management practices followed by farmers</b>		<b>Benefits</b>
<p>Farmers have low level of knowledge about the selection and use of crop cultivars and varieties based on local demand of market.</p> <ul style="list-style-type: none"> <li>• Farmers are not growing varieties and crops cultivars according to recommendation made for the different agro climatic zones in Gujarat state.</li> <li>• Farmers are not following the inter-cropping system, advocated by scientists i.e. proper use of leguminous crops.</li> <li>• Farmers have low level of scientific knowledge about the addition of organic manures, green manuring and incorporation of crop residues</li> </ul>	<p>Select cultivars and varieties, to meet local consumer and market needs according to their suitability in the area</p> <ul style="list-style-type: none"> <li>• Follow all crop production practices like sowing, irrigation, fertilizer applications etc</li> <li>• The variety should be highly responsive to fertilizers.</li> <li>• Inclusion of legumes crop variety to provide the biological fixation of nitrogen from the atmosphere.</li> <li>• Use balance use of organic and inorganic fertilizer to get the higher yield of the crop and to maintain the fertility level of the soil.</li> </ul>	<p>Recommended variety according to the agro climatic zone, gives higher yield and income to the farmers.</p> <ul style="list-style-type: none"> <li>• It can compensate the demand of the local markets</li> </ul>

<p>in the soil. They are applying poor qualities less decomposed organic matter in the soil and not adopting the balance use of organic and inorganic fertilizer in the soil.</p> <ul style="list-style-type: none"> <li>• They have poor knowledge about the recycling of crop residue and its importance in the soil.</li> <li>• Farmers are still adopting the indigenous method of rabbing practices after the harvesting of crop and not using the proper methods of recycling crop residues.</li> </ul>		
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### 5. Harvesting and Harvest Containers and Tools

Existing harvesting practices and use of containers and tools followed by the farmers in Gujarat state.		Benefits
<p>Proper hygienic conditions are not being maintained by farmers, i.e. proper hand-wash and use of bins for storing of packaging material. They are not properly maintaining the grading, sorting, processing, packaging and proper transportation facilities of their produce</p>	<p><b>Harvesting</b></p> <ul style="list-style-type: none"> <li>• Wash hands before starting to pick.</li> <li>• Reject produce that is damaged or having visible signs of bird droppings.</li> <li>• Do not harvest produce that has fallen on the ground. Otherwise wash it thoroughly with clean water.</li> <li>• Remove as much soil as possible from harvested produce.</li> </ul>	<p>By adopting recommended practices identified for harvesting and safe use of containers and tools, farmers can provide better quality of produce and hygienic food to consumers and as a result get better markets and higher prices for their produce.</p>

<p>after the harvest. They do not have the ideal facility to store the harvest produce therefore 25-30% losses occur after harvesting of perishable crops like fruits, vegetables etc.</p>	<ul style="list-style-type: none"> <li>• Don't let harvested produce remain in the field for a longer period than it is required.</li> </ul> <p><b>Harvest Containers and Tools:</b></p> <ul style="list-style-type: none"> <li>• Do not put clean produce in a dirty container</li> </ul>	
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Source: By Mr Trevor Hylton

# Land Management

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## **Soil as a Medium for Crop Production:**

Soil is essential and fundamental for crop production. Its **conservation, improvement, and protection** are of great importance.

## **Soil Texture:**

The proportion of various particle sizes present in the soil is called "texture." Soil consists of mineral particles of various sizes and proportions. Based on these size differences, the texture of the soil is classified.

Many physical properties of the soil depend on its texture. Likewise, water holding, air movement, temperature regulation, water absorption, and nutrient availability are also influenced by the soil texture.

Changing of soil texture is difficult and takes considerable time. Soil texture, determines how often to irrigate, how much fertilizer to apply to crop. Whether the soil is suitable or harmful for plant growth depends on the proportion of fine particles (clay) present in the soil.

## **Soil Structure:**

The specific arrangement of primary and secondary particles in the soil is known as soil structure. Sand, silt, and clay are considered primary particles. When these particles bind together to form aggregates, they are known as secondary particles.

Soil structure can be modified or improved by management practicing it is affected by factors like compaction, weight, air,

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water flow, heat absorption, and nutrients significantly affect soil structure. This, in turn, directly impacts plant growth.

If the soil structure is brittle, crumbles and porous, it helps plant growth. Various factors influence this structure, such as plant roots, the presence of beneficial microbes, wetting and drying cycles, cooling of the soil, and moisture content. Thus, soil structure is key to soil fertility.

### **Importance of Soil Structure in Agriculture:**

Soil scientists have confirmed that soil structure is the key to fertility. If the structure is unsuitable or compacted, even after adding sufficient fertilizers, nutrient uptake may be difficult by the plant.

In such situations, poor water and air movement become limiting factors for crop production. The availability of water and air required to the crops depends on the soil structure.

If moisture is insufficient, the plant cannot absorb nutrients. On the other hand, if there is excess water hence poor aeration, plants still cannot uptake nutrients.

Hence, for plant growth and seed germination, ideal conditions are necessary. Due to poor soil structure, the required elements are not be available, disrupting physiological processes in the plant.

As a result, plants cannot absorb nutrients properly. Therefore, in crop production, the relationship between soil, water, and air is crucial—and this depends on the soil structure. So, soil structure is the key to soil fertility.

### **Beneficial soil structure**

The space between soil particles is referred to as soil porosity.

- **Large Pores:**  
These are commonly found in sandy soils and loosely structured clay soils. Such soils are highly permeable and cannot hold moisture efficiently, but they allow quick air movement.
- **Small Pores in Sandy Soils:**  
The particles in sandy soils are relatively small, leading to

smaller pores. When organic manure or compost is added, it improves the water-holding capacity of soil.

- **Fine Pores:**

Clayey soils have a high proportion of clay particles, leading to fine pores. Such soils exhibit capillary action and retain water for a longer period, but air circulation is minimal. Adding compost to clayey soils makes them porous, increasing water absorption and retention.

### **Use of Organic Fertilizers:**

Organic fertilizers like **green manure, farmyard compost**, etc., are especially useful for **leguminous crops** as their **roots go deeper**, efficiently utilizing these nutrients-maintained soil fertility and crop yield .

### **Better Soil structure can be maintained by**

- Practicing **crop rotation**.
- Maintaining **proper soil moisture** for tilling.
- Using **improved agricultural tools** for better nutrient availability and soil distribution.

### **Essential Nutrients for Plant Growth:**

Various parts of a plant contain more than **60 different nutrients**, but research shows **16 are** essential to complete a plant's life cycle. These are:

A) Basic Nutrients from air and water are Carbon (C), Hydrogen (H) and oxygen (O) Available to plants

### **B) Essential Soil Nutrients (from soil):**

- These are divided into:

Primary Macronutrients:

Nitrogen (N), Phosphorus (P), Potassium (K)

- Secondary Macronutrients:

Calcium (Ca), Magnesium (Mg), Sulphur (S) Boron (B)  
Molybdenum (Mo) Chlorine (Cl)

- Micronutrients:

Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu)

Although **iron** is required in high amounts, it is categorized under **micronutrients** due to its function, while **sodium**, though needed in small quantities grouped under **macronutrients**.

### **Other Important Nutrients:**

- **Sodium (Na), Silicon (Si), and Cobalt (Co)** are also necessary for **certain crops**.

For example:

Silicon is important for rice crops.

Cobalt helps in nitrogen fixation in leguminous crops.

### **Conclusion:**

If all these essential nutrients are available in adequate amounts, the plant remains healthy and yields better. Most of these nutrients are absorbed by the plant through soil, so understanding which nutrients are present or lacking in the soil is crucial for efficient crop production.

### **Fertilizer Requirements for Crops**

Plants obtain carbon, hydrogen, and oxygen from the environment, while the remaining essential nutrients are mainly absorbed from the soil. Thus, the soil acts as a reservoir of plant nutrients, comparable to a warehouse filled with various essential elements. However, these nutrients can **deplete over time** due to crop absorption, leaching, evaporation, erosion, and other losses.

### **Fertilizer Application to Crop?**

Different crops absorb nutrients from the soil in varying amounts, hence the quantity of fertilizer to be applied also differs for each crop. In Gujarat, soils are generally deficient in nitrogen and phosphorus, and based on this, the Department of Agriculture recommends applying appropriate fertilizers.

Moreover, the soil testing laboratories across regions provide crop-specific fertilizer recommendations based on the soil test results. Every farmer should know the condition of their soil and then apply fertilizers accordingly, which helps in maximizing crop production with minimal costs.

The state government also provides Soil Health Cards, which include such fertilizer recommendations.

It's also observed that the use of chemical fertilizers alone is gradually reducing soil health as a result of beneficial soil microbes is also declining. These microbes play a vital role in transforming the nutrients of chemical fertilizers into mineral water a form which plant take easily

Furthermore, the physical condition of soil improves significantly with the use of organic materials. Thus, the role of organic matter is very important and must be acknowledged.

### **Negative Effects of Excessive Nitrogen Use:**

Excessive and continuous use of only nitrogen fertilizers not only reduces crop yields over the year but also depletes soil fertility and affects soil sustainability.

Due to lack of complementary micronutrients, the effect of applied nitrogen is not fully realized. If these supplementary nutrients are not added, crops cannot utilize nitrogen effectively.

### **Impact of Organic Fertilizer (Farmyard Manure):**

It has been **clearly observed** that the use of **well-decomposed farmyard manure** leads to:

- Significant **improvement in soil structure**
- Fulfilment of other **essential nutrients** required by crops

### **Symptoms of Nutrient Deficiencies in Plants**

<b>Nutrient</b>	<b>Deficiency Symptoms</b>
<b>Nitrogen</b>	- Leaves turn yellow- Pale red veins may appear- Plants remain stunted- Leaves are small and fewer in number- Elongation of internodes length- Growth becomes stilted
<b>Phosphorus</b>	- Leaves become dark green or purplish- Lower leaves start drying and falling- Leaves droopy purple color appears on the stem- Flower and fruit production is reduced
<b>Potassium</b>	- Yellowing starts from the border of leaves- old leaves show yellowing symptoms- blackish spots appear on the leaves- Plants remain stunted

Nutrient	Deficiency Symptoms
<b>Sulphur</b>	- New buds appear yellow- new leaves remain small- Overall plant size reduces
<b>Calcium</b>	- Growth of root and stem tips stop- Seedlings show dark coloration- Increase in brittleness of plant tissue
<b>Magnesium</b>	- Yellowing in older leaves- Interveinal chlorosis (yellowing of green veins)- Reddish or purple spots appear on leaves
<b>Iron</b>	- Leaves turn yellow, but main veins stay green- Tips of the plant dry and burn- Growth of new leaves stop- Leaves become pale, sometimes white
<b>Zinc</b>	- Plants appear weak- Leaves turn yellow- Leaf edges curl and rustling symptoms- short internodes- young leaves are small and clustered
<b>Copper</b>	- Tips of the leaves dry up- new leaves appear pale- Yellowing and growth staled bluish spots appear on leaf edges- Leaves may curl and become brittle- Sometimes sticky sap is seen under the midrib- Veins may break
<b>Manganese</b>	- Interveinal yellowing between green veins- new leaves lose their color- Leaves become dull and curled
<b>Molybdenum</b>	- Young growing points show leaf distortion- Yellowing at leaf tips- Overall plant remains weak
<b>Boron</b>	- Tips of leaves dry up- Newly sprouting leaves become distorted- older leaves show yellowing- Bright coloured patches may develop- Leaf tips become whip-shaped- Sap may drip under some areas- Veins of leaves may rupture

Major plant nutrients are provided in organic and inorganic forms. Based on soil testing and the recommendations of the agriculture department, supplying these nutrients in the required quantities can lead to optimal yield, while also maintaining soil fertility and crop productivity.

### Crops Sensitive to Micronutrient Deficiency

Many crops show visible symptoms immediately when certain Micronutrients are deficient micronutrient wish list of crops are as under.

- **Manganese (Mn):** Maize, wheat, paddy (rice), soybean, radish, brinjal (eggplant), peas, onion, carrot, sugarcane, sugar beet, lemon, and cotton.

- **Iron (Fe):** Jowar (sorghum), paddy, barley, cabbage, cauliflower, tomato, lemon, and other citrus crops.
- **Zinc (Zn):** Jowar, wheat, paddy, maize, cotton, soybean, onion, lemon, orange, and grapes.
- **Copper (Cu):** Maize, oats, wheat, barley, cabbage, cauliflower, cucumber, ridge gourd, onion, tomato, beetroot, tobacco, lemon, orange, and grapes.
- **Boron (B):** Castor, rice, sugar beet, cabbage, cauliflower, potato, lemon, and cotton.
- **Molybdenum (Mo):** Chickpeas, cabbage, cauliflower, cucumber, castor, beans, sugar beet, and lemon.

## 1. Organic Manures

### Farmyard Manure (FYM)

Among organic fertilizers, **farmyard manure** is the most widely available to farmers. It is a **bulky organic fertilizer**. It is made by collecting cattle dung, urine, waste straw, and other farm residues, and then decomposing them in a pit to form nutrient-rich manure.

### Nutrient Content (in Percentage) of Animals Excreta.

Type of Animal Manure	Nitrogen (%)	Phosphorus (%)	Potash (%)
Cow and Bull Dung	0.40	0.20	0.10
Goat and Sheep Droppings (Dry)	1.00	0.75	1.35
Horse Dung	0.50	0.50	0.30
Pig Manure	Much Lower	Much Lower	1.35
Poultry Litter	0.45	2.10	0.50

This **manure is considered a complete fertilizer**, as it contains the three **major nutrients** — **Nitrogen, Phosphorus, and Potash**, along with **secondary nutrients** such as **Manganese, Zinc, Copper, and Boron**.

## 2. Composition of Compost Manure

The composition of compost manure depends on the type of animal excreta used and proper decomposing time

Typically, compost manure contains:

- **Nitrogen:** 0.8%
- **Phosphorus:** 0.3%
- **Potash:** 1%

Its **physical composition** includes:

- **Moisture:** 75%
- **Organic matter:** 14–15%
- **Silica:** 7%

During the composting process, a mix of animal excreta and organic waste is used. Hence, it contains variable concentration of N, P, K are as follows.

### **Nitrogen**

- **60% is in solid form**, and
- **40% is in available form.**

### **phosphorus:**

- About **99% is in solid form** and
- A small portion is available.

### **For potash:**

- **60% is available**, and
- **40% is solid form.**

Despite this, the nutrient content may vary depending on the animal species, breed, feed and the nature of organic residues used. The method of composting also plays a key role.

If compost is produced using **scientific methods**, nutrient loss can be **minimized**, and higher-quality compost can be prepared. Several **scientific composting techniques** can be adopted for better results.

## **3. Bio-Fertilizers**

Soil naturally contains various **beneficial micro-organisms** that help plants in different ways. These microorganisms have following beneficiary effect

- Fix atmospheric nitrogen,
- **Convert unavailable phosphorus into available forms,** to plant and
- **Accelerate decomposition** of organic matter in soil

Collectively, these are known as **bio-fertilizers**.

Popular bio-fertilizers include:

- Rhizobium
- Azotobacter
- Azospirillum
- Phosphobacteria
- Blue-Green Algae
- Azolla

#### **Advantages of Bio-Fertilizers are as under**

- Are much cheaper compared to chemical fertilizers.
- Fix about 7 to 8% of atmospheric nitrogen and make it available to plants.
- Mobilize unavailable phosphorus in the soil and convert it into available form, which improves plant growth and increases yield.
- Help prevent soil-borne diseases.
- Enhance the availability of nutrients already present in the soil.
- Improve the physical, chemical, and biological properties of soil, thereby increasing its fertility.
- Even small and marginal farmers can afford them easily.
- They improve the fertility of degraded and low-fertility soils.
- In rain-fed farming, more useful in drought-prone conditions.
- Easy to use and eco-friendly.

#### **Limitations of Bio-Fertilizers**

- Sometimes, other microorganisms in the soil may **inhibit nitrogen fixation**, resulting in **insufficient nitrogen availability**.
- There may be a **shortage of bio-fertilizers** that balance the **physical, chemical, and biological** properties of soil.
- The **shelf life of microorganisms** in bio-fertilizers is generally **short**.
- Many farmers **lack awareness** about the **selection and usage** of appropriate bio-fertilizers.
- Bio-fertilizers are often **not available in sufficient quantities** in the market.
- **Water stress, excessive pesticide use, high temperatures, and sudden environmental changes** can **negatively impact their effectiveness**.

## A. Bio-fertilizers for Nitrogen Fixation

### (a) Rhizobium:

For **leguminous crops** like pigeon pea (tuver), chickpea, mung bean, groundnut, and soybean, Rhizobium bacteria help fix most of the nitrogen required by the plant. These bacteria form numerous nodules on the plant roots, each acting as a **small nitrogen-fixing factory**.

When leguminous crops are cultivated repeatedly in the same field, natural Rhizobium populations increase. Thus, **the type of crop** and the **matching Rhizobium strain** both play a major role in nitrogen fixation.

However, **high temperatures, waterlogging, predator organisms, and viruses** can reduce the population of Rhizobium bacteria in the soil. Hence, before cultivating legume crops, it is important to **treat seeds** with the appropriate Rhizobium strain to ensure effective nitrogen fixation.

By using the **recommended strain** of Rhizobium, chemical fertilizer to the tune of 20 Kg can be reduced.

### (b) Azotobacter:

Azotobacter is a type of **free-living nitrogen-fixing bacteria**. It has the **remarkable ability to fix atmospheric nitrogen** without

requiring any association with a specific crop (unlike *Rhizobium* which needs legumes). Therefore, *Azotobacter* is used as a **bio-fertilizer for non-leguminous crops** as well.

These bacteria live **independently in the soil** and require **organic matter** to grow and survive. They are mostly found in the **top 15–30 cm soil layer** of soil. They play a significant role in **improving soil fertility and productivity**. Mostly used in covered crops and sugar cane.

In one gram of soil, there can be anywhere between **1,000 to 1,00,000 live *Azotobacter* bacteria**.

#### (c) **Azospirillum:**

*Azospirillum* is another type of **nitrogen-fixing bacteria** used as a **bio-fertilizer**. Like *Rhizobium* and *Azotobacter*, *Azospirillum* also fixes **free atmospheric nitrogen** and converts it into a **usable form for plants**.

However, **unlike *Rhizobium***, which forms **root nodules**, *Azospirillum* **does not form any nodules** on the plant roots.

#### (d) **Blue-Green Algae (BGA):**

Blue-green algae is a type of **aquatic green organism** that is used as a **biofertilizer in paddy fields (rice farming)**. It appears **greenish-blue** depending on its concentration. Like other biofertilizers, it can **fix atmospheric nitrogen** and **store it within itself**. After it decomposes, the nitrogen is released and becomes available to the rice plants.

Dried algae contain **2% to 13.3% nitrogen** and **0.05% to 0.18% phosphorus**.

About **500 grams of dry BGA** can supply **15–20 grams of nitrogen per square meter**.

Different types of BGA have varying nitrogen-fixation capacities. On average, **20–25 kg of nitrogen per hectare** can be added using BGA.

#### **How to cultivate BGA:**

Farmers can create a **poly-lined trench** measuring **20 m x 1.0 m x 22 cm**. Water is added and kept at a shallow level. Then,

BGA inoculum is added. In **15–20 days**, a thick mat of algae forms on the surface, which is **then dried and stored** for use.

To control harmful organisms, **125 grams of Fura dan** is added per trench.

From one trench of 20 cm<sup>2</sup>, **10 kg of BGA inoculum** can be produced.

This can be **preserved for long-term use**.

After **transplanting rice**, about **10 kg/ha of BGA** is spread in the water-filled paddy fields.

BGA also produces **plant growth-promoting substances**, which support plant development.

#### **(e) Azolla:**

Azolla is a **floating aquatic fern**. Its leaves harbor **blue-green algae**, which help **fix atmospheric nitrogen**, allowing Azolla to meet **its own nitrogen requirement**.

- Fresh Azolla contains **0.2% to 0.3% nitrogen**, and **dry Azolla** has **3% to 5% nitrogen**.
- In **low-lying or wet fields**, Azolla is cultivated along with rice.
- **3–5 days** after rice transplanting, **500–1000 kg/ha of fresh Azolla** is introduced. Within **20–25 days**, the field becomes fully covered.
- After that, it is **incorporated into the soil**, which adds **10–12 tons/ha of green manure**, releasing **25–30 kg of nitrogen** within **5–10 days**.

Even after incorporation, some Azolla survives due to its **light weight and small size**, and **regrows**, providing an **additional 25–30 kg nitrogen** within **10–15 days**.

Thus, **Azolla can provide up to 60 kg nitrogen/ha** when used alongside paddy crops.

To obtain enough fresh Azolla at the time of transplanting, farmers are advised to **maintain their own Azolla nurseries**.

#### **(f) Acetobacter diazotrophic us:**

This is a type of **bacteria that lives inside sugarcane**. Like Rhizobium and Azotobacter, it has the ability to **fix atmospheric nitrogen**.

- This culture is **recommended for sugarcane crop**.
- If **used correctly**, the **nitrogen requirement in sugarcane** can be significantly reduced.
- It can **increase yield by 15–20 tons per hectare**.

## **B. Biofertilizers for Phosphorus Availability**

### **i) Phosphate Culture:**

- In most Indian soils, **available phosphorus is very low**.
- When phosphorus is applied as **super phosphate** or other forms, it **quickly becomes unavailable** due to fixation in soil and is not utilized by the crop.
- However, some **microorganisms present in the soil** secrete various **acids** that help **solubilize this fixed phosphorus**, making it **available to plants**.

### **Benefits of Phosphate Culture:**

- Use of recommended bio fertilizers can save **30–50 kg/ha of chemical phosphorus fertilizers** saving
- With recommended microbial fertilizers, crops can yield good output **without depending on expensive chemical phosphorus fertilizers**.
- Applying the appropriate microbial strain to the soil improves phosphorus availability and **increases crop productivity**.

**Note:** These microbes work if some phosphorus remains in the soil. Eventually, external phosphorus like **rock phosphate** may need to be applied.

### **ii) Mycorrhiza:**

- Mycorrhiza is a type of **fungus** that forms a **symbiotic relationship with plant roots** and **helps in absorbing phosphorus** from the soil.

- This biofertilizer is **recommended at the time of sowing or transplanting**.
- It is particularly beneficial in crops like **tobacco, brinjal, chili, tomato, lemon, and mango**.

### Methods of Using Biofertilizers

Biofertilizers can be applied in the following ways based on the crop's cultivation method:

#### 1. Soil Application:

- Biofertilizer packets generally weigh **200–250 grams**.
- Mix the powder in **200–300 liters of clean water** to make a slurry.
- Mix this slurry with **8–10 quintals of well-decomposed FYM (farmyard manure)** and apply it **uniformly in the field**.
- Dry in a cool place and then **use it during field preparation**.

#### 2. Seedling Root Dipping:

- Mix **1–2 kg of biofertilizer powder** in **10–15 liters of water** to make a solution.
- Dip the **seedling roots** in this solution for **15–20 minutes** before transplanting.

#### 3. Furrow Application:

- Mix **3–4 kg of biofertilizer** with about **50 kg of compost** and moist soil to prepare a slurry.
- Apply this slurry **in furrows** during planting. This method is particularly **effective for standing crops**.

#### 4. Liquid bio fertilizer can be applied through drip or spraying or with irrigation. NPK constorium in liquid form is also available which is applied through drip or irrigation.

### Recommendations:

- Use **multiple types of biofertilizers** as per crop requirements.
- For **sugarcane**, use **Acetobacter culture** for better results.
- Ensure **quality control standards** are followed for all biofertilizers.

- In **legume crops**, use **Rhizobium**, and in **non-legume crops**, use **Azospirillum or Azotobacter** cultures.
- Use **phosphate-solubilizing biofertilizers** to reduce fertilizer costs.
- In **rice fields**, use **Azolla and Blue-Green Algae (BGA)** for nitrogen supplementation.

### Efficient Use of Fertilizers

- Due to high-yielding varieties, easy availability of irrigation, and improved farming methods, the **use of fertilizers is increasing**.
- However, current domestic **production of fertilizers is insufficient** to meet demand.
- Thus, fertilizers are **imported**, but due to global shortages of raw materials, **prices have increased**.
- In this scenario, **efficient use of available fertilizers** is crucial.
- Farmers must aim to **maximize crop yield** per kg of nutrients supplied, thereby increasing profitability.

### For Fertilizer Efficiently following is more important

#### I. Following Recommended Farming Practices

- To achieve optimum yield, the **recommended plant population per hectare** must be maintained.
- Scientific guidelines related to **seed treatment, time of sowing, seed rate, and spacing** should be followed.
- If not followed, the **plant density is reduced**, and even if fertilizers are applied properly, their **benefits are not fully realized**.

#### Following Crop Protection Measures

- Fertilizers lead to **better crop growth**, which may also attract **pests and diseases**.
- Therefore, for efficient use of fertilizers, **timely and recommended plant protection measures** must be taken.

## Weed Management

- Weeds **compete with crops** for water and nutrients.
- If weeds are not controlled during the **first 7 to 21 days**, they can absorb about **25–30% of the applied nutrients**.
- Hence, weeds should be **removed before and after fertilizer application**.

## Timely and Appropriate Application of Fertilizers

- Efficient and profitable use of fertilizers depends not only on applying the correct quantity, but also on **applying them at the right time and using the right method**.
- **Nitrogen**, being highly mobile, should be applied in **2 to 4 split doses**, depending on crop growth stages.
- **Less mobile nutrients**, like **phosphorus and potassium**, should be applied as **basal fertilizers** before or during sowing.
- Phosphorus is especially essential during **early root development** and should be applied accordingly.
- In **sandy soils**, potassium should be split into **two doses**.
- In general, apply **phosphatic and potassic fertilizers** as **basal dose**, and **nitrogen fertilizers** in **half to three-fourths split doses**, depending on **crop type and soil condition**.

# Saline Land Management

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Saline soil in India is primarily concentrated in arid and semi-arid and coastal regions with Gujrat having highest area among all states in India. Soil is having high concentration of soluble salts. In India approximately 6.75 m hectares is saline whereas Gujrat is having 2.3 million hectares.

## 1. Effects of Salts Present in Soil

Salts in the soil affect plants in **two main ways**:

- Even when **moisture is sufficient**, plants are unable to absorb water.
- Even though **nutrients are available**, plants are unable to uptake them due to **salt toxicity**.
- Additionally, **salts directly damage plant tissues**, especially leaves which may burn and dry out.
- In saline-alkaline soils, salts such as **sodium, sulphate, chloride, boron, and bicarbonates** are commonly present, each with **different toxic effects**.

## 2. Characteristics of Saline Soils

- A soil is considered **saline** when:
  - Electrical Conductivity (ECe) > 4 ds/m (Deci siemens per meter)
  - Exchangeable Sodium Percentage (ESP) < 15%
  - pH value is **less than 8.5**

- Such soils often develop a **white crust** on the surface due to salts like **calcium, magnesium chlorides, sulphates, carbonates, and bicarbonates**.
- Soil particles in such soils remain **loose** and do not **bind together**, making the soil **powdery**.
- Salts interfere with the movement of **air and water**, and plants cannot absorb **moisture and nutrients**, leading to **wilting**.

### Main Causes of Saline Soils

- High salt content in **parent rock materials** from which the soil forms.
- In **arid and semi-arid** regions, **capillary rise** of salty groundwater or **seawater intrusion** raises salts to the surface.
- **Excessive irrigation** or **poor drainage systems** cause accumulation of salts at the surface.
- Use of **effluent water** from factories or untreated sources in agriculture also contributes to salinity.

### Farming in Saline Soils

Farming in saline soils is difficult due to several **interrelated problems**:

- **Poor germination** or **uneven seed germination**
- **Delayed or reduced crop emergence**.
- **Crusting** on the soil surface.
- **Sticky when wet, hard when dry**.
- Difficult **tillage**, resulting in **big clods**.
- **Reduction in beneficial soil microbes**.
- Difficulty in **inter-cultivation**.
- **Nutrients become unavailable**, leading to **deficiency symptoms**.
- **Poor soil structure and porosity - waterlogging** and stunted plant growth.
- Plants appear **yellowish and weak** due to **reduced root activity**.

- High salt concentrations **draw back sap**, causing plants to **wilt**.
- In high salinity, crops **fail to grow**.
- Plants remain **stunted** with **short leaves, stems, and branches**, and may exhibit **brownish-green foliage**.
- **Poor flowering, low fruit set, and small grain size**.

## Management of Saline-Alkali Soils

### 1. Drainage Management in Saline Soils

- In saline soils, salts should be removed using good quality water, preferably **rainwater** or **good quality groundwater**.
- If the **water table is not deep**, the land should be **levelled**, **narrow beds** should be prepared and during monsoon, **rainwater should be filled** to **leach the salts** into the deeper layers.
- In areas where the **water table is too high**, traditional methods may not work. In such cases, **controlled irrigation**, **leaching**, and **vertical PVC drainage pipes** (1 to 1.5 meters deep) should be installed to lower the water table effectively.

### 2. Improved Cultivation Techniques

- Implementing **ridge-furrow** planting or **broad bed-furrow** (BBF) method helps in **better root development** and **healthy plant growth**, ultimately increasing yield.
- Planting crops on **raised ridges** and leaving the furrow for water flow **reduces salt accumulation near the roots**.
- Organic amendments like **gypsum, press mud, compost**, and **green manure** (e.g., Dhan chia, sun hemp) help improve the structure and fertility of saline soils.
- Before sowing, the field must be **levelled, properly ridged**, and **drainage channels** should be constructed.
- During the **monsoon**, rainwater should be allowed to stand in the field to leached out **salt**.
- Generally, cultivating **salt-tolerant crops** in saline soils yields better results.

### 3. Crop Selection for Saline Soils

- Different crops and varieties have **varying levels of salt resistance**
- Crops must be selected based on **local soil salinity level**, ensuring they match the **soil's salt condition**.

### 1. Use of Ridge-Furrow Irrigation Method

- For irrigation with saline water, adopt a **ridge and furrow system**.
- Apply water in the furrow, and **sow seeds on the ridges** formed on both sides of the furrow to avoid direct salt exposure.

### 2. Deep Percolation through Intermittent Irrigation

- Follow **recommended spacing** and irrigate frequently every **2 to 3 days interval**.
- This helps **leach salts** below the root zone, protecting crops from salt damage.

### 3. Use of Drip Irrigation in Sandy

- In dry, sandy, or desert regions where water infiltration is poor, use **drip irrigation systems**.
- This enables **maximum utilization** of available water with **minimal waste**.

### 4. Frequent Irrigation

- Apply **lesser but more frequent** water to avoid **moisture stress**.
- This ensures the crop receives sufficient moisture and reduces salt accumulation in the root zone.

### 5. Mulching (Surface Covering)

- Mulching **reduces evaporation** and **minimizes salt accumulation** on the soil surface.
- Use materials like:

**Crop residues**

**Soil-based covers**

**Plastic sheets** (widely used and available in the market)

- In regions like **Kutch-Vagad**, **cotton stalk mulch** is common.
- Mulching with residues like **paddy straw** or **wheat husk** is also effective.
- Intercropping (e.g., chickpea, mung, moth bean, groundnut) between main crop rows helps **cover the soil surface**, limiting salt exposure.
- These **biological mulches** act as **natural protectors**.
- **Plastic sheet mulch** is also widely used and has shown good results across multiple crops.

### **Key Points to Consider for Saline Water Irrigation**

- **Choose crops with low water requirements.**
- Apply water **only at critical crop stages**, saving water and preserving soil health.
- Use **micro-irrigation techniques** like **drip** or **sprinkler systems**.
- Apply **adequate organic manure** to:
- Improve **soil water retention**
- Enhance **fertility**
- Maintain **soil structure**
- Use **mulching** to reduce salt effects.
- Ensure **proper drainage arrangements** for salt management.

### **Important points**

- **Where adequate water is available**, build **ridges and furrows** to push salts below the root zone.
- **Where water quantity and quality are poor**, and **drainage is inadequate**, use **drip or sprinkler irrigation**.
- These methods help **maintain optimal moisture** in the root zone and **reduce salt concentration**, improving crop productivity.

Source: Krushi Govidhya Magazine, November 2016

## Micro Irrigation

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In Gujarat, about **79% of the total agricultural land** is irrigated through **groundwater sources** (wells, borewells, etc.). Due to overuse, groundwater reserves are depleting, resulting in not-only falling of water tables but water quality from deeper sources become poor

In traditional furrow irrigation systems, water flows across the field by flooding, which leads to several disadvantages:

Excess water accumulates around the plant root zones.

Plants suffer from lack of air and increased heat stress, hindering nutrient absorption.

Increased weed growth and reduces fertilizer efficiency.

Besides sprinkler and porous pipe irrigation systems, **drip irrigation** stands out as the most effective modern method due to its multiple advantages.

### Advantages of Drip Irrigation:

- **Water Savings:**

Saves 40% to 60% water. Since water is delivered drop-by-drop directly to plant roots, the same quantity of water can irrigate 2–3 times more area.

- **Stable Microclimate:**

Daily or alternat day irrigation maintains consistent moisture, temperature, and humidity, enhancing root activity and promoting faster plant growth and development.

- **Fertilizer Efficiency:**  
Fully water-soluble fertilizers (e.g., urea, ammonium sulfate) and some pesticides can be delivered through irrigation water, reducing nutrient loss and saving 25%–30% on fertilizers.
- **Labor Savings:**  
Eliminates the need for making furrows, bunds, fertilizer application and constant labor for irrigating in land; reduces labor costs.
- **Suits All Soil Types:**  
Efficiently irrigates undulating or irregular terrain.
- **Weed Control:**  
Less weed growth results in savings on herbicides and labor.
- **Minimum Pest and Disease**  
Since the soil remains less waterlogged, pest and disease incidence is minimized.
- **Power Savings:**  
Around 30%–35% electricity savings.
- **Use of Saline Water:**  
Suitable for use with saline water in irrigation.
- **Ease of Cultivation:**  
Since only moisture is maintained (not flooding), land remains workable for longer periods.
- **Increased Yield and Quality:**  
About 30% higher yields with improved quality result in better market prices.
- **Early Harvest:**  
Crops mature earlier, allowing farmers to take advantage of early-season prices.

**Government Assistance:**

The Government of Gujarat, under the joint initiative of **GGRC**

(Gujarat Green Revolution Company) with GSAIDC, GNSFC, and GIIC, provides financial assistance:

**Subsidy:** 50% or up to ₹60,000 per hectare (whichever is lower). Even 90% to SC,ST farmer.

For application farmers should contact GGRC depots, agriculture offices, SAUs (State Agricultural Universities), or company representatives.

### Basics of Drip Irrigation:

#### 1. Definition:

A system where water reaches plant roots in the form of drops, minimizing water use and maximizing plant hydration through micro-pipelines with drippers/emitters.

#### 2. Water Requirement per Plant:

Crop	Water per Day per Plant	Irrigation Interval
Cotton	5–8 liters	Every 2–3 days
Paddy	15–20 liters per bed	Daily
Tomato, Brinjal	2–4 liters	Every 1–2 days
Sugarcane	6–10 liters	Every 2–3 days
Banana	10–15 liters	Every 3 days
Mango	10–15 liters	Every 4–5 days

#### Note:

- Water requirements are higher in summer.
- Sandy soils more frequent irrigation than black soils.

#### 3. Pipe Layout in the Soil:

- **Main pipeline:** Connected to the water source.
- **Lateral pipes:** Spread across fields between crop rows.
- **Emitters/drippers:** Installed at fixed intervals as fore spacing between plants.
- **Depth:** Pipes are generally laid at 6–12 inches, depending on crop root depth.

- **Water Savings:**

Drip irrigation can save 30%–60% water compared to traditional methods, and prevents unnecessary weed growth and more area can be covered for irrigation with saving water quantity.

**Summary**

- By irrigation alternate rows of the crop, the cost can be reduced by up to 50%.
- Using a high-capacity single dripper to irrigate more plants can further reduce costs.
- Replacing drippers with microtubes can reduce the cost by approximately 20%.
- Using PVC pipes instead of HDPE main and sub-pipes can also help lower expenses.
- In drip irrigation, alternate-day irrigation allows lateral pipes to be shifted between alternate rows, reducing the use of lateral pipes by up to 50%, depending on the crop type.

**Source : Dr. K. D. Mevada, Dr. M. V. Patel, Dr. N.V. Soni  
– Department of Agronomy, BACA, AAU  
College of Agricultural Information Technology, Anand**

## Purchase of Inputs

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For obtaining good production, farmers purchase inputs like seeds, fertilizer, pesticide, herbicides etc from market. the Following points to be considered while purchase of these inputs for better result and benefits.

### **Points to keep in mind while purchasing fertilizer**

- Purchase according to the crop nutrient requirement and soil condition.
- Always select fertilizers of reliable companies while choosing fertilizers.
- Assess the effect of farm-plot soil and select fertilizer as recommended.
- Select fertilizer that contain lower unit cost of nutrient elements.
- If two or more fertilizer bag details such as company name, percentage of nutrient elements, tagging and manufacturing, weight, price, license number, etc. before selecting fertilizer.
- At the time when fertilizer is to be given to the crop through drip, then only select water-soluble fertilizers.
- Physical condition of fertilizer should also be considered while selecting.

### **Points to be kept in mind while purchasing pesticides.**

- The pesticide must be registered. On the packing of the pesticide, the ISI mark of registration must be displayed.

- The technical as well as the trade name of the pesticide ingredient present and in which formulation (E.C./W.P./Dust/W.S./W.P./Granule etc.) it is available must be displayed.
- Information about which pests the pesticide controls must be available
- The effectiveness standard/dose of the pesticide and the toxicity class indicated by color (Green/Yellow/Red) in a triangular symbol must be displayed.
- In case of poisoning while spraying the pesticide, the symptoms and the antidote to be used for safety must be displayed.
- The packing of the pesticide must be sealed.
- On the packing of the pesticide, the date of manufacture as well as the **expiry date** must be displayed.

#### **Points to be kept in mind while purchasing seeds**

- Only purchase improved/hybrid varieties of seeds recommended by the Agricultural University and Agriculture Scientist for cultivation.
- Improved hybrid varieties of seeds should always be purchased only from Gujrat state seed corporation/authorized seed company dealers.
- While purchasing seeds, check who is the producer then purchase.
- While purchasing seed, check on the packing the germination percentage of seeds as well as which season's production it is, and only after checking purchase it.
- Farmers can themselves prepare improved varieties of seeds by keeping proper care, so there is no need to purchase improved varieties of seeds every year.
- Hybrid varieties of seeds must be purchased every year; hence it is not advisable for farmers to use the seeds of hybrid crops grown in their fields for the next year.
- For certified seeds blue labels providing by certification agency. Such certified seed at be punches.

# Crop Production Methods

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India has made significant strides in agricultural production. Farmers have increasingly adopted high-yielding varieties (HYVs) and production technologies recommended by Agri scientists. With rising input costs and stagnant crop prices, farmers must use inputs and techniques wisely to maximize returns. Some of these practices are either free or low-cost. Similarly some practices if followed properly more yield can be achieved without much cost-i.e. cost-effective techniques. These are as under.

## **Low-Cost Agricultural Practices:**

- 1. Timely Sowing:** As per agricultural university recommendations, sow crops at the right time. Early sowing after suitable monsoon rains improves yields. For example, sowing groundnut in the last week of May (during Margashirsha Nakshatra) can increase yield by 25% similarly rice transplanting in last week of June, increase yields together with less infestation of pest and disease.
- 2. Plant Spacing:** Maintain proper spacing as recommended for each crop. e.g., for spreading varieties of groundnut, a row spacing of 60 cm, and for erect varieties, 45 cm spacing gives better yield.
- 3. Seed Treatment:** To control seed rot and soil-borne diseases, treat seeds before sowing with 3 grams of Thiram or Captain per kg of seed. or treat with biofertilizer or pesticides(cotton) reduce initial fertilizer requirement and pest control.

4. **Seed Selection:** Use certified hybrid or improved varieties. Quality seeds contribute to about 20% of total crop yield.
5. **Seed Rate:** Use the recommended seed quantity per hectare for each crop to maintain optimum plant population's., wheat requires 100 kg of seed per hectare. Higher seed rate increases cost.
6. **Gap Filling:** Fill gaps immediately after germination to maintain proper plant population. If delayed, use short-duration crops like mung, urad, sesame, or maize in place of gaps to ensure supplemental production and income.
7. **Use of Soil Amendments:** For groundnut, gypsum is recommended in Saurashtra to reduce soil salinity, improve soil structure, and enhance yields. Gypsum is inexpensive and available with 50% subsidy at GSFC depots.
8. **Timely Harvesting:** Harvesting at the right time maintains crop quality and prevents yield loss. In groundnut, delayed harvesting may break pods underground, reducing yield. In wheat and paddy delayed harvesting may lead to grain shattering.
9. **Mulching (Covering):** In crops like groundnut, using farm waste or plastic sheets as mulch helps retain moisture. This can double the yield in drought-prone years. On vegetable, banana & pulses, cucumber, watermelon etc. much found useful.

### **Use of Agri Biotechnology:**

#### **(A) Biofertilizers:**

In regions like Saurashtra, Rhizobium culture is recommended for groundnut. Treating seeds with Rhizobium at sowing boosts yield. Companies like GUJCOMASOL and Agriculture university liquid bio fertilizers as well as nutrient consortium (N, P, K) in liquid is produced and available for different crops. GSFC sell these. This can compensate 20 kg N fertilizer hence reduce cost of production.

**In comparison to chemical fertilizer, bio fertilizer reduce cost and improve soil health**

## **(B) Biological Control (Biocontrol):**

Use beneficial insects for natural pest control. Examples include: Junagadh agriculture university produces bio agents like Trichogramma, Beauveria for farmers

- Ladybird beetle – feeds on aphids.
- Trichogramma – parasitizes pest eggs.
- Chrysopa – eats thrips and other soft-bodied insects.

## **Cropping Practices**

### **1. Crop Selection:**

Farmers often choose crops based on high market prices, which sometimes leads to overproduction and price drops. Hence, selecting crops that have lower market supply and higher demand is more beneficial. Farmers should analyze market saturation before choosing crops.

### **2. Crop Rotation:**

Crop rotation plays a key role in maintaining soil fertility and managing pests and diseases. For example, after growing groundnut (which has shallow roots), planting cotton (which has deep roots) helps utilize nutrients from deeper layers of the soil, maintaining fertility and reducing disease-pest incidences. proper crop rotation after castor helps in reducing will infection in crop.

### **3. Intercropping:**

In Saurashtra, intercropping systems like **Groundnut + Castor (3:1)** or **Groundnut + Pigeon Pea (3:1)**—i.e., after every three rows of groundnut, one row of castor or pigeon pea achieve higher yields and income compared to monocropping.

### **4. Relay Cropping:**

As per research recommendations, in groundnut fields, after the final intercultureing (about one month after sowing), pigeon pea can be sown between two rows. This provides additional yield without reducing the main crop's output.

## 5. **Mixed Farming:**

Integrating allied activities like animal husbandry, dairy farming, poultry, goat farming, or fish farming with agriculture enhances employment, production, and income to the farmers.

## 6. **Efficient Use of Farm Inputs and Implements:**

### a) **Efficient Use of Fertilizers:**

Farmers should test their soil and apply only the recommended quantity of organic and chemical fertilizers. At right time and proper method. based on crop requirements

### b) **Organic Fertilizers:**

Use of well-decomposed farmyard manure or compost during land preparation improves soil structure, enhances water holding capacity, and boosts crop productivity. Organically grown products can fetch 20–25% higher market prices. Green manning before trans planting of rice increases crop yields with 20-30 kg less fertilizer application

### c) **Appropriate Equipment Selection:**

Selecting suitable machinery according to land size is vital. For small landholders, using lower horsepower(HP) tractors and implements saves fuel and money. Multi-purpose tools like **seed-cum-fertilizer drills** are ideal—they sow seeds and apply fertilizers simultaneously, increasing efficiency and reducing costs.

### d) **Chemical Fertilizers:**

As per research-based recommendations, the **basal dose** of chemical fertilizers should be applied by mixing into the soil before sowing. Similarly, **top dressing doses** should be given at proper intervals and methods. Avoid broadcasting fertilizers followed by irrigation, as it can cause leaching. Instead, apply them beside the crop line or around the plant in a ring method to maximize absorption.

## **Water**

Adequate soil moisture is essential for crop production. Over-irrigation can damage the soil and waste water. Therefore,

maintaining the right moisture at each stage of crop growth is crucial. In raindrops, irregular rainfall reduces yield. For instance, at critical stages of crops like groundnut (flowering, fertilization, and pod development), if moisture is inadequate, providing **protective irrigation** can **increase crop yield by up to 50%**. **One irrigation at crown root initiation to rainfed wheat increase yield by 50%**.

### **Irrigation Methods**

By adopting improved irrigation techniques like **sprinkler** or **drip irrigation**, the irrigated area can be expanded double with the same water quantity. Supplying water as per crop requirement also reduces weed, disease and pest incidences, while maintaining the **quality of crop yield**.

### **Crop Protection**

Crop protection contributes **about 40%** to crop productivity. To avoid pest and disease outbreaks, **seed treatment** and **weed-free fields** are essential. One must correctly identify the pest or disease and take appropriate and timely action. Upon the first signs, immediate and proper pesticide spraying is necessary.

Generally, effect of one pesticide spray can last **up to 15 days**.

For short-duration crops, **three sprays** are often sufficient to prevent major pest/disease damage.

Important factors in spraying: **selection of pesticide, correct dosage, spray pump type**, and careful application.

### **Value Addition**

Farmers often don't get fair prices for their produce. Hence, **value addition** becomes essential. Even proper cleaning grading can fetch more main set rice. Even proper cleaning grading can fetch more manse rice.

#### **1. Cleaning and Drying:**

Removing debris and stones and ensuring proper drying reduces moisture content (generally acceptable up to 8%). This increases shelf-life and preserves quality.

#### **2. Storage:**

Use **rodent-proof godowns** with proper **air circulation and temperature control**. For fruits and vegetables, **cold storage** is necessary. This allows farmers to sell when prices are favorable.

### 3. Grading:

After cleaning and drying, **grading** helps in better pricing. Quality-based marketing can fetch **20–25% higher prices**. For example, wheat sold after grading can get ₹200 per quintal more forage.

### 4. Processing (Conversion):

Processing farm produce can yield higher profits. For instance, instead of selling raw groundnut, converting it into oil or peanut products is more profitable. Groundnut can be processed into 100+ products. Tomato, catchup prepared will give more profit, similarly, turmeric powder instead of raw turmeric gives more profit.

### 5. Packaging:

Rather than selling loose produce, packing into **specific weight units** like 5, 10, 15, or 20 kg makes the product more marketable and fetches better prices. For example, cumin sold in 100g packs can get ₹150/kg versus ₹100/kg in bulk. Vegetable seeds are also sold similarly in small, well-labeled packages.

### 6. Direct Marketing:

When farm produce passes through market yards, agents, wholesalers, and retailers, farmers lose out on full value. **Direct selling** to consumers helps farmers to earn higher profits.

Source : Shri N.S.D. Prajapati & Dr. D.B. Prajapati  
Agricultural Guide, Gujarat State

## Use of Modern Technology

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Many modern technologies have been suggested which farmers can adopt easily for better crop production with reducing cost of production These have been listed here under.

### 1. Sustainable Inputs

**Practice:** Use of agricultural inputs like bio-enriched organic fertilizers, Metarhizium, Pseudomonas, 13-00-45 fertilizer, pheromone traps, yellow and blue sticky traps, Beauveria, neem-based pesticides, and micronutrients.

**Outcomes:**

- **20% reduction in farming cost:** Bio-products replace chemical fertilizers and pesticides.
- **Improved soil and environmental health:** Continuous use of organic fertilizers enhances soil health and fertility.
- **25% increase in yield:** Use of sustainable inputs and IPM (Integrated Pest Management) results in better-quality produce.

### 2. Grid Locking System in Cotton

• **Practice:** Create 2.5 ft x 2.5 ft ridges and install grid locks every 10 ft in cotton fields. Around 1950 grids per acre.

**Outcomes:**

- **218,400 liters of water saved:** Improved rainwater harvesting.
- **Enhanced soil moisture retention:** Soil stays moist longer.

- **Improved soil fertility and nutrient availability:** Moisture retention enhances nutrient absorption.
- **Rising groundwater level:** Due to efficient rainwater percolation.

### 3. Moisture Meter for Irrigation

- **Practice:** Measure soil moisture up to 9 cm depth and irrigate only when moisture drops to 2.5–3%.

#### **Outcomes:**

- **8 lakh liters of water saved.**
- **Reduces soil salinity.**
- **Improves root development.**
- **Less water-borne diseases and pests' infestation**

### 4. Trellis and Telephone System in Vegetables

- **Practice:** Trellis system for bitter melon, bottle gourd, ridge gourd, and telephone system for tomato.

#### **Outcomes:**

- **25% increase in yield.**
- **15% reduction in cultivation cost** due to easier in harvesting and better crop management.
- **20–25% water savings** due to efficient use.

### 5. New Horticultural Planting

- **Practice:** Plantation of mango, banana, sapota, guava, pomegranate, coconut, lemon, etc.

#### **Outcomes:**

- **Improved fruit quality.**
- **Reduced production costs:** Less labor and water.
- **Lower input needs:** Efficient use of resources reduces fertilizer, water, and pesticide requirements.

### 6. Pheromone Traps

- **Practice:** Use in cotton, mango, coconut, and date palm etc crops. for control of pest with minimum cost.

#### **Outcomes:**

- **Cost-effective and easy pest control:** Effective against pests like pink bollworm in cotton, fruit flies in mango, brinjal etc.

- **Replace lures every 45 days** for better effectiveness.

## 7. FYM and Netting Compost

- **Practice:** Convert biodegradable waste into compost using bio-composting methods.

### **Outcomes:**

- **Improves soil fertility:** Adds organic matter to the soil.
- **Helps retain moisture:** Keeps plants healthy by maintaining soil moisture.

## 8. High-Density Planting

- **Practice:** High-density planting for mango, pomegranate, lemon, etc.

### **Outcomes:**

- **Higher yield per unit area.**
- **Reduced production costs:** Mechanization becomes easy harvesting feasible, labor cost reduced

## 9. Promotion of New Crop Varieties

- **Practice:** Use of new varieties like cotton (GCH 24 BGII), groundnut (GJG-32), wheat (GW 451, GW 463, GW 499), rice (GR-13, Mahisager, GR-9, GR-24).

### **Outcomes:**

- **Up to 20% cost reduction:** New varieties offer better efficiency having pest-disease resistance, better quality
- **Up to 10% increase in yield:** Due to better climate adaptability.

## 10. Laser Irrigation System

- **Practice:** Use of laser irrigation in groundnut and onion crops.

### **Outcomes:**

- **40% water saving.**
- **Increased productivity:** Efficient water delivery improves growth.
- **Lower electricity costs:** Less water used means reduced power requirement

# Horticulture

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Compared to field crops, horticultural crops play a significant role in India's agricultural development. To increase its production under changing climate conditions, following scientific approaches are suggested for increasing production.

1. Protect all crop to enhance productivity of horticultural crops under changing climate.
2. Control natural resources such as soil, water, and wind.
3. Use water scientifically.
4. Protect the tree plantation properly and promote plantation.
5. Adopt agricultural activities and modern scientific methods to increase productivity.
6. Use modern horticultural tools.
7. Implement modern agro-processing and value addition technologies.
8. Adopt modern marketing techniques.
9. Use greenhouse, net house, and polyhouse technologies to produce quality produce. These structures can protect fruit, flower, and vegetable crops from extreme cold, heat, or heavy rain.

## **Crop-specific Scientific Practices:**

For fruit crops like grapes, treat rootstocks with fungal (*Trichoderma*) treatment before planting.

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1. Use Rayan rootstock for sapota grafts and treat with Trichoderma.
2. Banana tissue culture plants/bulbs should be treated with Trichoderma before planting.
3. Use vermicompost and gypsum in each pit during sapling plantation.
4. For citrus crops, select varieties like Kagdi lime and soak grafts in Trichoderma solution for 15 minutes before planting.
5. In citrus crops, prune newly grown rootlets annually and remove them from the root zone.
6. Choose salt-tolerant horticultural crops like pomegranate, ber, coconut, and date palm for plantation in saline soil.
7. Use drip and sprinkler irrigation systems in saline soil to control salinity and increase productivity.
8. Adopt organic and inorganic mulching, green cover cropping, etc., to prevent salt accumulation on the soil surface.

### **Effects of Climate Change on Horticultural Crops:**

1. Due to increased temperatures, sensitive crops reach maturity earlier.
2. Excessive heat negatively affects pollen viability, leading to poor fruit and flower setting.
3. High temperatures delay tuber formation in potatoes and reduce quality in tomatoes. Heat also adversely affects crop color.

#### **(1) Coconut:**

1. Continuous moisture stress causes the loss of about 300,000 coconuts annually.
  - Cyclones under changing climate led to severe yield losses in coconut.
  - Increased CO<sub>2</sub> due to climate change results in more vegetative growth relative to reproductive parts ultimately, reducing production.
  - High temperatures affect photosynthesis, in plants causing reduction of yields.

## **(2) Effects on Spice Crops:**

- These are mainly grown in Rajasthan and Gujarat during winter.
- Severe cold and frost severely affect production of cumin, coriander, isabgol, and ajwain; sometimes causing complete crop failure, especially isabgol & cumin

## **(3) Amla (Indian Gooseberry - *Embolis officinalis*):**

- Amla is very important in Ayurveda due to its high polyphenol and vitamin C content (63 mg/100g).
- Recommended for arid and semi-arid regions like Rajasthan and Gujarat for high yield and quality.
- Hailstorms negatively affect production and quality of crops.
- Frost severely damages bud-grafted amla plants.
- Frost hinders growth and development, reducing flowering and fruiting.
- Extreme heat can kill amla plants.

## **(4) Ber (*Ziziphus Mauritian*):**

- Grows well in temperatures ranging from 4°C to 42°C.
- Fruit setting is adversely affected when temperature exceeds 35°C.
- Sensitive varieties show up to 40% reduction in leaves, fruits, branches, and foliage under high heat.
- Frost causes significant damage—browning, wilting, and eventually blackening of parts.
- Flowering and fruit setting are adversely affected by frost.

## **(5) Pomegranate (*Punica granatum*):**

- Thrives in temperatures between 10–35°C.
- Low temperatures severely affect the crop:
- Frost damages young plants and leaves.
- Reduces growth and flowering.

- Within 2–3 days of frost, all leaves fall off, making the plant leafless.
- New leaf growth is stunted, and fresh leaves perish under intense frost.

### **Effect of whether on fruits crops:**

- (1) Due to high temperatures, horticultural fruit crop tend to mature earlier. e.g., fruits like lemon, grapes, watermelon, and citrus crops ripen 15 days earlier than usual.
- (2) In strawberries, increased warmth accelerates growth but reduces fruit production due to excessive vegetative growth.
- (3) In pomegranate and strawberries, rapid completion of the dormancy period reduces overall vegetative growth, which affects crop development.
- (4) In citrus crops, delayed monsoons or prolonged rains during fruiting, and hailstorms during the flowering stage led to an increase in fungal infections. These result in:

- Fruit splitting
- Blackening of the fruit
- Fruit drop

Such factors significantly reduce overall production.

- (5) Due to climate change, banana crop experience negative effects from:
  - High temperatures
  - Water stress
  - Excessive rainfall, causing waterlogging problems

All of which adversely affect crop yield and quality.

- (6) High temperatures reduce the quality of tomatoes and brinjals (eggplant), causing:
  - Poor marketability
  - Up to 50–60% of fruits being discarded during grading due to poor quality.

- (7) A study by the Arid and Semi-Arid Region Research Centre

Bikaner in Rajasthan suggested that after frost, the following fruit crops were heavily affected:

- Amla (Indian gooseberry)
- Phalsa
- Ber (Indian jujube)
- Drumstick pods
- Jackfruit and fig

These fruits suffered from quality deterioration. However:

- Pomegranate and sapota (chikoo) were moderately affected.
- Date palm (kharek), being a frost-resistant fruit crop, showed no negative effects.
- Average Post-Harvest Losses (%) in Various Fruit and Vegetable Crops

Crop Name / Fruit Crop	Loss After Harvesting (%)	Crop Name / Vegetable Crop	Loss After Harvesting (%)
Mango	30%	Onion	25%
Sapota (Chikoo)	22%	Tomato	31%
Banana	30%	Cabbage	29%
Guava	15.50%	Cauliflower	22.50%
Papaya	24%	Cluster Bean (Guar)	27.55%
Ber (Indian Jujube)	16%	Chili	20%
Potato	29.50%	Okra (Bhindi)	21%

In saline and alkaline soils, cultivation of salt-tolerant horticultural crops like date palm (kharek), coconut, areca nut (supari) should be practiced. The date palm variety “Barahi” has shown very good results.

**Mango Crop:** According to research conducted at **Navsari Agricultural University**, the following impacts were noted:

**(1) Flowering Response to Temperature in Mango:**

- Flowering in mango begins when night temperatures are around 15°C and daytime temperatures around 20°C.

- If the temperature drops to 7°C to 10°C and remains for 5–6 days, it leads poor flowering, especially with an increase in the number of male flowers in the inflorescence.
- Higher temperatures affect sex differentiation in flowers.
- When temperature remains between 10°C to 15°C, the hermaphrodite flowers (both male and female) in a panicle are balanced, leading to better fruit set.

## (2) Effects of Temperature on Mango Pollination:

- At 25°C, fruit set percentage is observed to be high in mango.
- If the temperature is 15°C, pollen tube development does not occur completely.
- Temperatures between 15°C to 18°C are not favorable for mango fruit set.
- Low temperatures reduce pollen viability in flowers.
- At temperatures below 14°C, ovule fertilization does not occur.
- Below 14°C, more inflorescence and flowers are seen, resulting in higher fruit setting per panicle.

## (3) Effects of Untimely Rainfall on Mango:

- If **untimely rainfall/hailstorm/frost** occurs during flowering, it has the following adverse effects:
- Heavy rainfall during flowering leads to reduced fruit set due to pollen wash-off.
- Increased incidence of black fungal infections.

Source  
Dr B N Patel  
Former Principal, Horticulture College NAU Navsari

# Vegetables

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India ranks second in vegetable production after China, India contributes around 15% of the world's total production. India produces about 80 million tonnes of vegetables from 6.2 million hectares of area. Major vegetable crops in India include: potato, onion, tomato, brinjal, cabbage, cauliflower, smooth gourd, bitter gourd, sponge gourd, ridge gourd, bottle gourd, pointed gourd, kantola, yam, cluster bean, and cowpea, among others.

## **Effects of Climate Change on Vegetable Crops:**

- High temperatures reduce the number of fruit sets in tomatoes, resulting low yield, smaller fruit size, and poor quality.
- Due to high temperatures, pollen production becomes weak, leading to fewer fruit sets. Other effects include fruit drop, poor development, stomatal closure, and reduced carbohydrate synthesis.
- In black cotton soils, higher temperatures female parts and pollen dried up leading to poor fertilization and low fruit set.
- Excess salts in the soil hinder plant growth. Plants become stunted, leaves shrink, and photosynthesis reduces, ultimately plant die.
- Most vegetables are sensitive to excessive moisture and rain.

In dense sowings, the impact of air pollution is more severe.

**Examples:**

Tomato, watermelon, potato, soybean, peas, carrots, and beets are **highly affected by air pollution**.

**Tolerance Levels of Various Vegetable Crops:**

Sr.	Type of Tolerance	Crop Names
1	Drought Tolerant	Chili, watermelon, tomato
2	Heat Tolerant	Tomato, peas, beans, capsicum
3	Salt Tolerant	Watermelon, peas, onion
4	Tolerant to Excess Water	Tomato, onion, chili

**Fruits & Vegetables:**

1. **Dormancy** period ends early in fruits and vegetables.
2. In **severe winter**, fruit **production and quality decline**; to manage dormancy, proper **microclimate and irrigation** should be provided.
3. **High temperatures** result in **reduced ripening ability and yield decline**.
4. In vegetables, **phenol and ascorbic acid** content increases under cold temperatures, affecting quality.

**Measures to Mitigate Adverse Effects of Changing Climate:**

1. Choose varieties that are **resistant to extreme cold, heat, and rainfall**.
2. Select fruit/vegetable varieties with **dormancy traits** to manage extreme winter.
3. During winter, irrigate every **2–3 days** to establish a **favorable microclimate** for protection against frost.
4. **Store harvested vegetables in cold storage or pre-cool** them to extend shelf life.
5. Maintain **recommended storage temperature** in cold storage to **minimize deterioration**.
6. Provide farmers with **daily market rates** and **fast transportation** to reduce post-harvest losses.

7. Grading, pre-cooling, packaging, transport, and marketing must follow **standardized protocols** to minimize post-harvest losses.
8. Conduct **training programs** on post-harvest technologies to help reduce losses through direct and indirect expert guidance.

### 1. **Potato:**

- Increase in **carbon dioxide levels** due to changing weather leads to **higher incidence of bacterial blight and scab** diseases.

### 2. **Tomato: Improved Varieties & Trellis System in Changing Climate**

- Use of **modern trellis systems** in fast-growing vegetables like tomato, bottle gourd, sponge gourd, ridge gourd, and cucumber ensure:
  - Better fruit development
  - Sufficient light, air, and nutrients
  - Higher yields
- The **Horticulture Department** provides **subsidies** for trellis systems, drip irrigation, mulching, and improved seed purchase.

### **Post-Harvest care for Vegetables**

- Harvest at the right maturity stage.
- Perform pre-cooling at recommended temperatures to improve shelf life
- After market surveys, carry out agro-processing and value addition through designated agencies to ensure better returns via modern marketing channels
- For the export/sale of fruits and vegetables, the provision of timely transportation in refrigerated vans from airport or market yards is a crucial aspect to obtain better prices and to maintain quality.
- For marketing the services of an experienced professional

holding an MBA-level degree in agriculture play an important role Under their guidance, establishing sales channels at megacity, national, and international levels contributes significantly to achieve higher profits.

## **POST-HARVEST MANAGEMENT**

### **Introduction**

- India is the world's largest producer of fruits, accounting for about 8% of total world fruit production.
- However, between 20 and 30% of India's fruit production goes to waste due to poor post-harvest management.
- Losses are estimated at approximately Rs 40,811 crore (\$6 billion), annually.

### **The need for Post-Harvest Intervention**

1. Improve product shelf life
2. Improve product appearance
3. Improve product value
4. Ensures that the product complies with established quality standards
5. Reduce losses and
6. Improve revenue and food security
  - Once harvested, the overall quality of fresh fruits can hardly be improved but it can be maintained with good post-harvest practices
  - Focus should be on methods/ activities that are realistic.
  - are efficient (prevent waste)
  - are cost effective
  - can create employment

### **Post-harvest activities include but are not limited to:**

Post-harvest management begins with good pre-harvest practices

1. Frequency of irrigation (watering)
2. Fertilizing (organic/inorganic)
3. Pest and disease control

4. Cultivation practices
5. Harvesting practices (time and methods)

These affect the quality of the final product

### **Pre-harvest activities can influence overall fruit quality**

Some Examples:

- Spraying gibberellic acid (25 ppm) at full bloom can increase yield and fruit retention.
- Gibberellic acid (10 ppm) at color break stage, can delay color development and maintain firmness.
- Pruning can result in larger fruits.
- Harvesting practices can damage fruits or accelerate decay.

### **POST-HARVEST QUALITY CONTROL MEASURES**

- We must consider the natural processes that occur in fruits and learn how to control/manipulate them
  1. Respiration
  2. Transpiration
  3. Ethylene production
  4. Maturity
- We must also consider the external factors that can cause fruit deterioration

#### **Respiration**

- A process in all living organisms involving the intake of oxygen and the release of carbon dioxide to produce energy
- Respiration continues after the fruit is harvested and is important to keep them fresh.

#### **The not so good thing about respiration**

- Since the process of respiration uses food reserves stored in the fruit, it results in fruit deterioration over time.
- This is exhibited in loss of nutritional value, changes in texture, color,

- flavor, and loss of weight.
- These negative effects lower the market value of fruits.

### **Important things to know**

- Temperature is perhaps the most significant factor in post-harvest management of fruits.
- The rate of fruit deterioration doubles for each 10 °C rise in temperature.
- Temperature regulation is the most effective way of extending shelf life of fruits and vegetables.
- Temperature above/below the optimum can cause heat or frost damage.

### **Optimum Temperature for Selected Crops**

<b>Crop Type</b>	<b>Optimum temperature (0 0C)</b>	<b>Storage life (weeks)</b>
Mango	13	2 - 4*
Date palm	- 18 to 0	24 - 52*
Pomegranate	5	8 -12*

### **Post-harvest Treatment: Pre-cooling**

- The rapid cooling of fresh produce from field temperature (pulp temperature at the time of harvesting) to its best storage temperature.
- The main objective is to remove field temperature (field heat).
- Removing field heat reduces the rate of the natural processes that occur in fruits hence increases their shelf life.

#### **Pre-cooling Methods**

#### **Forced Air (recommended)**

- Cool air with high-speed moves over the fruits to remove the field heat. Both packed and unpacked fruits can be pre-cooled

#### **Pre-cooling Innovations**

- Farmer buys an abandoned trailer and customizes it (wooden pallets, shelves, etc.)

- Farmer buys a low-cost refrigeration unit and installs it.

Note: Electricity was available.

### **Post-harvest Treatment: Managing Ethylene Gas**

- Fruits produce ethylene gas which affects the ripening process
- The amount of ethylene depends on whether fruits are classified as climacteric or non-climacteric

#### **The Amount of Ethylene gas Depends on Type of Fruit**

##### **1. Climacteric:**

- Give off large amounts of ethylene gas
- the fruit is fully developed but may not be ready for immediate consumption (mango, date palm, papaya, pineapple guava and banana).

##### **2. Non-Climacteric:**

- Give off little or no ethylene gas
- Ready to eat at maturity.
- Do not ripen after harvest (pomegranate, grape, citrus)

#### **Nine things to know about ethylene production**

1. Ethylene gas is an important artificial ripening agent for climacteric fruits.
2. However, one over-ripe fruit can induce spoilage in an entire crate of fruits.
3. When the concentration of ethylene reaches 0.1-1.0 ppm in climacteric fruits, the ripening process is considered irreversible.
4. Reducing ethylene is key to longer shelf life.
5. Avoid keeping sources of ethylene gas close to your storage room.
6. Refrigeration reduces the rate of ethylene production.
7. Carbon dioxide (Co<sub>2</sub>) also reduces the rate of ethylene production.

8. Potassium permanganate has been scientifically proven to absorb ethylene.
9. Stress or damage to fruits speeds up ethylene production.

### **Post-harvest Treatment: Maturity and Ripening (Mango)**

- Red/yellow skin is not a good indicator of maturity, ripeness, or fruit quality
- Train workers to know the optimum maturity stage
- Maturity can be judged by factors such as internal colour, peel colour, firmness, degrees Brix and fruit shape.
- Internal flesh colour, which develops near the seed and progress outward is generally the best indicator of maturity and ripeness.

### **Harvesting and Storage: Mango**

- Harvest mangoes with a long stem (about 5 cm or longer) to avoid latex drip.
- Trim stems to the abscission zone (approximately 1 cm) and immediately place the fruit with the stem end down to allow latex to drip.
- Store mangoes with the tip down for efficient latex removal (ranges between 20 minutes to 4 hours).

### **Additional things to know about maturity and harvesting**

1. Maturity varies from species to species
2. Fruits to be shipped should be picked at a mature but unripe stage
3. Control/manipulate ethylene production
4. Best temperature for ripening mango is 20° C – 22° C
5. Again, it is good to know fruit types (climacteric/non-climacteric)

### **Controlling External Factors**

- Biological: Pests and diseases
- Chemical: Toxic sprays, pesticides, unpleasant flavours left by insects etc.

- Mechanical: injury from cuts, bruises, dirt
- Physical: Sunburn, heat, freeze, dehydration, latex scalds, etc.

### **Packaging Storing and Transporting**

- Be careful not to damage fruits.
- Avoid large piles.
- Do not pack fruits with different stages of maturity.
- Do not over-fill cartons.
- Ensure that air can circulate around the fruits in the carton.
- Use plastic crates or crates lined with polyethylene material.
- Do not over-stack crates.
- For long distance and international transport, use refrigerated trucks.

### **Summary**

- Pre-cooling is a compulsory post-harvest treatment in developed countries for almost all perishable commodities.
- The quality of fresh fruits and vegetables largely depends on precooling before storage and marketing.
- Post-harvest fruit quality depends on pre-harvest agricultural practices.
- Time of harvest can affect fruit quality. Harvest during the cooler periods of the day, usually before 10:00 AM
- Do not overload storage rooms or stack boxes tightly as it will hinder air movement through all boxes.
- Monitor temperature in the storage room by placing thermometers at different locations.
- Remove damaged or diseased produce to prevent the spread of pathogens.
- Storage rooms should be always kept clean.
- Store only high-quality produce, free of damage & decay and of proper maturity.

- It is true that a small farmer may not be able to afford this on his own but Self-Help Group (SHG) or farmers' cooperative, or micro enterprise can setup this.

**Source: Dr gilbert-FAMU**

## Mechanization

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With the use of science and technology, farming is becoming increasingly modern. Various small and large tools are used to carry out essential farming operations. As part of improved agricultural practices, tools such as upgraded implements have helped in increasing farm productivity and reduced cost. Inputs like agricultural machinery, farm tools, seed technology, tissue culture, greenhouses, and efficient use of water play a critical role in enhancing production through scientific methods.

Using modern agricultural implements and machinery enables timely completion of tasks, allowing a second crop to be sown quickly after harvesting the first. It also addresses labour shortages. However, these tools and machines are often expensive, making their maintenance and proper upkeep essential. If maintained properly, these tools operate without major issues for a long time, extending their lifespan, reducing repair costs, and ensuring a return on capital investment.

From sowing to marketing, various implements are used at different stages of agriculture, such as:

- Primary tillage implements
- Sowing and fertilizer application equipment
- Interculturing and weeding tools
- Spraying equipment
- Harvesting and threshing machines

- post-harvest and value addition tools

### **Use of Agricultural Implements in Farming**

Agriculture is the backbone of India's economy, with nearly 65% of the population directly or indirectly dependent on farming and allied activities. India ranks among the top agricultural producers in the world, thanks largely to the use of tools, improved seed varieties, fertilizers, irrigation systems, soil health management, and effective use of pesticides. In ancient times, farming was entirely manual, and later progressed to the use of animal-drawn tools like ploughs. With the Green Revolution and beyond, private institutions developed many farmer-friendly tools and machines.

With declining livestock availability, increased labor costs, and the need to grow multiple crops per year, mechanization has gained importance. Tools are needed for ploughing, spraying pesticides, sowing and fertilizers, weeding, and harvesting. In intensive farming areas where three crops are grown annually, efficient machinery is essential. In summary, mechanization in farming is the need of the hour.

Due to rural migration to urban areas and growing disinterest in farming, labor shortages are common in villages. This has led to higher wage rates, making farming costlier. Farmers have realized that using machines saves time, labor, and money, and allows them to complete tasks from ploughing to harvesting with efficiency, preventing post-harvest losses.

Developed countries produce much more per capita due to highly mechanized farming. To increase per-hectare yield, India also needs to use more mechanical power inputs. For multiple cropping and timely operations, along with improved implements, use of diesel engines, tractors, and power tillers is essential. Currently, India produces over 2.5 lakh tractors annually. Additionally, many other tools such as diesel engines, seed drills, high-capacity power threshers, sprayers, duster machines, irrigation pumps, combine harvesters, and other farm machinery are also being manufactured and used over the past decade, Agricultural mechanization in India has significantly

advanced, increasing the use of farm power in ploughing, sowing, weeding, harvesting, irrigation, threshing, and other agricultural operations.

### **Classification of Tillage and Tools**

Based on the type of tillage:

1. By time: (a) Primary tillage, (b) Secondary tillage, (c) Final tillage
2. By depth: (a) Shallow tillage, (b) Deep tillage
3. By soil condition: (a) Ideal tillage, (b) Unorganized tillage

Power source:

- Manual tools
- Animal-drawn tools
- Mechanized tools

Thus, tools range from simple hand implements like a khurpi to modern combine harvesters. Before detailing tools, let's see the main benefits of mechanization:

### **Major Benefits of Agricultural Mechanization:**

- Increased productivity in less time as timely operation particularly sowing operation.
- Timely farm operations ensure optimal crop production
- Reduced per-hectare cost
- Less need for manual labor – saves human effort
- Quicker market access leads to better prices
- Economical use of costly inputs like seeds, fertilizers, and pesticides
- Minimizes post-harvest losses and protects crops from adverse weather

### **Modern Implements for Agriculture**

Mechanized tools allow more work with fewer labourers. Farming tasks are completed timely and efficiently. Higher production can be achieved through optimal land use, even with reduced labour and time.

### **Modern Tools for Land Preparation:**

- Cultivator, Rotavator, Disc Harrow, Disc Plough, Mouldboard Plough – all are tractor-operated for deep tillage.

### **Power Tiller:**

This is useful for horticulture, grape orchards, and vegetable farming. It tills the soil up to 15 cm deep and is suitable for inter-cultivation in crops like cotton, pigeon pea, castor, sugarcane, banana, and tobacco. Depth of operation can be adjusted between 30–75 cm. It typically has a 7.5 to 12.5 HP diesel engine and can cover about 2 ha/day. Attachments include cultivators, ploughs, seed drills, and even water pumps or threshers.

### **Laser Leveler:**

Used for levelling land efficiently using laser guidance. It leads to efficient ensures even water distribution, increases productivity, and saves 20% water. Approx. cost: ₹3.5 to ₹4 lakh Use: Land leveling for efficient irrigation

### **Transplanters:**

- **Rice Transplanter:** Self-propelled or manual, with 6–8 rows capacity. Cost: ₹1,00,000 to ₹1,75,000
- **Raised Bed Planter:** Ideal for wheat, maize, and vegetables. Helps in seed germination and efficient irrigation. Cost: ₹45,000

### **Sugarcane Planter:**

Cuts and places sugarcane setts at desired spacing. Covers 1.5 ha/day. Has seed containers, fertilizer box, furrow opener, and pressing wheels.

### **Vertical Conveyor Reaper:**

Efficient machine for harvesting crops like wheat and paddy. Reduces labor cost by 50–60% and time by 60–70%. Use: Ideal for uniform, weed-free, large fields.

### **Precautions for Using Reaper:**

- Tighten all nuts and bolts before use

- Oiling of all important parts
- Clean cutter bar to prevent rust
- Keep children away and wear tight-fitting clothes
- Never touch moving parts

## **Modern Implements for Spraying in Crops**

### **1. Tractor Mounted Sprayer:**

This sprayer, mounted at the back of a tractor, is very useful for quick and uniform application of insecticides, liquid fertilizers, or organic solutions like Jeevamrut. It typically includes a 400-liter capacity fiberglass tank, spray boom, pump, etc. The spray boom is 15 to 20 meters long and can be adjusted up to 3.5 meters in height using a chain-pulley block, which helps match the crop height. Ensure enough space is left for movement to avoid crop damage. The pump can generate a pressure of up to 28 kg/cm<sup>2</sup> and is usually a triplex type. Other components include:

- Nozzles on the boom
- Pressure controller
- Bypass valve
- Control valve
- Fluid return pipe
- Agitator for mixing solutions in the tank

With this equipment, pesticides can be sprayed on approximately 2 hectares in an hour.

## **Modern Equipment for Weed Control**

### **2. Self-Propelled Power Weeder:**

This engine-driven tool runs on petrol and can operate on kerosene. Designed by CIAE (Central Institute of Agricultural Engineering), it is suitable for weed control in crops like groundnut, maize, soybean, etc. It works best when the row spacing is more than 30 cm.

### **3. Use of Hand Tools in Agriculture:**

Hand tools are essential in various agricultural operations. They

are efficient, cost-effective, and labor-saving, suitable for tasks like weeding, harvesting, land preparation, digging, bunding, separating, or collecting.

**Qualities of Good Hand Tools:**

- Durable structure and reliable material
- Enhance speed and reduce fatigue
- Flexible and adaptable to different needs
- Safe and not hazardous to users
- Easily modifiable for small changes
- Locally available
- Durable, strong, and affordable

**Importance of Hand Tools:**

Manual labor remains essential in Indian agriculture due to the high cost of animal or mechanical power. Efficient use of hand tools increases productivity and reduces cost. These tools can be operated by hand or foot and are generally categorized by:

**(1) By Operation Type:**

- General hand tools: Hoe, spade, sickle
- For interculture/weeding: Khurpi, wheel hoe
- For spraying: Sprayer, duster
- For harvesting/threshing: Sickle, hand thresher
- For horticulture: Pruners, budding knife
- For threshing: Maize sheller, mini threshing machine

**(2) By Power Type:**

- Hand-operated: Hoe, spade, sickle, sprayer, hand thresher
- Foot-operated: Chaff cutter, pedal thresher, foot sprayer

**Important Hand Tools**

- **Stand-up Weeder:**

A long-handled tool that allows weeding while standing, reducing back strain by 30%. Enables 8 hours of work with less fatigue compared to 6 hours bent over.

- **Hand Hoe (Karabadi):**  
Used for inter-row cultivation in transplanted crops like paddy, ladyfinger, and brinjal. available with an adjustable handle and pronged head for deeper weeding.
- **Spiked Rotary Weeder:**  
Helps remove weeds, break soil crust, and conserve moisture. Operated by pushing while standing. Front wheel has spikes, and a blade is fixed at the back.
- **Wheel Hoe:**  
Lightweight and push-operated, used for inter-row weeding and moisture conservation. Has a front wheel and interchangeable blade attachments.
- **Maize Sheller (Handheld):**  
Hand tool for removing kernels from maize cobs. The cob is pushed through and rotated to separate grains. Can shell 15–20 kg/hour.
- **Groundnut Pod Remover:**  
Removes pods from uprooted groundnut plants. Operated by back-and-forth motion, separating pods with minimal breakage. Can process 50–80 kg/hour.
- **Castor Sheller (Large):**  
Like groundnut remover, used for castor seed decorticator from capsule. Can process 60–90 kg/hour.
- **Seed Dressing Drum:**  
Used to coat seeds with pesticides or fungicides. Has a rotating drum with mixing plates for even coating. Lightweight and easy to use.
- **Crank-Type Broadcaster:**  
Used to broadcast seeds or granular fertilizers. Operated by a crank mechanism that distributes material evenly in a 4-meter radius. Can cover 1 hectare/hour.
- **Cotton Stock Puller:**  
Removes dried cotton or pigeon pea plants from the roots without breaking. Made of galvanized iron pipe and has

ergonomic design for left- or right-hand use.

- **Mango Harvester:**

Used to pick mangoes without damaging the fruit. Features a circular frame with a nylon net and cutting blade that detaches fruit by from plants

- **Lemon Harvester Stick:**

Used for picking lemon, ber , and similar thorny fruit trees. Comes with a half-round metal plate with a netted collection bag attached to a pipe.

- **Banana Cutter:**

Used to separate banana hands from the main bunch without damage. Can cut 100–120 banana hands per hour using a sharp semi-circular blade.

- **Potato Digger Tool:**

multi-purpose animal-drawn tool used for ploughing, interculture, ridging, and potato digging. Reduces the need for multiple tools and saves money.

### **Solar-Powered Modern Pump: A Sustainable Agricultural Solution**

- **Solar Photovoltaic Pump:**

Helps irrigate crops in remote areas where electric power is unavailable. The system consists of solar panels that generate DC power and operate mono-block or submersible pumps via inverter. It can lift water from 6 meters suction head and deliver up to 10 meters. Operates pumps up to 2 HP efficiently and can also store excess energy.

### **Maintenance of Electric Motors and Pumps in Irrigation:**

- Install motors above water level, protected in a box during monsoon.
- Keep motors dry and inspect thoroughly before use if exposed to moisture.
- Lubricate bearings every six months.
- Protect electrical switches and wiring from water or humidity.

### **Conclusion:**

Proper maintenance of agricultural equipment significantly

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improves their lifespan, reduces repair costs, and ensures efficient performance. Energy is better utilized, productivity increases, and operational costs decline—ultimately benefiting the farmer economically.

### **Maintenance of Various Agricultural Tools/Machines:**

Most farmers now possess specialized agricultural machines like openers for grain separation, winnowing machines, etc. Before operating such tools, one must check manually that they run smoothly and without any obstructions. The opener's teeth and sieve should have the appropriate-sized gaps. Use engines or electric motors of the specifications recommended by the manufacturer. Avoid running belts too loose or too tight, and check that bearings do not overheat. Overheating may occur if bearings are damaged or if there is a shortage of grease.

After threshing work is completed, clean the surroundings of the opener of dust and leaves and run it empty for 5–10 minutes to clear internal debris. Clean rotating parts like bearings properly and refill with grease, then wrap with cloth to prevent dust ingress. Remove belts and store in a dry, moisture-free place. Additionally, to prevent damage from rain, store the opener under a shed and cover it with plastic or canvas, if possible.

For machines with tires (e.g., harvesters, tractors, carts, openers with wheels, trailers), keep tyres properly during storage. Support the machine on bricks or stones to avoid direct weight on the tires. Without this, air gradually remove, and cracks may develop. Also, store tyres and equipment in shade to protect from sun and rain.

### **Tractors and Their Importance**

In this era of mechanization, tractors play a crucial role in farming. Farmers who cannot afford bullocks now rely on tractors, either owned or rented. Tractors have become indispensable for timely agricultural operations and are increasingly in demand. From operating tractors to daily maintenance and troubleshooting

**Source:**

**Dr. R. R. Gajera, Associate Professor, College of Horticulture, AAU, and  
Dr. N. C. Patel, Vice Chancellor, Anand Agricultural University, Anand**

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– all require proper knowledge to save time, money, and to increase the tractor’s lifespan.

**7. Engine Issues and Solutions:**

<b>Problem</b>	<b>Cause</b>	<b>Solution</b>
White smoke	Poor combustion, excess diesel, cold engine, water in fuel	Check engine, adjust timing, warm up engine before load, use clean diesel
High oil consumption	Worn valve guides, leakage, wrong oil grade, worn piston/rings, blocked air intake	Replace guides/rings, stop leaks, use recommended oil, clean pipes
High diesel usage	Wrong timing, overloading, leakage, clogged air filter, clutch slip, excess nozzle flow	Set timing, reduce load, remove leakages, clean filter, service clutch/nozzle
Low engine power	Overheating, brake drag, carbon buildup, clogged air filter, poor combustion, poor injector function, improper valve seating	Improve cooling, repair brakes, clean carbon, service fuel system, use clean fuel
Engine overheating	Stuck thermostat, faulty radiator cap, excess load, poor coolant flow, loose fan belt, faulty water pump, clogged radiator pipes, low/poor oil	Replace thermostat, use correct cap, reduce load, refill coolant, tighten fan belt, repair pump, clean radiator, top up with proper oil
Engine not cranking	Dead battery, starter failure, seized engine	Charge/replace battery, repair starter, full engine check
Engine won’t start	Empty tank, water in diesel, poor compression	Refill tank, clean tank and refill with clean fuel
Engine stalling	Valve faults, jammed plunger in nozzle, clogged filter	Clean/replace parts, clean or change filter

**Other Tractor Systems:**

- **Steering System:**  
Contains 90-grade oil. Regularly check and maintain oil levels.
- **Clutch System:**  
Connects engine power to gearbox. Check and repair clutch plates as needed.
- **Gearbox:**  
Uses 90-grade oil at recommended level to prevent bearing damage.
- **Differential:**

Transfers power from gearbox to wheels. Maintain proper oil level.

- **Hydraulic System:**

Pump sends oil to lift mechanism. Oil passes through magnetic filter to remove metal shavings. Clean filter regularly to avoid hydraulic shocks and maintain performance.

**Additional Tractor Care Tips:**

1. Maintain correct tyres pressure based on task.
2. Avoid contact with grease/oil on tires.
3. Do not brake suddenly – prevents tire wear.
4. Rotate tires periodically to extend lifespan.
5. Regularly check front wheel alignment.
6. Keep hydraulic adjustments proper to prevent wheel slip.
7. Protect tires from heat and weather when not in use.
8. Grease moving parts at recommended intervals.
9. Keep battery always charged.
10. Use petroleum jelly on terminals, never grease.
11. Always use distilled water in battery.
12. Replace leakages or damaged battery immediately.
13. Have dynamo repaired at authorized service centers.
14. Avoid using substandard spares for dynamo repair.
15. Protect starter and dynamo from dust and water.
16. Keep starter connections clean and tight.
17. Keep hydraulic lift always in neutral when not in use.
18. Periodically service and overhaul tractor.
19. Clean off dust after field work and store covered if possible.

**Source:**

**Shri A. J. Parghi, Shri J. J. Chavda, Shri D. K. Vyas  
College of Agricultural Engineering and Technology,  
Anand Agricultural University, Godhra**

# Marketing

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Marketing skills is very essential for obtaining good price of the products some tips are as under.

## 1. Know Your Product & What Makes It Special:

- **Agriculture (Grains, Pulses):** Focus on good quality, clean produce.
- **Horticulture (Fruits, Vegetables):** Freshness is key! Sort by size and quality.
- **Animal Husbandry (Milk, Eggs, Live Animals):** Ensure hygiene for milk, fresh eggs, healthy animals.
- **Cow Dung Based Inputs (Vermicompost, Jeevamrut):** Highlight its natural, organic benefits for soil.
- **Fisheries (Fish):** Focus on freshness and proper handling.

## 2. Where to Sell (Market Places):

- **Local Markets (Haats/Mandis):** The easiest way. Go directly, sell your fresh produce.
- **Direct to Consumers:**
  - **Home Delivery:** If possible, deliver to houses in nearby towns/cities.
  - **Roadside Stalls:** If your farm is on a busy road.
  - **Sell to Eateries/Shops:** Talk to local restaurants, hotels, or small grocery shops.

- **Whatsapp Groups:** Create a group with interested buyers from nearby areas and share daily updates of your available produce.
  - **Self-Help Groups (SHGs) & Farmer Producer Organizations (FPOs):**
    - **Join or Form One:** This is very powerful! SHGs/FPOs help you combine your produce with other farmers. This means you can sell more quantity, get better prices, and share transport costs. They also help with packaging and selling in bigger markets.
    - **Value Addition:** SHGs/FPOs can help make products like jams from fruits, pickles from vegetables, dried fish, or organic compost packets from cow dung. Value-added products fetch higher prices.
  - **Online Platforms (for tech-savvy groups):**
    - **e-NAM (National Agriculture Market):** A government online platform where you can sell your crops to buyers across India. You need to register at your nearest e-NAM linked mandi.
    - **Other Apps/Websites:** Some apps connect farmers directly to consumers or businesses. Your FPO or SHG might help with this.
- 3. How to Access Market Information & Select Crops:**
- **Talk to Others:** Ask other farmers, local traders, and SHG/FPO members about what crops are selling well and at what prices.
  - **Visit Markets:** Go to the nearest mandi and observe the prices of different crops.
  - **Government Websites/Apps:**
    - **e-NAM:** Check live prices of different commodities in various mandis.
    - **Kisan Suvidha App:** Provides information on weather, market prices, agro advisories, etc.

- **Radio/TV:** Listen to agricultural programs for market news like KISAN CHANEL, LOCAL NEWS BULLATIN
- **Local Agriculture Department:** They can give advice on suitable crops for your area and market demand.
- **Select Crops Carefully:**
  - Grow what is **in demand** in your local market.
  - check comparative market price
  - Choose crops that is sustainable based on your **soil health and water** analyse
  - Consider **local festivals or special occasions** when certain products might be in high demand.

#### 4. **How to Approach for Sale under Minimum Support Price (MSP)**

MSP is a price set by the government to protect farmers from sharp falls in market prices, especially for key crops.

**Check MSP Crops:** Not all crops are covered under MSP. Primarily, staple food grains (like wheat, paddy), some pulses, oilseeds, and a few other crops are covered. Check the list announced by the government for each cropping season. Presently Government announces MSP for 23 crops (7 cereal, 5 pulses, 7 oilseeds and 4 commercial crops)

**Find Procurement Centres:** The government agencies (like FCI, NAFED, Cotton Corporation of India) set up procurement centres (often at APMCs/mandis or temporary centres) during the harvest season. Find out where your nearest procurement centre is.

- **Registration is Key:**
  - You usually need to **register online** on the state government's procurement portal or at the designated procurement centre.
  - You will need your land details, crop sown details, Aadhaar card, bank passbook, and mobile number.
- **Quality Check:** Your produce must meet specific quality

standards (moisture content, impurities) set by the government.

- **Bring Your Produce:** Take your registered produce to the procurement centre on the given date.
- **Direct Payment:** Once your produce is accepted, the payment for the MSP amount is usually transferred directly to y.

## Food Processing for Enhancing income

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“From Farm to Industry: Enhancing Income through Processing and Packaging” is one of the best methods to help rural communities increase their profits.

Instead of selling their crops directly in the market, **farmers should focus on processing their produce and producing commercial products through small-scale or home-based industries.**

This is often the most natural fit, given the agricultural base of rural areas.

- **Pickles and Preserves:**
  - **Traditional Pickles:** Mango, lemon, mixed vegetable, chili, garlic, ginger. These have a huge market, both rural and urban.
  - **Chutneys & Sauces:** Tomato ketchup, chili sauce, various regional chutneys (e.g., groundnut chutney, coconut chutney powder).
  - **Jams & Squashes:** From seasonal fruits like mango, guava, berry (Amla, Jamun), or even exotic fruits grown locally.
- **Spices and Masalas:**
  - **Whole Spices:** Cleaning, sorting, and packaging locally grown spices like turmeric, chili, coriander, cumin.
  - **Ground Spices/Masalas:** Preparing and packaging commonly used spice blends (e.g., garam masala,

sambar powder, rasam powder, chaat masala). Quality and authenticity can be key selling points.

- **Millets and Grains (Value-Added Products):**
    - **Flour (Atta):** Processing locally grown wheat, maize, jowar, bajra, ragi into flour using small chakki (flour mills). There's a demand for fresh, stone-ground flours.
    - **Roasted & Puffed Grains:** Puffed rice (murmura), roasted chana (gram), roasted groundnuts. These are popular snacks.
    - **Millet-based products:** Ready-to-cook mixes (dosa mix, idli mix, upma mix) from millets, millet cookies, millet flakes (poha). The urban market has a strong demand for healthy, traditional grains.
  - **Snacks and Savories (Namkeen):**
    - **Traditional Snacks:** Papad (various types like potato, rice, lentil), wadi Yaan (dried lentil dumplings), chips (banana, potato, jackfruit).
    - **Authentic Regional Snacks:** Many regions have unique savory snacks that can be commercialized.
  - **Dairy Products (if livestock is common):**
    - **Ghee (Clarified Butter):** High demand for pure, homemade ghee.
    - **Paneer (Indian Cottage Cheese):** Can be made fresh and supplied to local shops or urban centres.
    - **Khoya/Mawa:** Used in various Indian sweets.
  - **Dehydrated Fruits and Vegetables:**
    - Drying vegetables like onion, tomato, potato, green leafy vegetables drumstick leaves powder to extend shelf life and create convenience products for urban consumers.
    - Sun-dried fruits (e.g., mango slices, amla candy, fig).
  - **Bakery Products (Simple):**
    - Local cookies, rusks, and simple breads, especially if there's a local demand or a school/college nearby.
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## II. Non-Food Products (Leveraging Local Resources & Skills):

### • Handicrafts and Artisanal Products:

- **Textiles:** Embroidery, weaving (e.g., handloom sarees, stoles, dupattas), block printing, tie-dye.
- **Pottery & Terracotta:** Traditional clay pots, decorative items, diyas.
- **Basketry:** Products made from bamboo, cane, jute, or local grasses (e.g., storage baskets, decorative items, mats).
- **Jewelry:** Traditional or contemporary jewelry made from beads, threads, natural materials.
- **Home Decor:** Wall hangings, showpieces, traditional dolls, coir products.

### • Herbal and Medicinal Products:

- **Herbal Powders:** From locally available medicinal plants (e.g., Amla powder, Neem powder, Turmeric powder, drumstick leaves powder).
- **Herbal Oils:** Hair oils, massage oils infused with traditional herbs.
- **Incense Sticks (Agarbatti):** Can be made from natural ingredients.
- **Soaps & Cosmetics:** Natural, handmade soaps using traditional ingredients. like neem, Alovera etc

### • Sustainable and Eco-friendly Products:

- **Jute Bags:** Reusable shopping bags, tote bags.
- **Leaf Plates/Bowls:** From Sal leaves or other broad leaves, as an eco-friendly alternative to plastic.

### • Cleaning & Household Products:

- **Detergent Powder/Cakes:** Small-scale manufacturing of basic cleaning agents.
- **Phenyle/Floor Cleaner:** Simple household cleaners.

## III. Services (Often Combined with Products):

- **Catering for Local Events:** Providing homemade meals for village functions, small parties. Traditional meal shops.

- **Tailoring and Stitching:** Custom clothing, repairs, school uniform stitching.
- **Beauty Services (Basic):** Small beauty parlors.

### Key Factors for Success for Women in Home Processing:

#### 1. Market Research:

- **Local Demand:** What do people in the village and nearby towns frequently buy? What traditional products are losing out to packaged goods but could be revived?
- **Urban Demand:** What are urban consumers looking for (e.g., organic, natural, traditional, healthy, convenience, artisanal)?
- **Competitors:** Who else is selling similar products? How can you differentiate?

2. **Raw Material Availability:** Choose products where raw materials are abundant, affordable, and consistently available locally. This reduces transport costs and ensures supply.

3. **Skill Set:** Leverage existing traditional skills (cooking, weaving, crafting) or invest in training for new skills.

4. **Quality and Hygiene:** This is paramount, especially for food products. Adherence to basic food safety standards (FSSAI norms for larger scales) is crucial for market acceptance and scaling.

5. **Packaging and Branding:** Simple, attractive, and hygienic packaging can make a huge difference. Even basic branding (a catchy name, a simple label) helps.

6. **Pricing:** Price competitively, considering raw material costs, labour, and market rates.

#### 7. Marketing and Sales Channels:

- **Village Level:** Local kirana stores, weekly markets (hats), direct sales to neighbours, word-of-mouth.
- **Urban Centres:**
  - **Direct Sales:** Farmers' markets, local exhibitions, melas.
  - **Local Shops:** Tie-ups with small grocery stores, organic stores, or specialty stores.

- **Online Platforms:** While challenging initially, e-commerce platforms (even local ones like WhatsApp groups or community platforms) can expand reach.
- **Bulk Orders:** Supplying to caterers, small restaurants, or institutions.
- **Self-Help Group (SHG) Networks:** SHGs are excellent for collective production, marketing, and accessing support.
- **Training and Support:**
  - **Skill Development:** Programs from government bodies (like Rural Self Employment Training Institutes - RSETIs), NGOs, or agricultural universities (KVKs).
  - **Financial Literacy:** Understanding costing, pricing, and basic accounting.
  - **Government Schemes:** Look for schemes under the Ministry of Food Processing Industries (MoFPI) like PM FME (Pradhan Mantri Formalisation of Micro Food Processing Enterprises Scheme) which supports individual units, FPOs, and SHGs. NABARD also supports such ventures.
- **Scalability:** Start small, test the market, and then gradually scale up based on demand.

By focusing on these aspects, women in rural areas can successfully establish home processing businesses, contributing to their own financial independence and the local economy.

# Animal Husbandry

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Livestock, Cattle, buffalo, poultry and fisheries are an important source of income to farmers. The contribution of livestock in agriculture GDP is 30.2%. Like crops, climate change also affects livestock. The tips for management of livestock in changing climate are given here under.

## **Climate Smart Livestock Practices**

Livestock contribute to food security and livelihood. It is no longer supplementary source of income. In fact, it provides cash income on weekly basis based on how well the marketing infrastructure is laid out. Historically for arid and semi-arid areas are known as drought prone areas like Kutch district of Gujarat, every year government-initiated cattle migration which was organized due to lack of drinking water. But livestock are prone / sensitive to changes in climate:

### **I. Main Impacts**

- Causes of climate change
- Increased temperature
- Shifts in rainfall distribution
- Increased frequency of extreme weather conditions.

### **Impact**

- Low productivity with increased heat stress
- Quality and availability of feeds and fodder

- Emergences livestock disease
- Increased competence with other sector for water source results in exhaustion of water.
- The grazing area – Gauchars – get minimum yield of grass, they become barren due to over use. Reduced water availability leads to increase in disease and even migration as cost of feed go up.

## **II. Adaptive Measures**

- Grazing Areas
  - The community must reduce number of animals depending on grass available
  - Government has to set-up fodder depots and provides water – non availability same may require planned migration of cattle to forest area/ irrigated areas where feed is available. In Kutch, up to year 2000 systematic cattle migration was practice. But with water supply from Narmada Dam pipeline and with Fodder Bank/ Fodder Depots, cattle migration is minimized.
- Early Warning System and Insurance
 

Use of weather information can help to local administration plan grassdepots and water supply within districts or work out a planned migration.

## **III. Cattle Insurance at present covers cattle death but cost of forced migration may have brought under insurance cover**

- Breed Selection
 

The crossbreed animals – particularly from European – American breeds are very heat sensitive. It may, therefore, be necessary to focus on original cattle breeds which are climate resilient and can endure heat stress or have capacity for long travel. The original cattle breeds of Gujarat – Geer & Kankreji cows are suitable for this purpose.
- Promoting Community Bio-gas Plants – will help optimize on methane derived from cattle. The dung slurry can be

converted into vermin compost and marketed. This is evident from the case example of local level action from Chhota Udaipur.

#### **IV. Landless Animal Holders**

These are most vulnerable – as they depend on community grassing areas which get depleted – will need special assistance.

#### **V. Milch Animals – suggested measures:**

- **Summer:**

The summer is the period when temperature of atmosphere is very high which directly affects the reproductive health of milk animals, poultry and fishes. The energy of animal is spent to keep body temperature cool and hence they do not get the typical symptoms of coming in heat to do artificial insemination. The milk production reduces for buffaloes and slight increase of milk production for cows. If summer-monsoon gets delayed or summer is followed by drought then milk animal health is severely affected which leads to consistently reduction in milk production. During heat and cold wave, the feed intake reduces considerably in poultry, which effects the growth of the birds and production of eggs. Birds' mortality also increases and disease resistance reduces. During high temperature period growth of pond and marine fishes gets affected. The reproduction of fishes and disease resistance also reduces.

- **Monsoon:**

Monsoon is good period to get green fodder which is available in plenty, farmers try to feed excessive green fodder which is not in balance of fat carbohydrate and protein hence it leads to reduction in fat in milk and also animals get frequently sick. If excessive rain leads to flood and also causes outbreak of diseases

- **Winter:**

Winter is highly favourable to milk animal and particularly to buffalo. Milk production of buffalo increases whereas

milk production in cows slightly decreases. Winters are also the best period for fertility of milk animals. During extreme cold it is necessary to protect milk animals by keeping them in warmer place or covering them with warm covers.

- **Effect of climate change impacting Milk Animals, Poultry and Fisheries**

- With time human needs increase resulting in increased industrialisation and urbanisation which started producing greenhouse gases harmful not only to humans but also hazardous to the eco systems. This has led to increase in the earth's atmospheric temperature which has also gradually affected the milk animals .. Temperature and humidity have direct effect on milch animals.
- Milch animals get stressed as temperature and humidity start rising. We will discuss how these affect the milk animals and how to identify the level of stress:
  - 1) **Mild stress:** When the animals have increase respiration rates panting, sweating, leaks body surface and drinks water frequently that means animal is under mild stress.
  - 2) **Moderate Heat Stress:** During moderate heat stress animal will have profuse sweating, rapid breathing and reduction in milk production
  - 3) **Severe heat stress:** If animal is having open mouth breathing with panting, stop eating feed means that it is under severe heat stress.
- **EFFECT ON MILK PRODUCTION:**
  - Milk production of cow and buffalo declines as the Temperature and Humidity index rises. 10 to 30 % decline in milk production can be seen for long exposure of milk animals to high temperature and humidity.
- **EFFECT ON FEED INTAKE:**
  - As the temperature rises the feed intake of milk animal starts declining which leads to decline in milk production and also poor reproductive health.

- **EFFECT ON REPRODUCTIVITY HEALTH OF MILK ANIMALS.**
  - Temperature affects the reproductive health of milk animals. It leads to decline in conception rate. Animal needs repeat service to conceive. Long exposure to heat will lead to high calf mortality and reduces weight gain. It will also lead to decline in milk production of next generation and delay in maturity of calf. Heat will reduce the sperm count in male.
- **EFFECT ON HEALTH AND DISEASES:**
  - Rise in Temperature and Humidity Index will lead to reduced immunity and outbreak of infectious diseases.
- **PROTECTION AGAINST CLIMATE CHANGE**
  - It is not in one's hand to prevent the changes in climate that are taking place but knowing that these changes will affect our milk production, Poultry and fisheries production which will affect our economy, one can prepare to protect the milk animals, Poultry and fisheries against the changes that are taking place by adopting the prevention as describe.

### 1) **SELECTION OF MILK ANIMAL BREED:**

In Gujarat we have two major climatic zones for milk animals. North Gujarat where climate is hot and dry and second is Saurashtra, Central and South Gujarat where climate is hot and humid. While selecting animals care must be taken that animal suitable for the zone must be selected i.e. if one wants to buy buffalo in Sabarkantha, then it must be from Mehsana or Palanpur and those in Saurashtra should buy Surati buffalo. Indigenous cow breed suitable for our weather is breed of cattle like Kankrej, Gir and others which sustain and yield well in adverse climate.

### 2) **SHELTER FOR MILK ANIMALS**

The shelter for the milch animals is very important. If proper shelter is provided, one can eliminate 50% effect of climate changes. The shelter must have following features:

- 1) Shelter should be in wind direction i.e. east to west so

the morning sun light gives good lighting and being in wind direction will have good ventilation.

- 2) Shelter must have proper roofing covered with 3-inch dry grass to reduce the heat when sun is hot. Before putting grass paint the roof with cement and lime solution
- 3) Shelter must have little slope towards drain and preferably covered with wood slits.
- 4) Shelter sides toward south north preferably closed with windows so that during afternoon and during extreme cold winter it can be closed to provide protection.
- 5) Shelter should have good spacing to comfortably house the milk animals. Minimum of 3 mtr by 1,5 mtr space is required per animal. The height of the roof should not be less than 3 mtrs.
- 6) The shelter should be provided with cooling fan, water spray and large water tank with water makes up provision for drinking water.
- 7) Shelter should be surrounded by fodder trees which not only give conducive environment but also gives fodder during drought and summer.
- 8) There are many animal holders who may not have their own land. Community Shelter could be constructed in village grassing land for housing their animals. This can perhaps be undertaken under NAREGA. A typical sketch showing requirement of shelter is given below:

### **3) FEEDING PRACTISE**

The feeding practice is very important to protect the milk animals against the climate change. One must ensure that a total feed is given to animal all through 24 hours which should be properly prepared. The feed must be balanced with urea treated dry fodder properly cut mixed with silage green fodder, concentrated feed and mineral mixture. Fresh, palatable, high-quality feed with high biological value should be provided in the feed bunk at all the time to provide

maximum opportunity for feed consumption Reduce the use of poor-quality straws in the diet of livestock. Feeding frequency should be increased rather feed to be made available all 24 hours.

- **Mixing the ration:**

- It may be useful to shift feeding times to match animal behaviour. Animals tend to change meal patterns and eat more feed during the cooler times during the day hence make feed available all 24 hours of the day. Grain and fibre recommendations are as follows: Precautions to be taken during Extreme Heat for Milk Animals:
- Dietary fat content should not exceed 5 to 6% of the total diet dry matter
- Do not exceed 55-60% concentrates in rations
- Bypass protein and bypass fats are recommended
- Water mix feed
- Provision of cold water

- **Precautions to be taken during Extreme Cold for Milk Animals:**

- Cold weather increases feed needs of cows. Hay provides more heat during digestion than concentrate feeds.
- Cows need dry, draught-free resting area.
- Use ample amount of good, dry bedding
- Having dry teats when the cow leaves the parlour is important. One way to lessen the risk is to dip the teats, allow the dip of about 30 seconds and then blot dry using a paper towel

- **Precautions to be taken during Drought Period for Milk Animal:**

- Preservation of fodder
- Preserve water resources
- Feeding of chaffed fodder

- Prevents feeding of poisonous plants and feed
- Prevents feeding of pre-mature sorghum (cyanide poisoning)
- Prevents feeding of moldy grains or fodder (aflixicosisato)
- Prevent over feeding due to starvation
- **During extreme monsoon and flood care which is to be taken for Milk**

- **Animal:**

The Animals to be let free or taken to be high areas The sufficient stock of feed to be stored at sufficient height to avoid the flood water damaging feed. The store area should be dry and water tight.

#### 4) **DRINKING WATER AVAILABILITY**

Proper sized drinking water tank with availability of fresh water should be provided inside the shelter. Care should be taken that water remains fresh and cool. Milk animals should have access to water all 24 hours. Fresh water should be available to cows after milking. Water intake may increase by 20 to 50% during heat stress conditions.

#### 5) **BREEDING PRACTISES**

Care must be taken while breeding the milk animal. One must regularly record the milk per lactation of the milk animal and then decide about the semen doze. While getting artificial insemination one should know the pedigree and progeny of male whose semen is being used for AI. If the cow produced by the male must give more milk than the animal being serviced. It is advisable to carry out all in late evening or early morning. This will give better result in summer. AI must be done by knowledgeable AI Worker to avoid repeat AI. Natural services should be avoided as far as possible.

#### 6) **REARING PRACTICES**

Rearing of calf is very important. If you properly give feed and vaccination, calf will mature within 18 to 24 months and

also will give good milk production. Expenses on feeding and rearing of calf to be considered as the investment and will generate good profit.

## **7) VACCINATION AND PREVENTIVE HEALTH CARE**

The milk animals must be regularly vaccinated as advised by Veterinary Doctors from time to time and also anti worming treatment must be given at every six months. Milk animal must be washed regularly and shelter should be maintained clean. Regular treatment must be given to arrest fly and other insects.

## **VII. Conclusion**

Compared to crops – which fail completely if rainfall fails and drought occurs. cyclone or heavy floods wash away standing crops; Livestock are more resilient with proper planning they can continue to support livelihood. The most important supportive action is to provide drinking water and bring fodder from outside and make available through Fodder Depots. But in case this does not become possible forced migration is only solution. Livestock do discharge high quantity of methane gas. This can be migrated by setting up of individual bio-gas plants and community bio-gas plants (i.e. case study Chhota Udaipur).

**Source : DR Mayur Vyas  
formerly MD, Sabar dairy.**

# Traditional Veterinary Practices

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There are traditional homemade treatments for various diseases in animals. Some of these are given here under.

Traditional Methods for Treating Udder Diseases in Livestock

## **1. Swelling/Lump Formation in the Udder Ingredients:**

A fresh neem twig (thin), turmeric, butter or ghee.

### **Preparation Method:**

1. Cut a neem twig according to the length of the udder (cut from the bottom/thicker end).
2. Make a paste of turmeric and butter/ghee and apply it on the twig.
3. Clean the infected part of the udder properly.

### **How to Use:**

1. Insert the medicated twig (with the thicker side out) upside down into the affected teat.
2. After each full day, replace it with a freshly prepared twig.

## **1. Accumulation of Water in the Udder (Swelling due to fluid retention) Ingredients (for single use):**

Sesame/mustard oil – 200 ml, turmeric – 1 handful, garlic – 2 cloves.

**Preparation Method:**

1. Heat the oil and add chopped turmeric and garlic pieces.
2. Stir it well until the aroma is released, then remove from heat (do not boil).
3. Let the mixture cool.

**How to Use:**

1. Apply and massage the mixture on the swollen part and both thighs.
2. Do this 4 times a day for 3 days.

**Note:**

Before applying the mixture, confirm whether the swelling is due to mastitis or not.

**2. Swelling / Poison Not Draining (Abscess / Toxin Retention)****Ingredients:**

- Radish: 1 whole
- Okra (Ladyfinger): 1.5 tolas (approx. 15–20 grams)
- Jaggery: As required
- Salt: As required

**Preparation Method:**

- Cut the okra into 2 pieces.

**Usage Method:**

1. Feed the animal one whole radish early in the morning for 2 days.
2. If the swelling/poison does not drain within 8 hours, feed the animal a mixture of 1.5 tolas of okra, jaggery, and salt.
3. If still not drained after 12 hours, make a small incision 2 inches below the top swollen part (lump). The lump will drain itself internally.
4. Do not try to squeeze or forcibly burst the abscess/swelling.
5. Continue feeding 1 radish daily for up to 4 weeks.

### **3. Preventing Miscarriage (Avoiding Premature Labor)**

#### **How to Use:**

1. Begin this treatment on the first or second day after signs of heat appear.
2. Feed the animal once a day with the freshly prepared ingredients listed below, mixed with jaggery and salt, in the given sequence:
  - (a) 1 radish – for 5 days
  - (b) Juice of 1 aloe vera leaf – for 4 days
  - (c) 4 handfuls of drumstick leaves – for 4 days
  - (d) 4 handfuls of coriander – for 4 days
  - (e) 4 handfuls of fresh neem leaves with turmeric – for 4 days
  - (f) If the animal is not pregnant, repeat the entire cycle once more in the same order.

### **4. Uterus Coming Out / Uterine Prolapse**

#### **Ingredients:**

- Aloe vera gel: from 1 full leaf
- Turmeric: tablespoon
- Lajwanti (Touch-me-not plant) leaves: 2 handfuls

#### **Preparation Method:**

1. Extract the gel from the aloe vera leaf.
2. Wash the gel thoroughly until the stickiness is removed.
3. Mix it with about 1 liter of water.
4. Add a pinch of turmeric, heat it halfway, then allow it to cool.
5. Separately make a paste of Lajwanti leaves.

#### **How to Use:**

1. Clean the prolapsed uterus (uterine part that has come out).
2. Sprinkle the cooled aloe vera solution over the uterus.
3. Once it dries, apply the paste of Lajwanti leaves.

4. Repeat this process as often as needed until the condition improves.

#### 5. **Mouth Ulcers – Excessive Salivation – Blisters in the Mouth**

##### **Ingredients (for single use):**

- Cumin seeds: 10 grams
- Fenugreek seeds: 10 grams
- Black pepper: 10 grams
- Turmeric: 10 grams
- Garlic: 4 cloves
- Fresh ginger: 1 piece
- Jaggery: 120 grams

##### **Preparation Method:**

1. Soak cumin, fenugreek, and black pepper in water for 20–30 minutes.
2. Grind all ingredients together into a paste.
3. Add freshly grated ginger to the paste and mix thoroughly.
4. Prepare a fresh paste each time before use.

##### **How to Use:**

1. Apply the paste inside the mouth, on the tongue, and gums.
2. Apply the paste 3 times daily for 3 to 5 days.

#### 6. **Mouth Ulcers – Blisters on Lips / Cheeks / Gums**

##### **Ingredients:**

- Bidi tobacco or tough grass leaves: 1 handful
- Garlic: 10 cloves
- Neem leaves: 1 handful
- Sesame oil / castor oil: 500 ml
- Turmeric: 20 grams
- Henna leaves: 1 handful
- Basil leaves: 1 handful

**Preparation Method:**

1. Grind all ingredients together into a paste.
2. Add 500 ml of sesame or castor oil and heat the mixture. Then let it cool down.

**How to Use:**

1. Clean the wound properly and apply the mixture directly on it. Alternatively, soak a clean cloth in the oil mixture and tie it over the affected area.
2. If maggots are found in the wound, first apply a paste of custard apple leaves or add camphor to neem oil and apply it on the wound.

**7. Fever****Ingredients (for one day):**

- Garlic: 2 cloves
- Coriander seeds: 10 grams
- Cumin seeds: 10 grams
- Damro (medicinal plant) leaves: 1 handful
- Dried tamarind leaves: 10 grams
- Black pepper: 10 grams
- Nagarmotha (Cyperus) leaves: 5 pieces
- Small onions: 2 pieces
- Turmeric: 10 grams
- (ajwain) powder: 20 grams
- Holy basil (Tulsi) leaves: 1 handful
- Neem leaves: 1 handful
- Jaggery: 100 grams

**Preparation Method:**

1. Soak cumin, black pepper, and coriander in water for 15 minutes.
2. Grind all ingredients together into a paste.

**How to Use:**

- Feed small quantities of the paste to the animal in the morning and evening.

**Diarrhea****Ingredients (for one day):**

- Dried fenugreek seeds: 10 grams
- Onion: 1 piece
- Garlic: 1 clove
- Cumin seeds: 10 grams
- Turmeric: 10 grams
- Tender neem leaves: 1 handful
- Khus Khus (poppy seeds): 5 grams
- Black pepper: 10 grams
- Jaggery: 100 grams
- Asafoetida (hing): 5 grams

**Preparation Method:**

- Roast cumin, asafoetida, poppy seeds, and fenugreek
- Let the mixture cool and grind it into powder.
- Mix the powder with the remaining ingredients and grind into a paste.

**How to Use:**

- Make small balls from the paste.
- Feed the animal one ball per day for 1 to 3 days.

**8. Bloating / Indigestion (Gas / Flatulence)****Ingredients (for one day):**

- Onion: 100 grams
- Garlic: 10 cloves
- Dried red chilies: 2 pieces
- Cumin seeds: 10 grams

- Turmeric: 10 grams
- Jaggery: 100 grams
- Black pepper: 10 grams
- Nagarmotha (Cyperus) leaves: 10 pieces
- Ginger: 100 grams

**Preparation Method:**

- Soak black pepper and cumin seeds in water for 30 minutes.
- Grind all the ingredients together into a paste.

**How to Use:**

- Make small balls from the paste.
- Feed 3–4 balls daily, mixed with jaggery, for 3 days.

**9. Stomach Worms / Internal Parasites**

**Ingredients (for one day):**

- Onion: 1 piece
- Garlic: 5 cloves
- Mustard seeds: 10 grams
- Neem leaves: 1 handful
- Cumin seeds: 10 grams
- Bitter gourd: 50 grams
- Turmeric: 5 grams
- Black pepper: 5 grams
- Raw banana: 100 grams
- Guava leaves: 1 handful
- Jaggery: 100 grams

**Preparation Method:**

- Soak black pepper, cumin seeds, and mustard seeds in water for 30 minutes.
- Grind all ingredients into a paste.

**How to Use:**

- Make small balls from the paste.
- Feed 1 ball daily with jaggery for 3 days.

**10. Lice / Mites (Kutthiri / Itardi)****Ingredients:**

- Garlic: 10 cloves
- Neem leaves: 1 handful
- Neem fruits (Limbodi): 1 handful
- Sweet flag root (Vach): 10 grams
- Turmeric: 20 grams
- Gandharo (Rukhdi) leaves: 1 handful
- Holy basil (Tulsi) leaves: 1 handful

**Preparation Method:**

- Grind all ingredients together into a fine paste.
- Add 1 liter of clean water to the paste.
- Strain the mixture through a fine cloth or sieve.
- Store the filtered liquid in a spray bottle.

**How to Use:**

- Spray the liquid all over the animal's body.
- Also spray in cattle sheds and corners of the walls.
- Alternatively, soak a clean cloth in the liquid and wipe the animal's body.
- Apply once a week until the lice are completely gone.
- Perform this procedure during the day.

**11. Pox / Warts / Udder Sores****Ingredients:**

- Garlic: 5 cloves
- Turmeric: 10 grams
- Cumin seeds: 15 grams

- Damro leaves: 1 handful
- Neem leaves: 1 handful
- Butter or ghee: 50 grams

**Preparation Method:**

- Soak cumin seeds in water for 15 minutes.
- Grind all ingredients thoroughly

**How to Use:**

- Feed the animal small amounts of the prepared paste in divided portions.
- Prepare a fresh paste each time and feed the animal 3 times a day for up to 2 weeks.

**Note:**

Alternatively, in severe cases, 2–3 drops of the prepared paste (after mixing with jaggery) can be applied in the animal's eyes every hour.

**12. Joint Inflammation (Arthritis / Swelling in Joints)**

**Ingredients:**

- Aloe vera: 100 grams
- Lime (calcium hydroxide): 10 grams
- Sida cordifolia stem (Bala / Joad-Jod): 100 grams
- Turmeric: 15 grams
- Garlic: 5 cloves
- Sesame oil: 1 liter

**Preparation Method:**

- Grind all ingredients into a fine paste.
- Boil the paste in 1 liter of sesame oil and allow it to cool.

**How to Use:**

- Apply on the affected area 4 to 5 times a day.
- Give a warm water fomentation (hot compress) twice daily.

### 13. Cough

#### Ingredients (for one day):

- Adulsa (Ardusi) leaf: 1
- Holy basil (Tulsi) leaves: 1 handful
- Garlic: 5 cloves
- Turmeric: 10 grams
- Black pepper: 10 grams
- Jaggery: as needed

#### Preparation Method:

- Soak black pepper in water for 15–20 minutes and grind separately.
- Mix all ingredients, add jaggery, and grind into a paste.

#### How to Use:

- Feed the animal 2 to 3 times a day until recovery.

### 14. Animal Unable to Stand or Remains Sitting

#### Ingredients (for one-time use):

- Native hen eggs: 2
- Drumstick leaves: 4 handfuls
- Sida cordifolia (Joad-Jod): 4 handfuls
- Jaggery: as needed

#### Preparation Method:

- Take 2 raw eggs
- Separately grind the drumstick leaves and Sida cordifolia stems; add jaggery as needed and make two separate pastes.

#### How to Use:

- Feed both raw eggs (with yolk) to the animal 3 times a day.
- Before feeding the eggs, pierce a small hole in each one.
- Every 2 hours, feed the pastes of drumstick and Sida cordifolia (4 handfuls each).
- Do not try to make the animal stand for 4 days.

## **15. Pesticide Poisoning / Cyanide Poisoning / Mycotoxicosis**

### **Ingredients (for one day):**

- Papaya leaves: 10
- Black pepper: 10 grams
- Whole salt: 10 grams
- Tamarind: 1 piece (approx. 100 grams)
- Water: 1 liter
- Extract of 1 drumstick leaf
- Jaggery: as required

### **Preparation Method:**

#### **Paste Preparation:**

- Grind papaya leaves, black pepper, and whole salt into a paste.
- Add jaggery and mix well.

#### **Liquid Preparation (for one day):**

- Soak tamarind for 15 minutes.
- Extract the pulp/juice from soaked tamarind.
- Add water, drumstick leaf extract, and jaggery.
- Mix thoroughly.

#### **How to Use:**

- First, feed the paste made from papaya, black pepper, and salt.
- Every 2 hours, give the animal 200 ml of the tamarind–drumstick–jaggery solution.
- After giving the solution, again feed small portions of the paste repeatedly.

## **16. Blood in Milk**

### **Ingredients (for one day):**

- Mild neem leaves: 2 handfuls
- Drumstick leaves: 2 handfuls

- Jaggery: 100 grams
- Lemons: 6

#### **Preparation Method:**

- Grind neem and drumstick leaves with jaggery into a paste.
- Cut the lemons into halves.

#### **How to Use:**

- Feed the paste twice daily until recovery.
- Feed 2 lemon halves (1 whole lemon) 3 times a day for 3 days.
- **Note:** This treatment is also effective for udder swelling (mastitis).

### **17. Not Coming into Heat During Summer**

#### **How to Use:**

- Feed the following fresh ingredients twice a day with jaggery and salt:
  - One white radish — for 5 days
  - One aloe vera leaf — for 4 days
  - 4 handfuls of drumstick leaves — for 4 days
  - 4 handfuls of *Sida cordifolia* (Joad-Jod) — for 4 days
  - 4 handfuls of mild neem leaves + 5 grams turmeric — for 4 days

**Note:** 15 days before starting this treatment, deworm the animal using appropriate medication.

**Source :** Dr. N. Punyamurthiji:  
National Dairy Development Board (NDDB), Anand

## Poultry Farming

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Climate change has become one of the most pressing global challenges of our time, affecting not only natural ecosystems but also livestock and poultry production systems. Poultry farming, which plays a vital role in food security, rural livelihoods, and agricultural income, is highly sensitive to fluctuations in temperature, humidity, and rainfall. As weather patterns become more unpredictable, poultry birds face increased physiological stress, resulting in reduced productivity, higher mortality, and greater economic losses. Understanding how changing climate conditions impact poultry and adopting preventive measures is essential for sustainable and profitable poultry farming.

### **Adverse Effects of Changing Climate on Poultry Farming:**

#### **(A) When the atmospheric temperature exceeds 34°C:**

In **adult meat chickens (broilers)**, mortality rate increases by **8.4%** due to high temperatures.

- In broilers, mortality increases by 0.84%.
- In **desi (native) chickens**, mortality increases by **0.32%** when temperature crosses 34°C.

#### **(B) High temperatures reduce feed intake in poultry:**

- At **31.6°C**, feed intake reduces by **108.3 grams/bird/day**.
- At **37.9°C**, feed intake reduces by **68.9 grams/bird/day**.

**(C) High temperatures reduce egg production:**

- In **broilers**, egg production decreases by **7.5%**.
- In **layers**, egg production decreases by **6.4%**.

**(D) When temperature in poultry sheds increases from 28°C to 42°C,**

- The body temperature of chickens increases from **41°C to 45°C**.
- If shed temperature goes beyond **42°C**, **mortality increases significantly**.
- Chickens with **naked necks (featherless necks)** show greater resistance compared to fully feathered birds in terms of:
  - Heat resistance
  - Growth and overall health
  - Better feed efficiency
  - Stronger immunity

**Precautions During Extreme Heat:**

- During hot weather, **protein intake drops by 2%** and energy intake drops by **100–150 kcal/kg** in chickens.
- Feed should be provided **early in the morning** or in **3–4 small portions with water** throughout the day.
- **Whitewash poultry shed walls** to reduce heat.
- Use **foggers and ceiling fans** between **11:00 AM to 6:00 PM**, allowing birds to move freely in a **5 sq. meter** area for cooling.
- Provide **energy-rich and vitamin-fortified water-soluble feed additives** to boost disease resistance.
- **Reduce poultry density by 10%** during hot periods.

**Precautions During Cold Weather:**

- Provide **high-protein and high-energy** feed.
- Use **electric heaters** to increase shed temperature.
- **Increase bird density by 10%** in the shed to retain warmth.

- Prevent **cold wind exposure** from outside by sealing off the shed properly.
- Precautions During Heavy Rain or Flooding:
- Raise the poultry shed **at least 3 feet above ground level** to avoid waterlogging or flood impact.
- Store feed in **dry, secure places** to prevent moisture and fungal contamination.
- To reduce economic loss, **insure** poultry sheds, equipment, and birds under poultry insurance schemes.

## Conclusion

In conclusion, changing climatic conditions—whether extreme heat, cold, or heavy rainfall—pose significant challenges to poultry health, productivity, and farm profitability. High temperatures reduce feed intake, egg production, and overall growth, while also increasing mortality. Cold weather stresses birds and requires additional energy for body warmth, and excessive rainfall or flooding threatens shed infrastructure and feed quality. However, by implementing proper management practices such as temperature control, adjusting feed, modifying stocking density, and improving housing systems, poultry farmers can significantly reduce climate-related losses. Proactive adaptation and preparedness will ensure healthier birds, stable production, and long-term sustainability in poultry farming amid the impacts of climate change.

# Fish Farming

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**Fish farming** (Freshwater aquaculture) plays an important role in the current food industry. The main objective of this activity is the systematic rearing of fish. Ponds are an ideal model for fish farming, where essential resources like water, nutrients, and protection can be provided. This article provides complete information about the steps, preparation, and important points necessary for fish farming.

## **What is the fisheries Industry?**

The fisheries sector includes the economic exploitation of various aquatic ecosystems such as oceans, rivers, lakes, reservoirs, estuaries, and brackish waters where organisms like fish, prawns, mollusks, algae, and pearls are cultivated or harvested naturally. The main objective of fisheries is to obtain nutritious food from diverse water sources. Additionally, by-products are produced which are used in fertilizers, medicines, perfumes, ornaments, and animal/poultry feed, contributing to the economy.

## **Types of Fish Farming Methods**

Natural fish production from natural water sources is limited. With the growing human population, the demand for fish and prawns is naturally increasing. Also, modern fishing tools, satellite-based fish locating technologies, and excessive fishing and pollution from industrial units have negatively impacted fish stocks.

To meet the increasing demand, **Aquaculture** — the controlled

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production of fish/prawns using artificial water bodies with scientific methods — is promoted.

Fish farming methods based on stocking density in ponds are categorized into three types:

**1. Traditional System:**

- No use of fertilizers or feed
- Stocking density: 500–1000 fingerlings/ha
- Very low and economically unviable production

**2. Semi-Intensive System:**

- Use of lime, fertilizers, and balanced feed
- Stocking density: 5000–10000 fingerlings/ha
- Better production than traditional methods

**3. Intensive System:**

- Stocking density: 10000–25000 fingerlings/ha
- All nutritional needs provided externally
- Highest yield potential

**Natural Fish Feed Management in Rural Ponds**

Natural fish feed mainly includes **Plankton** and **Periphyton**:

• **Plankton:**

Free-floating microscopic organisms – phytoplankton (plant-like) and zooplankton (animal-like)

• **Periphyton:**

Attached aquatic microorganisms that grow on submerged surfaces, include both plankton and detritus.

**Measuring Plankton Levels in the Pond**

When plankton levels are high, pond water turns green or brownish. Use a **Secchi Disk** (20 cm wide, half black and white) to measure water transparency. Lower the disk into the pond and record the depth at which it is no longer visible.

## Management Based on Secchi Disk Reading:

Secchi Depth	Management Practice
Less than 25 cm	No fertilizers; monitor for oxygen shortage
25–40 cm	No fertilizers needed
40–60 cm	Apply fertilizers as needed
More than 60 cm	Apply more fertilizer than usual

A Secchi reading of 50 cm typically indicates good plankton levels.

### Fertilization Schedule for Nursery Ponds

1. Apply **lime** based on soil ph.
2. Before stocking fry, enhance natural productivity using:
  - Cow dung: 5 tons/ha
  - Poultry manure: 2 tons/ha
3. Split application (per hectare):
  - Neem cake or Mustard cake: 750 kg
  - Cow dung: 200 kg
  - Single Super Phosphate (SSP): 50 kg

### Fertilizer Schedule After Stocking Fingerlings

Days After Stocking	Neem Cake	Cow Dung	SSP
3 Days	350 kg	100 kg	25 kg
5 Days	175 kg	50 kg	12.5 kg
10 Days	175 kg	50 kg	12.5 kg

### Fertilizer Schedule for Rearing Ponds

- At 10 days after stocking:
  - Cow dung: 3–4 tons/ha
  - SSP: 30–40 kg
- Apply poultry manure at half the rate of cow dung
- Adjust fertilizer quantities based on pond fertility status (low/medium/high)

## Pond Soil and Fertilizer Indicators

Fertility Status	N (mg/100g)	P (mg/100g)	Organic Carbon (%)	pH
Low	<25	<3	<0.5	<5.5
Medium	25–50	3–6	0.5–1.5	5.5–6.5
High	>50	>6	>1.5	6.5–7.5

## Lime Application in Fish Ponds

Soil pH	Sandy Soil	Clay Soil	Clayey Soil
5.0–6.0	600 kg/ha	1200 kg/ha	1800 kg/ha
6.0–6.5	500 kg/ha	1000 kg/ha	1500 kg/ha
6.5–7.5	200 kg/ha	400 kg/ha	600 kg/ha

Apply 40% lime before stocking, remaining in divided doses after. Lime is helpful when water alkalinity is less than 40 mg/L.

Pond Nutrient Requirements (per ha per season)

Pond Type	Cow Dung (kg)	P (kg)	SSP (kg)	N (kg)	Urea (kg)
Low Fertility	10,000–12,000	100–125	625–780	200–250	435–545
Medium	8000–10,000	75–100	470–625	150–200	322–435
High	5000–8000	50–75	313–470	100–150	218–322

- Apply 20–30% base manure 15 days before stocking; rest every two months.
- Apply chemical fertilizers every 15 days.
- Suspend fertilizers during algal blooms.

## Guidelines for Sustainable Natural Fish Feed Production

- Use copper sulphate (0.2–0.5 ppm), dimethoate, diuron (0.3 ppm), or 500 silver carp/ha to control unwanted algae.
- **Avoid chlorine** in stocked ponds — only use it in unstocked or newly constructed ponds.
- **Change water** only if water quality declines significantly — not frequently required.

## Fisheries – Suggested Measures under climate change

- Drought:  
Provide water linkage to all the ponds either by water

through tankers or by pumping water from nearby reservoir. Alternatively capture the mature fishes and send to market to reduce stocking density or transfer others to alternative water ponds. In case of Capture Fisheries i.e. both marine and inland fishes either migrate or not survive.

- **Flood and Cyclone:**

In case of Capture fisheries, the flood will have positive impact but flood will affect culture ponds which are situated nearby the river. It damages the ponds and also contaminated the culture. In such case harvest the culture fish and wild fish which come with the flood water. Repair the ponds, disinfect the ponds with chemicals after the flood and recharge the fresh water.

- **Heat Wave and Cold Wave:**

Heat and cold wave affect the fish stock, in case of capture marine and inland fishes will migrate to safer place where as culture fisheries will have large effect as fish growth will be retarded as well as breeding and rearing of fish larvae will be severely get affected. In such case one has to exchange the water from time to time during heat wave. During cold wave provide heaters with thermostat to maintain constant water temperature and aerator to maintain the oxygen level. Increase the fish density. Provide probiotics as well as fresh and live feed.

## **Conclusion**

Proper fertilizer application increases pond fertility and fish production. The amount and type of fertilizer depend on the soil and water characteristics. Balanced use of organic and chemical fertilizers is crucial for effective fish farming.

Enhancing natural fish food production in ponds reduces reliance on expensive external feed and helps rural farmers achieve sustainable yields.

**Source:**

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# Contingency Crop Planning

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## **What is Contingency Crop Planning?**

When unexpected, undesirable, and adverse climatic conditions occur before or after sowing a crop, and such conditions cause direct or indirect damage to crop growth or production, strategies made to mitigate or reduce these effects are known as contingency crop planning.

## **Effects of sudden weather changes on agricultural crops:**

- Due to irregular rainfall, changes in the cropping system of the respective area become inevitable.
- Rising temperatures increase the water requirement of crops, which increase production costs.
- In high temperature conditions, crops suffer scorching, and pollen dries up, leading to poor pollination and reduced grain numbers, ultimately lowering crop yield.
- Low rainfall reduces soil moisture, which negatively affects seed germination. Crop growth
- Even if average rainfall occurs but is not well-distributed, resulting to crop failure or reduced yield.
- Excessive rainfall increases pest and disease infestations, increasing the cost of cultivation. Waterlogging in the field hampers crop growth, causing yellowing and drying of plants.

- Inadequate rainfall reduces the absorption of nutrients from the soil by crops.
- Sudden rain or storms at harvest time cause plants to lodge, and fruits or flowers to drop, reducing both yield and quality, resulting in lower market prices.
- If the monsoon is delayed, nursery seedlings like rice become overaged, reducing tillering and ultimately yield. Crops cannot be sown at proper time hence reduce yield.
- Irregular rainfall patterns also impact livestock, poultry, and fisheries industries.

### **Waterlogging due to heavy rainfall (Flood):**

- Remove stagnant water from standing crop fields.
- Harvest mature crops like maize cobs, vegetables etc.
- If crops like bajra and paddy are ready for harvest, delay harvest.

### **Effects of changing climate on agriculture and related activities:**

Generally, climate change leads to higher-than-average temperatures during summer and lower or higher temperatures than average in winter. Irregular rainfall creates four types of adverse situations for agriculture:

- Early onset of monsoon
- Delayed onset of monsoon
- Long dry spells after monsoon begins
- Early withdrawal of monsoon) or extended monsoon till October

### **Contingency crop planning in response to sudden weather changes:**

When weather changes suddenly, farmers should adopt the following suggested measures:

#### **1. Heat Wave:**

- Provide life-saving irrigation to crops.
- Create windbreaks around fields with heat-tolerant plants

(e.g., surround banana or papaya with sorghum or summer maize, sunhemp).

## **2. Cold Wave:**

- Provide life-saving irrigation to crops.
- Burn waste grass in fields to create smoke.

## **3. Dry Spell (No rain after initial rainfall):**

- A break of 8–10 days generally does not affect crops.
- If rain is absent for 15 days, provide supplementary irrigation during critical crop stages.
- Thin out crops at proper spacing and fill gaps where needed.

If the dry spell last for 25–30 days:

1. Do inter culturing
2. Remove weeds
3. Provide life-saving irrigation to protect the main crop
4. Spray 2% urea solution on crops like castor, cotton, pigeon pea
4. If urea top-dressing is pending, postpone until rainfall resumes
5. If irrigation is unavailable and crops cannot be saved, remove the main crop to avoid further losses

## **4. Early Withdrawal of Monsoon:**

- Harmful to crops
- If moisture stress occurs during grain development, yield may significantly decrease, hence provide supplementary irrigation

## **5. Extended Monsoon:**

- Beneficial for late kharif and rabi crops
- In black or medium black soils, delayed monsoon moisture benefits rabi crops like gram, wheat, linseed, mustard, barley,

## **Water conservation measures by farmers:**

### **• Compartmental Bunding:**

If the field is long with a 1% slope, construct bunds against the slope to retain water in the field and conserve moisture.

- **Contour Farming:**

If the field has a 1–2% slope, carry out farming across the slope to maintain uniform levels and improve moisture retention.

- **Strip Cropping:**

To reduce erosion and increase moisture retention, plant main crops with 6–8 lines of inter crop in between (e.g., between two lines of pigeon pea, plant 6–8 lines of spreading groundnut).

- **Mixed/Intercropping: rainfed conditions mixed / winter crops cropping helps to consume moisture and is insurance**

Mixing seeds of different crops or planting different crops in separate rows together enhances biodiversity and increases natural enemies of pests.

Examples: Sesame + cotton, pigeon pea + maize, upland rice + maize, pigeon pea + upland rice, maize + soybean, pigeon pea + groundnut, sorghum + mung bean.

- **Ridge-Furrow System:**

This method helps retain rainwater in furrows and preserves moisture in ridges saving crops during dry spells.

- **Deep Tillage in Summer:**

Once every 3 years, deep plowing helps break hard soil layers and increases rainwater infiltration and soil moisture retention. It also exposes deep soil layers to sunlight, killing pests and releasing nutrients.

- **Graded Bunds in Sloped Areas:**

In hilly regions (1–6% slope), construct bunds against the slope to prevent runoff. Trees and grasses like Gajraj or Dhaman can be planted between bunds.

### **Alternate Uses of Land:**

- **Agroforestry:**

In low rainfall areas with low soil fertility, short-duration and drought-resistant crops (like mung bean, cowpea, moth

bean, mustard, gram, sorghum, pearl millet, ragi) can be grown with trees (e.g., babool, khijda, shisham, teak with light shade).

Even if crops fail due to poor rainfall, trees continue to grow and provide long-term income—this is called sustainable agriculture.

- **Agri-Horticulture:**

In areas with fertile soils and rainfall over 500 mm, integrating horticultural crops with field crops is economically beneficial.

**Roles of Government/Panchayats:**

- Implement watershed schemes
- Build water harvesting structures like check dams, farm ponds, and village tanks with public participation, ensuring construction quality through village agencies.

**Good Agricultural Practices to mitigate climate change effects:**

1. Use sprinkler or drip irrigation with mulching to utilize water and fertilizers efficiently.
2. Following farm processing and value addition, quality agricultural produce can fetch better prices.
3. Farmers can practice contract farming for high-value crops and obtain crop insurance.
4. Through cooperative societies and online marketing, farmers can get good prices for their produce.
5. Adopt integrated pest and disease management, weed management, irrigation management, and nutrient management to reduce farming costs and prevent soil and environmental pollution due to overuse of water, fertilizers, and pesticides.

**Sources: Building climate smart farmers (Edition- jan,2018)**

## Strategy for Restoration

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- Climate Change has brought in recent years. Some major calamities which have affected entire agriculture and livelihood in affected areas.
- To illustrate in the current year
  - Uttarakhand cloud bursting
  - Odisha cyclone
  - International level – Philippines cyclone
  - At local flooding in Navsari district and part of Anand District
- Such devastation cannot be remedied by existing mitigation or adaptation strategies.
- It needs total rehabilitation of agriculture activity which is not forming part of current disaster Management strategies which cater to cease emergency situation and provide relief measure.
- What is needed is total restoration

<b>Impact of disasters and action needed</b>		
Over topping of fields /damage to check dams due to floods	<ul style="list-style-type: none"> <li>• Repair check dams.</li> <li>• Restore washed away soil.</li> </ul>	Cropping pattern based on fresh Soil Health & Moisture Analysis along with making available of seeds and other inputs.

<b>Impact of Disaster and Action Needed</b>	
<p>Permanent increase in sea level and submergence of agriculture land. Washing out of soil strata and spread of salinity due to cyclone both underground and over-ground.</p>	<ul style="list-style-type: none"> <li>• Farmers have to be given alternative land</li> <li>• If feasible protection wall has to be constructed along with plantation of mangroves outside of the wall</li> <li>• Soil replacement</li> <li>• New cropping pattern based on fresh Soil Health &amp; Moisture analysis along with analysis of               <ol style="list-style-type: none"> <li>a. sub soil water strata</li> <li>b. water availability for irrigation from wells/tube wells</li> </ol> </li> <li>• Making available certified seeds and other inputs for cropping pattern suggested and agro advisory on new crop management – Kutch case studies</li> </ul>
<p>Loss of tractors/storage bins/ agriculture implements. Mortality of livestock and Poultry</p>	<ul style="list-style-type: none"> <li>• Replacement of all these under government support and insurance</li> </ul>

**Sources: Building climate smart farmers (Edition- jan,2018)**

## Safety Net

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This component primarily focuses on mitigating financial losses for farmers due to unforeseen events in agriculture:

- **Life Insurance:** While not exclusive to farmers, affordable schemes like **Pradhan Mantri Jeevan Jyoti Bima Yojana (PMJJBY)** and **Pradhan Mantri Suraksha Bima Yojana (PMSBY)** offer crucial financial security to farmers' families in case of death or disability. Rural Postal Life Insurance (RPLI) also caters to this need.
- **Crop Insurance:** The cornerstone of agricultural risk management is the **Pradhan Mantri Fasal Bima Yojana (PMFBY)**. This scheme provides comprehensive coverage against losses arising from natural calamities, pests, and diseases for various crops. Farmers pay a minimal premium, with the bulk subsidized by central and state governments, ensuring income stability and promoting sustainable farming. Other specialized products include the Weather-Based Crop Insurance Scheme (WBCIS) and Coconut Palm Insurance Scheme (CPIS).
- **Cattle Insurance:** To protect valuable livestock assets, schemes under the **National Livestock Mission (NLM)** promote cattle insurance, covering death due to accidents, diseases, or surgical operations, with significant government premium subsidies.

- **Fisheries and Boat Insurance:** The **Pradhan Mantra Matsya Sampada Yojana (PMMSY)** includes accidental insurance for fishers, offering financial assistance for death, disability, and hospitalization expenses due to accidents. State governments may also support boat insurance for the fishing community.
  - **Government Relief for Women Farmers:** Recognizing their pivotal role, initiatives like the **Mahila Kisan Sashaktikaran Pariyojana (MKSP)**, a sub-component of the National Rural Livelihoods Mission (NRLM), empower women farmers through technical training, financial support, and promotion of sustainable agricultural practices. Other broader government schemes, such as the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) which mandates one-third jobs for women, also indirectly benefit women in agriculture by providing income and employment.
2. **Safety Net for Disasters Like Cyclones and Floods: Cash Subsidies and Targeted Aid**

This part of the safety net provides immediate financial and humanitarian aid during and after major natural disasters, often through direct cash assistance:

- **State Disaster Response Fund (SDRF) and National Disaster Response Fund (NDRF):** These are the primary financial reservoirs for disaster response. The SDRF is the initial fund for states, supplemented by the NDRF during severe calamities. A significant portion of relief from these funds is disbursed as **cash subsidies or Direct Benefit Transfers** to affected individuals. This includes:
  - **Ex-gratia payments** for loss of life, injury, or livelihood.
  - **Assistance for damaged houses** for repair or reconstruction.
  - **Gratuitous Relief (GR)** in cash or kind for essential needs like food and clothing.
  - **Cash compensation** for agricultural input losses due to the disaster.

Sources: Building climate smart farmers (Edition- jan,2018)

## Climate Smart Agriculture in Arena of Climate Change

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Climate change effects are experienced every year affecting crops, livestock and fisheries production. The changes are normally with respect to rainfall, temperature, storms and pest-disease occurrence. Under such changing climate farmers has to adopt certain techniques so that minimum loss can occur. Such guidelines are as follows for crops, livestock Fisheries and other bioresources.

**Table 1 : Common weather threats and adaptive options for crops**

Adaptive options			
Weather-related threats	Environmental	Practices to be followed	Other practices
Lower average rainfall	Adopt water harvesting practices (rock lines, hedges, contour ridges, bunds/demi-lunes, infiltration trenches, zai holes etc.) Adopt moisture conservation practices (mulch, manure/green manure, cover crops etc.)	Less water demanding crops/ varieties	Planting density Planting location System of rice intensification
Late/uncertain start to rainy season	Adopt water harvesting practices Adopt moisture conservation practices	Grow early maturing varieties Grow crops with shorter maturation periods	Use dry seeding Use seed soaking Use seed coating (with P)

Dry spells during reproduction period/grain filling	Adopt water harvesting practices Adopt moisture conservation practices	Grow drought-tolerant crops/ varieties Grow indeterminate crops/ varieties	Change planting location Adopt intercropping (double-up legumes) Use seed coating (with P)
Earlier ending of rains	Adopt water harvesting practices Adopt moisture conservation practices	Grow shorter season crops/ varieties Grow photoperiod-sensitive crops/ varieties	Adjust cropping seasons
Shorter growing season	Adopt water harvesting practices Adopt moisture conservation practices	Grow shorter season crops/ varieties	
Longer growing season		Grow longer season crops/ varieties	Practise relay cropping Practise sequential cropping Practise ratoon culture
Large storms/ flooding	Apply mulch Use vetiver hedges	Grow flood-tolerant crops/ varieties	
Strong and/or drying winds	Practise agroforestry	Grow dwarf varieties	Adopt intercropping
Rising average temperature	Practise agroforestry Apply mulch	Grow heat-tolerant crops/ varieties	Adopt intercropping
High temperatures during reproduction	Practise agroforestry Apply mulch	Grow heat-tolerant crops/ varieties	Adopt intercropping
Changing weed pressures	Apply mulch		Adopt intercropping (push-pull) Grow cover crops Practise rotation

Changing pest and disease pressures	Adopt habitat management and ecosystem engineering approaches for conservation and augmentation of natural enemies	Grow resistant varieties	Adopt intercropping (push-pull) Practise rotation Apply hot water treatment Use seed soaking Apply biopesticides (e.g. neem)
Declining pollinator populations	Use engineered habitat	Grow self-pollinating crops	Grow pollinator plants

**Table 2 : Common weather threats and adaptive option matrix for livestock**

Key weather-related threats and effects on livestock production		Adaptive options		
		Environmental	Genetic	Other management practices
<b>Increased temperature</b>	Lower yield in milk, meat and eggs, primarily due to heat stress and lower feed intake and feed conversion efficiency	Adopt integrated crop-livestock production system	Include heat-resilient ruminants in livestock assets	Make appropriate adjustments in herd and feed management Adapt feed management options, using of climate- resilient fodder crops
	Effects on health, longevity, production and reproductive capacity of livestock and poultry assets	Adopt agroforestry practices: feed crops, trees as shade for animals		Adopt multi-nutritional block for feeding fattening sheep or cattle Feed cattle with urea-treated straw
	Gradual loss of biodiversity, i.e. cattle having the highest number of extinct breeds	Improve pastures with introduction of pasture species	Diversify livestock assets/ species	Manage manure, including harnessing animal waste as fertilizer for forage and feed

		(usually grasses in combination with legumes)	Diversify livestock assets/ species, introduce breed upgrading	crop production and use in inland fisheries
<b>Shifts in rainfall distribution</b>	Low rainfall pattern: reduced water supply for animal drinking and cultivation of feed crops	Adopt water harvesting practices (e.g. rainwater catchment)	Diversify livestock assets/ species	Raise animals in livestock systems that demand less water
	Increased vulnerability of livestock assets to disease epidemic	Raise animals in locations with water abundance	Practise animal husbandry; introduce breed upgrading	Protect water sources for animal watering
<b>Increased frequency and intensity of extreme weather events</b>	Drought, heatwave and floods: effects (e.g. water scarcity) on fodder crops, animal health, and overall livestock and poultry production	Reduce stock densities to provide sufficient space for animal movement Adopt agroforestry practices – feed crops, trees as shade for animals  Introduce pasture conservation belts	Diversify livestock assets/ species to minimize risk or loss due to extreme weather events  Practise over-sowing with improved grasses	Carry out studies on inherent genetic capabilities of different breeds and identify those that can better adapt to hostile climate conditions. Select Indigenous breeds like – Gir-Cows, Kankaraj-Cows, Mehasani Buffalo
	Susceptibility to changing pest and disease patterns		Upgrade livestock assets to more pest-resistant breeds	Carry out biological control of livestock pests

**Table 3 : Common weather threats and adaptive option matrix for aquaculture and fisheries**

Key weather-related threats and effects on fisheries and aquaculture		options		
		Environmental	Genetic	Other management practices
<b>Changes in seawater temperature and circulation patterns</b>	Affects overall production ecology in both marine and freshwater systems, leading to changes in species composition (e.g. advent of more invasive species), lower yield and production, changes in distribution and seasonality, emergence of diseases and other disruptions, coral bleaching and calcification	Practise mariculture, i.e. seaweed farming	Diversify and use heat-tolerant species	Adapt fish culture practices Improve feed conversion efficiency for inland fisheries and aquaculture settings Adopt ecosystem approach to management of capture fisheries and aquaculture
	Increasing coastal acidification weakens coastal habitats' capacity to support marine life resulting in restraints on raising yield and productivity Specific to aquaculture, changes in sea surface temperature increase stock vulnerability to diseases and parasites, presence of more harmful algal blooms that release toxins in the water resulting in fish kills	Consider transferring cage units to cooler areas	Promote salt-tolerant fish species for aquaculture in waterlogged areas and ponds Use species tolerant of changes in temperature and chemical content of coastal waters	Protect against pond floating, mechanize boats, adopt fishing technology, develop pond aquaculture, Grow Seaweeds

	<p>Rising sea level, as compounded by melting of ice over land, specifically affects habitats</p> <p>Coastline erosion, wetland flooding, soil contamination with salt affect habitats</p>	<p>Carry out coastal rehabilitation, mangrove management restoration and dune rehabilitation with community focus/ participation</p>		<p>Adopt integrated fish farming (e.g. with livestock, crops)</p> <p>Diversify sources of livelihood of farmers/ fishermen</p> <p>Practise other appropriate culture methods</p>
	<p>Specific to aquaculture, rise in sea level increases severe flooding and results in loss of areas available for aquaculture, causes salt intrusion into groundwater and loss of areas for mangroves as protection from waves/surges and as nursery resource for aquaculture seeds</p>	<p>Improve physical defences in flood-prone areas alongside integrated coastal management</p> <p>Improve farm siting and design</p>	<p>For coastal/ saline area, use short cycle and fast growing saline-tolerant fish species</p>	<p>Adopt early warning system and improve education</p>
<p><b>Frequency, severity of extreme events</b></p>	<p>Coastal flooding and storm surge affect production cycles in both marine and freshwater environments, threatening food security and livelihoods</p>	<p>Where water availability is an issue, set small seasonal ponds for coastal and saline areas when available freshwater can still be used for fish</p>	<p>Select more resilient species</p> <p>Adopt short-cycle species in flood-prone areas</p>	<p>Take out insurance options to minimize production (escape of stock) and economic loss due to extreme weather events</p> <p>Use indigenous stocks to minimize biodiversity impacts</p>

	Droughts lead to reduced natural spawning, limited water volume, reduced water quality in addition to salinity changes	Use water reservoir to address water shortage during drought		Improve efficacy of water usage, improve water sharing
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**Table 4 : Common weather threats and adaptive option matrix for forestry and agroforestry**

Key weather-related threats and effects on forests		Adaptive options		
		Environmental	Genetic	Other management practices
<b>Frequency and intensity of forest wildfires</b>	Fire affects forest ecosystem, disturbing wildlife habitat, accelerating nutrient cycling and mortality of individual trees	Adopt afforestation/ reforestation in areas with reduced tree populations, mainly due to forest fires	Promote or plant heat-tolerant trees	Adopt better forest management system to improve and sustain forest productivity and health and minimize risks associated with forest fires, deforestation and degradation
<b>Outbreaks of pests and diseases</b>	Environmental stresses like winter injury, drought, salt damage, wood-boring insects, vascular wilt diseases, and herbicide injury can result in diebacks in trees  Soil compaction, excavation damaging roots, vole damage to roots and root disease can result in dieback of branches	Adopt agroforestry activities Prevent further forest degradation and manage timber production for carbon stocks to remain constant or increase over time, thereby restoring degraded forests	Use species that can adapt better to changing conditions	Apply forest pest management Implement forest conservation and protection measures  Monitor changing conditions and promptly set in place appropriate modifications

<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>Frequency and severity of extreme weather events</b></p>	<p>Damage from extreme events, i.e. severe drought, typhoons and high winds, can be further aggravated by changes in temperature and precipitation regimes, changes in water availability and increased damage from wildfires and outbreaks of pests and diseases</p> <p>Loss of species and impacts on forest biodiversity</p>	<p>Promote sustainable forest management Adopt agroforestry activities, especially in most vulnerable and/or most affected forests and forest communities</p>	<p>Increase the population of heat-resistant or drought-tolerant species in planted forests Maintain genetic variation in tree populations and promote natural regeneration, when possible Match species and varieties to current and projected site and climatic conditions</p>	<p>Adopt other forest management options to reduce vulnerability of both forests and forest communities or address lower yield expectations Diversify sources of livelihood including other products and income-generating activities for forest-dependent poor communities Adjust harvesting schedules (e.g. hunting seasons, cutting cycles and non-wood forest product collection)</p>
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**Source: Food and Agriculture Organization of the United Nations Rome, 2021 (adapted)**

# Water Cycle

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## **Understanding impact of Climate Change on Water Cycle for Agriculture**

Even without climate change, underground water resources are reducing due to high extraction through tube wells – both for agriculture in rural areas and for managing increasing daily urban needs.

With the temperature increase due to higher evaporation rate etc., there will

be reduced water availability. This will also reduce “Soil Moisture” having

direct impact on crop productivity and its sustainability. This causes drinking water scarcity for cattle and human’s being and cause migration. Rise in sea – level is already being experienced in Gujarat villages of Dandi – Navsari, Cambay – Anand. This is a) resulting in direct loss of agri. land b) salinity ingress in sub-soil strata affecting root zone as vegetation. Further inundation from flood wipes out surface soil.

Women play very important part in Management of water resources – but more particularly their needs for household needs washing of cattle etc. It is important them to play lead role in conserving water resources – by trench – farm ponds and use of micro-irrigation, drip irrigation system and quality of drinking water. It is, therefore, very important that they understand water cycle and make smart use of water.

## WATER CYCLE Vulnerability of Areas - Gujarat

Major agricultural systems	Vulnerability			Typical response Main climate options
	Main Climate Change Exposure	Sensitivity	Adaptive capacity	
Kutch	Rainfall variability, droughts, floods	High: mostly rain fed agriculture, marginal lands, poor soil moisture capacity	Low: high prevalence of poverty, limited options, knowledge, social safety nets and resources	Watershed management and on farm water storage for water conservation; Integrated water resources management in river basins; investment in social infrastructures
	High temperatures, rainfall variability, droughts	High: crop and animal sensitivity to high temperature and droughts, high population density on marginal lands	Low: high prevalence of poverty, limited social safety nets and resources, limited capacity for water storage	
North Gujarat				On-farm water storage; crop insurance; increased productivity through better crop-livestock integration; integrated water resources management

<p>Valsad Navsari South &amp; Middle Gujarat</p>	<p>Reduction in annual rainfall, increased rainfall variability, reduction in runoff and aquifer recharge, high temperatures, higher occurrence of droughts and floods</p>	<p>Variable, depending on the region and level on reliance on agricultural activities. Agricultural systems highly sensitive to changes in temperature and water availability.</p>	<p>Low adaptive capacity for agriculture in water scarce areas</p>	<p>Water conservation where possible; integrated water resources management; crop insurance; improved floods and drought management plans; shifting out of agriculture</p>
<p>Junagadh Saurashtra Region</p>	<p>Increased rainfall variability, reduced water availability in places.</p>	<p>Medium to low. Some high yielding varieties more sensitive to temperature and water stress . Rain-fed agriculture</p>	<p>Possibilities to compensate water stress through supplemental irrigation in many regions; low capacity in water scarce areas</p>	<p>On-farm storage for supplemental irrigation; integrated water resources management at river basin level</p>

## Climate change and its impact on water cycle

Element of Water Cycle	Climate Change
Annual precipitation	Expected to increase globally during the 21 <sup>st</sup> Century, with potentially great spatial variations
Interannual variations in precipitations	Expected to increase everywhere
Seasonal variability of rainfall	<ul style="list-style-type: none"> <li>• Expected to increase everywhere</li> <li>• Delayed monsoon</li> <li>• Interim delay within season</li> </ul>
Soil moisture stress (droughts)	Moisture stress to generally increase as a result of increasing variability of rainfall distribution (longer periods without rain) and increasing temperatures and deplete soil moisture faster than natural vegetation
Floods	Increased as a result of increasing frequency and intensity of extreme rainfall events flood intensity can affect standing crops, washing away of upper fertile crust of soil & cause soil erosion
River discharge	Increased variability as a result of changes in rainfall patterns. Changes in annual runoff expected to vary from region to region
Groundwater	Varies as a function of changes in rainfall volumes and distribution. Impact is complex, with floods contributing to increasing recharge, and droughts leading to increased pumping
Evapotranspiration	Increases as a function of temperature increases
Water quality (in rivers, lakes and aquifers)	Moderate impact through temperature increase
Salinity in rivers and aquifers	Potentially high impact where sea water level rise combines with reduced runoff and increased withdrawal

Source: adapted from a comparative analysis of Turrall et al., 2011;  
Comprehensive Assessment, 2007

## Energy Saving and Climate Change

CSA OBJECTIVES		
Sustainable increases in productivity and income	Strengthened resilience to climate change and variability	Agriculture's reduced impact on climate change
<p><b>General:</b> Savings on energy costs (after meeting costs for technology) will result in increased profit if productivity is not excessively decreased</p> <p><b>Specific:</b> Practices such as use of solar energy, micro-irrigation system replacement of synthetic fertilizers with application of agricultural residues or manure, which require fewer external inputs and increase yields, can contribute to both increased energy efficiency and sustainable increases in productivity and income.</p>	<p><b>General: Lesser</b> energy costs will result in increased income and to enhance adaptive capacity.</p> <p><b>Specific:</b> Practices such as conservation agriculture that enhance crop cover, soil water retention and soil organic matter may increase resilience to drought and extreme weather events</p>	<p><b>General:</b> Improvements in energy efficiency, whether due to lower embedded energy in inputs or on-farm fuel combustion, will reduce GHG emissions in the production chain</p> <p><b>Specific:</b> Practices such as natural farming reduced or zero tillage, precision agriculture, replacement of synthetic fertilizers with agricultural residues or manure,</p>

<p>Practices that reduce external energy inputs and (at least) maintain yields, (using N<sub>2</sub> fixing cover crops) such as reduced or zero tillage, will increase energy efficiency and Improved crop and food storage, packaging and distribution.as part of post harvesting management will enhance profitability.</p>		<p>elimination of pesticides through integrated pest management or enhanced distribution logistics that reduce fossil fuel combustion will generally lead to reduced GHG emissions. Reduced or zero tillage, in combination with permanent crop cover, crop rotation and elimination of agrochemicals may also sequester carbon.</p> <ul style="list-style-type: none"> <li>• Use of micro-irrigation drip system.</li> <li>• Use of solar operational pumps &amp; dryers.</li> </ul>
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# Solar Energy

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Solar energy plays an important role in agriculture as an eco-friendly and cost-effective source of energy. Solar pump systems for irrigation, require less maintenance compared to traditional diesel or electric pumps. Solar dryers, improve product quality and shelf life. Greenhouses use solar energy to maintain ideal temperature and humidity conditions. Solar lights are used for field illumination, supporting work during low-light hours. Additionally, solar-powered fencing support security systems. all solar

## **Use of Solar Energy in Agriculture**

An average of 8 to 9 hours of sunlight per day is available, providing approximately 6.5 to 7.0 kWh/m<sup>2</sup> of solar energy. This makes it feasible to carry out various agriculture-related tasks in rural areas as follows

1. Solar photovoltaic systems for running water pumps for drinking and irrigation purpose.
2. Solar dryers for drying agricultural produce
3. Soil solarization for soil treatment
4. Solar cold storage for vegetables and fruits
5. Seed treatment
6. Household usage

Additionally, solar cookers, solar fans, solar water heaters, solar streetlights, home lighting systems, and solar power plants can

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be used for domestic and agricultural purposes.

### **Solar Pumps**

1. Solar pumps operate using sunlight, eliminating the need for electricity or fuel and saving energy costs.
2. They are long-lasting, highly reliable, easy to use, and require minimal maintenance. noise-free and pollution-free, contributing to a cleaner environment.

### **Types and Working System of Solar Pumps**

The working mechanism of solar pumps is similar to electric pumps but powered by DC electricity generated by solar panels. Adequate sunlight is necessary, so the panels must be positioned facing the sun. These systems usually come with a warranty of 90% efficiency for up to 10 years. When solar power is used to operate AC pumps, an inverter is required.

#### **Main components and working:**

- Solar Array: Converts sunlight into electricity (DC). The panels are connected to form the required voltage. For example, a 1.0 HP pump needs about 900 watts of solar array.
- Motor Pump Set: Available in AC or DC types.
- Solar Tracking System: Manually or automatically adjusts the panels to face the sun.
- Electronic Components: MPPT controller, on/off switches, motor controller, and safety system to prevent dry running or damage.

### **Solar Pump Sizes and Installation**

Solar pumps are available in AC and DC models. Commonly used pump capacities:

- 1.0 HP for drinking water
- 3.0, 5.0, 7.5 HP for irrigation

They can be installed on open wells, farm ponds, lakes, borewells, or tube wells using mono block or submersible pumps.

Panel positioning: If not adjustable, they can be fixed at a

south-facing tilt angle based on geographic latitude. If manual, tilt east before noon and west after noon.

At a depth of 150 feet, the water output from AC solar pumps is:

- 3.0 HP – 60,000 liters/day
- 5.0 HP – 100,000 liters/day
- 7.5 HP – 150,000 liters/day

### **Pump Discharge Table**

<b>Dynamic Head (m)</b>	<b>Shut-off Head (m)</b>	<b>DC Pump (L/HP/day)</b>	<b>AC Pump (L/HP/day)</b>
10	12	90,000	81,000
20	25	45,000	40,500
30	45	31,000	28,800
50	70	18,900	17,100
70	100	12,600	11,700
100	150	8,550	7,650

**Pump sizing depends on crop water needs, field size, and well depth.**

### **Space Requirement and Maintenance for Solar Pumps**

- A 1.0 HP pump needs about 10 m<sup>2</sup> space.
- A 5.0 HP pump needs about 50 m<sup>2</sup> space.

### **Maintenance Tips:**

- Keep panels clean and dust-free.
- Performance drops if panel temperature exceeds 25°C.
- Panels should be installed close to the pump.
- Ensure no shading on panels.

Using spray water to clean panels solves both dust and temperature issues.

### **Cost of Solar Pumps**

- Approximate cost of 5.0 HP AC solar pump: ₹2.346 lakhs
- Government subsidy: ₹1.62 lakhs

- Beneficiary share: ₹1.8 lakhs

Information about subsidies and schemes can be obtained from:

- Gujarat Energy Development Agency (GEDA), Gandhinagar
- PGVCL / Gujarat Electricity Board offices

### **Solar Dryers**

Drying after harvesting is essential for processing and value addition. Traditionally, crops are sun-dried in open fields, risking damage due to weather, contamination, animals, and lower drying efficiency.

**Solar dryers mitigate these risks and are ideal for fruits, vegetables, pulses, and oilseeds.**

#### **Types & Working of Solar Dryers:**

- Natural draft, blower-type, and hybrid dryers.
- Two main types: Direct (cabinet) and Indirect (hot air) dryers.

Drying temperature must not exceed 60°C to retain quality and prevent burning. Solar dryers are more efficient and cost-effective than open sun drying.

### **Soil Solarization**

To control soil-borne pathogens, pests, and weed seeds, soil solarization is used:

#### **Process:**

- During peak summer, harrowing the field, level it, and remove debris.
- Apply light irrigation (50 mm) to moisten soil.
- Cover with transparent polythene sheet (7–25 microns).
- Seal sides with soil to trap heat and moisture.
- Maintain for at least 6 weeks.

#### **Benefits:**

- Kills harmful organisms weed seed, fungus etc. and improves soil structure, chemistry, and biology.

- Increases crop yields significantly. At 100°C, these effects double.

## **Other Solar-Powered Agricultural Tools**

### **1. Solar Lanterns:**

Useful for night field work and useful in power deficient rural areas. Powered by photovoltaic panels, connected to a battery and equipped with 5-7W LED bulbs.

### **2. Solar Home Lights:**

Provides power for tube lights, fans, TVs using solar panels. Can be connected to the grid using net metering, enabling compensation from government schemes.

### **3. Solar Cookers:**

A clean and healthy way of cooking. Saves 3-4 LPG refills annually. Can cook 1 to 1.5 kg of food like rice, vegetables, pulses, and sweets in 2 to 2.5 hours.

### **Contact for More Information:**

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Gandhinagar – 382011

Phone: +91 79 23251255-60

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Last Updated: 25/05/2020**

# Ocean Areas: Development

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India, with its vast coastline, offers unique opportunities for cultivating useful vegetation in seashore environments and even within seawater. These plants, particularly halophytes (salt-tolerant plants) and seaweeds, have significant ecological and economic potential, especially for coastal communities.

## **Useful Vegetation along Sea shore and in Sea water (with focus on India)**

### **1. Mangroves (Seashore & Estuaries - Brackish Water)**

- **Description:** Mangroves are trees and shrubs that grow in saline coastal sediments, typically in brackish water of estuaries, lagoons, and sheltered coastlines. They have specialized adaptations like prop roots, pneumatophores (breathing roots), and salt glands to thrive in tidal zones.
- **Key Species in India:** *Rhizophora* spp., *Avicennia* spp., *Bruguiera* spp., *Sonneratia* spp., *Ceriops* spp., *Excoecaria agallocha*.
- **Usefulness/Potential:**
  - **Coastal Protection:** Act as natural barriers against erosion, storm surges, and tsunamis, protecting coastal villages and infrastructure.
  - **Biodiversity hotspots:** Provide vital habitats and nurseries for a wide variety of fish, crustaceans, birds, and other wildlife, supporting local fisheries.

Highly efficient at sequestering carbon, contributing to climate change mitigation.

- **Livelihood Support:** Directly support fisheries and indirectly support tourism (ecotourism). Some mangrove species have medicinal uses.
  - **Timber/Firewood (Sustainable harvesting):** Historically used for timber and firewood, though modern efforts focus on conservation and sustainable management.
  - **Challenges:** Habitat destruction due to development, pollution, and unsustainable resource extraction affect mangroves. Reforestation efforts are crucial.
2. **Salt-Tolerant Terrestrial Plants (Halophytes) along Seashore**
- grow on coastal land exposed to salt spray or saline soil. They are not necessarily submerged in seawater but can tolerate high levels of salinity.

#### **Examples in India:**

- **Salicornia (Glasswort/Marsh Samphire):** A succulent plant that can be grown as a vegetable (often called “sea asparagus”), forage, or even for oil extraction. It’s highly salt-tolerant. best use of select
  - **Sesuvium portulacastrum (Coastal Purslane/Sea Purslane):** A trailing succulent often found on sandy beaches, sometimes consumed as a leafy green.
  - **Atriplex (Saltbush):** species we used as fodder for livestock in saline areas.
  - **Casuarina equisetifolia (Coastal She-oak):** A fast-growing tree often planted in coastal areas for shelter belts, timber, and fuelwood, as it can tolerate some salinity.
- Ipomoea pes-caprae (Beach Morning Glory): is a common dune stabilizer, helps prevent sand erosion.
- **Spinifex littoreus (Beach Spinifex):** another important dune stabilizer.

## Usefulness/Potential is in

- **Bio-saline Agriculture:** Cultivating these crops on saline wastelands using brackish or saline water, thus not competing with freshwater resources.
- **Food and Fodder:** Many halophytes are edible for humans and livestock, providing alternative food sources in arid or salt-affected regions.
- **Biofuel/Bioenergy:** Some halophytes show promise as biomass for biofuel production.
- **Phytoremediation:** Can help in cleaning up salt-affected soils.
- **Coastal Stabilization:** Preventing soil erosion and dune movement.

### 3. Seaweeds (in Seawater)

- **Description:** Seaweeds are macroalgae that grow in marine environments. They are broadly classified into three groups based on their pigmentation: Red Algae (Rhodophyta), Brown Algae (Phaeophyta), and Green Algae (Chlorophyta).
- **Key Species of Commercial Importance in India:**
  - **Red Seaweeds:** Kappaphycus alvarezii (for carrageenan), Gracilaria spp. (for agar), Gelidiella spp., Hypnea spp.
  - **Brown Seaweeds:** Sargassum spp., Turbinaria spp. (for alginates, fertilizers, animal feed).
  - **Green Seaweeds:** Ulva spp. (sea lettuce), Caulerpa spp. (edible).
- **Potential of Seaweed and Success for Income of Coastal Villages:** Seaweed farming is rapidly emerging as a “blue revolution” for coastal communities in India, offering immense potential for economic empowerment and sustainable livelihoods.
- **Diverse Applications and high demand:**
  - **Food:** Direct human consumption (e.g., Ulva, Caulerpa), and as ingredients in various food products (thickeners, stabilizers, gelling agents like agar, carrageenan, alginates).

- **Pharma & Cosmetics:** Used in medicines, supplements, skincare products (due to bioactive compounds, vitamins, minerals).
- **Agriculture:** Excellent bio-fertilizers, soil conditioners, and biostimulants due to their rich nutrient content and growth-promoting hormones.
- **Animal Feed:** As a supplement to enhance animal health and productivity.
- **Biofuel:** Potential source of biomass for sustainable energy production.
- **Biomaterials:** Research into seaweed-based biodegradable plastics and packaging.

### **Ecological Advantages:**

- Seaweed cultivation requires no arable land, freshwater, or synthetic fertilizers/pesticides, making it an environmentally friendly and sustainable venture.
- They absorb significant amounts of CO<sub>2</sub>, contributing to ocean de-acidification and climate change mitigation.
- They also help in nutrient absorption, improving coastal water quality.

### **Economic Impact and Income Generation for Coastal Villages:**

- **High Profitability:** High-value species like *Kappaphycus alvarezii* can yield significant income. Reports suggest farmers can earn up to ₹13.28 lakh per hectare annually from such species.
- **Livelihood diversification:** Provides an alternative and stable income source for traditional fishing communities, especially during lean seasons or when fish catches are low.
- **Women's empowerment:** Seaweed farming often involves women in various stages, from seedling preparation to harvesting and processing, leading to increased financial independence and social standing.
- **Low Initial investment:** Compared to many other aquaculture

ventures, the initial investment for setting up seaweed rafts is relatively low, especially with government support.

- **Value addition:** Opportunities for local processing and value addition (e.g., drying, powdering, extracting compounds) can further increase income.
- **Reduced import dependency:** India currently imports a significant amount of seaweed and its derivatives. Local cultivation can reduce this dependency and create a robust domestic industry.

### Success Stories in India:

- **Tamil Nadu:** Mandapam in Ramanathapuram district is a prominent hub. Villages here have seen significant success with *Kappaphycus alvarezii* cultivation, with women's self-help groups playing a vital role. The CSIR-CSMCRI (Central Salt and Marine Chemicals Research Institute) Bhavnagar Gujarat has been instrumental in providing technical know-how and promoting tissue culture techniques for faster growth and better quality.
- **Gujarat:** Gujarat has a long coastline suitable for seaweed cultivation, and efforts are ongoing to promote it.
- **Lakshadweep Islands:** Pilot projects guided by ICAR-CMFRI (Central Marine Fisheries Research Institute) have shown huge success in commercial-scale seaweed farming, particularly with indigenous species like *Gracilaria edulis* and *Acanthophora spicifera*, generating significant man-days of employment for local women.
- **Government support:** The Indian government, particularly through schemes like the **Pradhan Mantri Matsya Sampada Yojana (PMMSY)**, is actively promoting seaweed farming with financial assistance for establishing culture rafts, providing planting materials, and developing post-harvest infrastructure. A **Multipurpose Seaweed Park** is being established in Tamil Nadu, and a **Seaweed Brood Bank** in Daman and Diu, to further boost the sector.

## **Challenges and Way Forward:**

Despite the immense potential, challenges include:

- **Inconsistent Seed Quality:** Ensuring a consistent supply of high-quality seeds/planting material.
- **Environmental Risks:** Vulnerability to cyclones, ocean temperature fluctuations, and diseases.
- **Market Linkages:** Strengthening market connections between farmers and processing industries.
- **Technological Gaps:** Need for continuous research and development in cultivation techniques, processing, and value addi

# Sakhi Mandal

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In Gujarat, **Sakhi Mandals** are essentially **Self-Help Groups (SHGs)**, primarily composed of women from similar socio-economic backgrounds they come together to pool their savings and access financial and other support for livelihood generation and empowerment. They are a crucial component of the **National Rural Livelihood Mission (NRLM)**, which in Gujarat is implemented through the **Gujarat Livelihood Promotion Company Limited (GLPC)** under the **Rural Development Department**.

A brief note on their registration and available assistance in Gujarat is as follow:

## 1. **Sakhi Mandal (Self-Help Group) Formation and Registration Process**

Unlike formal cooperative societies that require specific registration under the Cooperative Societies Act, Sakhi Mandals (SHGs) usually follow a more informal, community-driven formation process, though they often get formally linked to banks and government programs.

### **Key Steps for Formation and Linkage:**

#### 1. **Group Formation:**

- Typically consists of 10-20 women from poor families, sharing similar difficulties, living in the same neighborhood.
- The group agrees to meet regularly (e.g., weekly or fortnightly).

- Members commit to regularly saving a mutually agreed-upon small amount (e.g., ₹50-₹200 per month). This pooled saving forms the group's internal loan fund.
- Members can take small loans from this pooled fund for their immediate needs, with mutually agreed-upon interest rates and repayment schedules.
- Decisions are made democratically, with each member having an equal voice.

## 2. Registration:

- While not always a formal “registration certificate” like a company, SHGs need to be **recognized and linked** to government programs and banks to avail benefits.
  - This recognition is often facilitated by **Community Resource Persons (CRPs), Cluster Level Federations (CLFs), Village Level Organizations (VLOs)**, and officials from GLPC or NGOs working under NRLM.
  - The group typically maintains basic records in the form of
    - Membership register
    - Meeting minutes book
    - Savings and loan ledger
  - After a period of successful internal functioning (usually 3-6 months with regular savings and meetings), the SHG becomes eligible for grading and bank linkage.
  - **Grading:** Banks and GLPC conduct a “grading” exercise to assess the group's performance, regularity, financial discipline, and adherence to SHG principles. A good grade makes the group eligible for financial assistance.
2. **Assistance Available for Sakhi Mandals in Gujarat** primarily comes under the umbrella of the **Deen Dayal Antyodaya Yojana – National Rural Livelihood Mission (DAY-NRLM)**, implemented by the **Gujarat Livelihood Promotion Company Limited (GLPC)**.

- **Financial Assistance is available though**
  - **Revolving Fund (RF):** SHGs that have successfully functioned for at least 3-6 months and passed the grading test can receive a Revolving Fund from GLPC (usually ₹10,000 to ₹15,000 per SHG). This is meant to strengthen their internal lending capacity.
  - **Community Investment Fund (CIF):** Larger amounts are provided to Village Organizations (VOs) or Cluster Level Federations (CLFs) of SHGs, which can then be lent to individual SHGs or members for livelihood activities.
  - **Bank Linkage and Loans:** This is a crucial component. SHGs are facilitated to open bank accounts and access bank loans.
    - **Interest Subvention:** A significant benefit is the **interest subvention** scheme, where SHGs can get loans at concessional interest rates (e.g., 7% per annum for loans up to ₹3 lakh, with additional subvention for timely repayment, effectively making it 4% in some cases, and higher limits up to ₹20 lakh with market rates).
    - **Collateral-free loans:** Loans to SHGs are generally collateral-free up to a certain limit.
- **Capacity Building and Training:**
  - **Skill Development:** GLPC and partner organizations provide training in various livelihood activities (e.g., tailoring, handicraft, food processing, animal husbandry, petty trade) to enhance members' skills and income-generating potential.
  - **Financial Literacy:** Training on managing finances, record-keeping, and understanding banking operations.
  - **Leadership Training:** Developing leadership qualities among SHG members to manage their groups effectively and participate in federations.

## Co-operative society

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In Gujarat, cooperative societies play a significant role in various sectors, from agriculture and dairy to housing and finance. Their functioning is primarily governed by the **Gujarat Cooperative Societies Act, 1961**, and the **Gujarat Cooperative Societies Rules**,

### 1. Registration Process for Cooperative Societies in Gujarat

The registration process is with **District Registrars of Co-operative Societies**, appointed by the State Government of Gujarat.

#### Key Steps:

- **Minimum Members:** A society (other than one where the State Government is a member) generally requires a minimum of **seven (7) adult persons (18+ years)** to form, though recent amendments might have changed this to eight for certain types like housing societies. Members should be from different families and reside within the society's area of operation.
- **Name Selection:** Choose a unique name that reflects the society's objectives.
- **Documents Required for Registration:**
  - a) Application under **Gujarat Co-operative Societies Act, 1961 (Act No. 10 of 1962)**
  - b) **Form-A** for registration (as per Rule 3)

- c) A list of **10 eligible individuals** (from separate families) who qualify as members (as per Section 8(2))
  - d) Signature of the **main promoter** in the application (Section 8(3))
  - e) **Resolution** authorizing the main promoter to sign the application (Section 8(3))
  - f) **Police verification certificate** stating that none of the 10 individuals, including the promoter, are involved in criminal activity
  - g) **Bank certificate** from the district central co-operative bank (Rule 3-B)
  - h) **Share capital and entry fee** deposit proof (Minimum ₹500 share capital) (Rule 3-C)
  - i) **Project report** detailing the plan and functioning of the society (Rule 3-D)
  - j) In case of bylaw amendment, the **amendment proposal timeline** (Section 9(1)(B)) (Rule 3-M), if applicable
  - k) **No-objection certificate** from any existing society already working in the same area (Section 4)
  - l) **Opinion from an existing competent society** regarding viability (Section 4)
  - m) **Residence proof** (e.g., Talati's certified copy) confirming that 10 eligible individuals are from separate families residing within the operational area (Section 6(1))
  - n) **Four copies of the society's proposed bylaws** with authorized signatures (Section 8(1))
4. **Submission:** Submit the application and documents to the respective District Registrar's office.
  5. **Scrutiny and Inspection:** The application is scrutinized. If complete, a field inspection may be ordered. Clarifications or additional documents might be requested if there are deficiencies.
  6. **Approval/Rejection:** Based on the scrutiny and field report, the District Registrar approves or rejects the application.

**7. Certificate of Registration:** Upon approval, a Certificate of Registration is issued, which typically takes about a month.

Cooperative societies in Gujarat are diverse and categorized based on their primary objective and the services they provide to their members.

### **Assistance Available**

The Government of Gujarat provides assistance

- **Grants and Subsidies:** For specific activities or for strengthening certain types of societies (e.g., for agricultural credit societies like PACS/LAMPS for reconstruction and reestablishment, based on their performance and growth).
- **Loan Facilities:** Access to loans through cooperative banks at favorable rates.
- **Capital Contribution:** In some cases, the government may contribute to the share capital of cooperative societies.
- **Tax Relief:** Specific income tax reliefs might be available for cooperative societies.
- **Gujarat State Co-operative Union:** This apex body plays a crucial role in promoting, educating, and training cooperative members and managing committees. It helps in the formation of new societies and provides guidance.

# Farmer Producer Organizations (FPOs)

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Farmer Producer Organizations (FPOs) are a crucial mechanism for empowering small and marginal farmers in India by leveraging the power of collectivization. They enable farmers to address challenges related to fragmented landholdings, lack of access to quality inputs, technology, finance, and remunerative markets.

## 1. FPO Concept

An FPO is essentially a legal entity formed by primary producers, primarily farmers. The core idea is to bring together individual farmers into a collective body to achieve economies of scale in various agricultural activities.

### Key Characteristics:

- **Voluntary & Democratic:** Members voluntarily join and democratically control the FPO, with “one member, one vote.”
- **Producer-Owned & Controlled:** The FPO is owned and governed by its farmer-members.
- **Business Entity:** It functions as a business organization aiming to enhance the income of its members.
- **Services:** FPOs provide end-to-end services, including:
  - **Input Procurement:** Bulk purchase of quality seeds, fertilizers, pesticides, and farm machinery at competitive prices.

- **Production & Productivity Enhancement:** Facilitating access to modern technology, best farming practices, and extension services.
- **Post-harvest Management:** Collective harvesting, sorting, grading, packing, and primary processing.
- **Marketing:** Aggregating produce, enhancing bargaining power, and direct market linkages to reduce intermediaries and ensure better price realization.
- **Financial Access:** Facilitating access to credit, insurance, and other financial services for members.
- **Value Addition:** Encouraging processing, branding, and certification of agricultural produce.

## 2. Registration Process

FPOs are registered under one of the following legal frameworks:

### 1. **Producer Company under the Companies Act, 2013 (Part IXA):** This is the most common and preferred legal structure for FPOs due to its corporate governance framework, perpetual succession, and ease of raising capital.

- **Some important features are:** At least 10 individual producers or two Producer Institutions.
- **Most come together and have:** at least 5 Directors.
- **Process:**
  - Obtain Digital Signature Certificate (DSC) and Director Identification Number (DIN) for the proposed directors.
  - Apply for name approval with the Registrar of Companies (ROC) using the SPICe+ form. The name must end with “Producer Limited Company.”
  - Draft the Memorandum of Association (MOA) and Articles of Association (AOA). The MOA defines objectives, and AOA defines internal rules.
  - Prepare other necessary documents (PAN, Aadhaar, address proof of members/directors, registered office proof).

- File the integrated SPICe+ form along with all attachments to the ROC.
  - Upon approval, the ROC issues a Certificate of Incorporation.
  - Apply for PAN and TAN for the company.
2. **Cooperative Societies Act (of the concerned State):** Some FPOs are registered as Cooperative Societies under state-specific Cooperative Societies Acts (e.g., Gujarat Cooperative Societies Act, 1961).
  3. **Societies Registration Act, 1860 / Public Trust Act:** Less common for business-oriented FPOs, often used for promotional or welfare-oriented farmer groups.

### 3. Assistance Available

- **Management Cost Support:** FPOs receive financial assistance (e.g., up to ₹18.00 lakh over 3 years) for professional handholding, capacity building, and meeting initial operational expenses.
- **Matching Equity Grant:** To strengthen their equity base and enhance creditworthiness, FPOs can receive a matching equity grant (e.g., up to ₹2,000 per farmer member, with a limit of ₹15.00 lakh per FPO).
- **Credit Guarantee Facility:** FPOs can access collateral-free project loans from eligible lending institutions (e.g., up to ₹2 crore per FPO) under a credit guarantee scheme, reducing risk for banks.
- **Venture Capital Assistance (SFAC):** Supports agribusiness projects by FPCs, often with interest-free loans.
- **Subsidies/Grants:** Access to various other government schemes like Agriculture Infrastructure Fund (AIF) for creating storage, processing, and other infrastructure, with benefits like interest subvention.
- **Professional Handholding:** FPOs receive support from Cluster Based Business Organizations (CBBOs) or other professional agencies for up to 5 years, covering business plan preparation, management, and technical guidance.

- **Skill Development:** Training programs for FPO management, members, and directors on business management, financial literacy, market linkages, and technical aspects of agriculture.
- **e-NAM Integration:** FPOs are encouraged to onboard onto the e-National Agriculture Market (e-NAM) platform to facilitate online trading of their produce, enhancing transparency and market access.
- **Direct Marketing:** Support for establishing direct linkages with bulk buyers, processors, and retailers.
- **Branding & Certification:** Assistance for branding FPO products and obtaining quality certifications (e.g., organic, GI tags).
- **Infrastructure Support:** Financial and technical assistance for establishing common facilities like collection centers, grading/sorting units, cold storage, and processing units.

## Drone Scheme

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Drone Didi Scheme or PM Drone Didi Yojana was launched by Prime Minister Narendra Modi on November 30, 2023. To economically empower women by providing drones to Women Self-Help Groups (SHGs) for agricultural services.

- A **Central Financial Assistance (CFA)** of **80% of the cost of the drone and accessories**, up to a maximum of **₹8.0 lakhs**, will be provided to the women SHGs for purchasing the drone package.
- The remaining amount (20%) can be raised as a loan, for which a **3% interest subvention** is available under the Agriculture Infrastructure Fund (AIF) loan facility.
- The scheme provides a comprehensive package that includes:
  - The basic drone with a spray assembly (for liquid fertilizers and pesticides).
  - Four spare battery sets (to ensure continuous operation, covering up to 20 acres per day).
  - One spare propeller set.
  - Nozzle set, dual channel fast battery charger, battery charger hub.
  - One year comprehensive insurance.
  - Two years annual maintenance contract (AMC).
  - Applicable GST.
  - Each SHG will select one or more members to be

trained as **drone pilots**. This is a mandatory **15-day training** program provided at DGCA-approved Remote Pilot Training Organizations (RPTOs).

- Additionally, a family member of the pilot (often a “Drone Assistant”) may also receive training in basic repair and maintenance of the drone.
- The training also covers aspects of agricultural applications, ensuring the women are skilled in precision spraying of nutrients and pesticides.
- The trained women SHG members will offer drone-based rental services to farmers for agricultural purposes (initially focusing on spraying liquid fertilizers and pesticides). It is envisioned that each SHG can earn an additional income of at least **₹1 lakh per year** through these services.
- Lead Fertilizer Companies (LFCs) are expected to play a role in the execution of the scheme at the state level, coordinating with state departments, drone manufacturers, and SHG federations.

## 2. Use of Drones in the Agriculture Sector

Drones (Unmanned Aerial Vehicles or UAVs) are revolutionizing agriculture, offering precision and efficiency that traditional methods cannot match.

### 1. Precision Spraying:

- **Pesticides & Fertilizers:** Drones can spray liquid fertilizers, pesticides, and herbicides with high precision, minimizing wastage, reducing human exposure to chemicals, and ensuring even distribution. This is a primary focus of the Drone Didi scheme.
- **Controlled Volume:** Drones can apply chemicals in much lower volumes (Ultra-Low Volume spraying), making it more efficient and environmentally friendly.

### 2. Crop Health Monitoring & Scouting:

- **High-Resolution Imagery:** Drones equipped with RGB, multispectral, and thermal sensors capture detailed images of fields.

- **Early Disease/Pest Detection:** Farmers can identify early signs of nutrient deficiencies, water stress, or pest infestations, allowing for timely intervention.
  - **Vegetation Indices (e.g., NDVI):** Specialized cameras can generate maps indicating plant health, helping farmers identify stressed areas that require immediate attention.
- 3. Soil Analysis and Field Mapping:**
- Drones can collect data to create detailed 3D maps of fields, analyze soil conditions (nutrient levels, moisture content), and identify variations across the land. This information aids in precise planting, irrigation, and fertilizer application.
- 4. Irrigation Management:**
- By monitoring crop stress and soil moisture levels, drones can help optimize irrigation schedules, preventing over-watering or under-watering, leading to significant water savings.
- 5. Planting and Seeding:**
- Drones can be used for automated seeding and planting, especially for small seeds or in difficult terrains.
  - Drone-assisted pollination is also an emerging application.
- 6. Livestock Monitoring:**
- Drones can track and monitor livestock, helping farmers keep tabs on their health and behavior, locate lost animals, and even detect injuries or sickness.
- 7. Insurance Claims & Damage Assessment:**
- High-resolution imagery from drones provides accurate data for assessing crop damage due to natural calamities (floods, hailstorms), facilitating quicker and more accurate insurance claims.
- 8. Security and Surveillance:**
- Monitoring fields for theft, wildlife intrusion, or unauthorized access
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# Agroforestry

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Historical Perspective: Farmers have traditionally integrated trees like Neem (*Azadirachta indica*), Babul (*Acacia nilotica*), and various fruit trees (Mango, Sapota) into their farmlands for shade, fodder, fuel, and timber. These practices were often driven by necessity and local ecological wisdom.

There are diverse range of agroforestry systems adapted to local conditions:

## 1. Agri silviculture (Trees + Crops):

- o This is the most common system. Farmers grow agricultural crops (e.g., cotton, groundnut, wheat, maize, soybean, sesame) alongside timber or multi-purpose trees.
- o Common Tree Species: Eucalyptus (highly popular for quick returns), *Melia dubia* (Malabar Neem - fast-growing timber), Teak, Babul (*Acacia nilotica*), Neem, Sandalwood (in specific areas).
- o Examples: Eucalyptus with groundnut, *Melia dubia* with cotton, Teak with rice.

## 2. Agri horticulture (Fruit Trees + Crops):

- o Integration of fruit trees with agricultural crops.
- o Common Fruit Trees: Mango, Sapota (Chikoo), Citrus, Guava, Custard apple, Jamun, Ber, Pomegranate, Drumstick, Tamarind, Coconut.

- o Examples: Mango/Sapota plantations with intercropped groundnut, wheat, vegetables, or spices.
- 3. Agrisilvipasture (Trees + Crops + Pasture/Livestock):**
- o Combines trees, crops, and fodder or pasture for livestock.
  - o Common in: Regions with significant livestock populations, like parts of Kutch (e.g., Banni grasslands context) and Saurashtra.
  - o Examples: Teak with fodder crops and groundnut/cotton.
- 4. Silvopastoral Systems (Trees + Pasture/Livestock):**
- o Trees planted in pastures to provide shade for livestock and additional fodder.
  - o Common in: Kutch and other arid/semi-arid regions where livestock rearing is prominent. Tree species like Babul and Prosopis are often seen.
- 5. Boundary Plantations:**
- o Planting trees along farm boundaries (e.g., Teak, Eucalyptus, Casuarina, Arjun). These act as windbreaks, prevent soil erosion, provide timber, and do not significantly compete with main crops.
- 6. Block Plantations/Woodlots:**
- o Dedicated blocks of timber trees within or adjacent to farmlands, primarily for commercial timber production. Eucalyptus and Melia dubia are common choices due to their fast growth.

Agroforestry offers a multitude of benefits for farmers and the environment: Farmers get income from both agricultural crops (short-term) and trees (medium to long-term timber, fruits, fodder).

**Improved Soil Health and Fertility:**

- o Tree roots bind the soil, preventing erosion by wind and water (especially crucial in arid/semi-arid Gujarat).
- o Fallen leaves and organic matter from trees enrich the soil with nutrients, increase organic carbon content, and improve soil structure.

- o Leguminous trees fix atmospheric nitrogen, naturally enhance soil fertility.

### **Water Conservation and Management:**

- o Trees act as natural sponges, enhancing groundwater recharge and reducing surface runoff.
- o Shade from trees reduces evaporation from the soil, conserving moisture, which is vital in water-stressed regions.
- o Windbreaks reduce wind speed, preventing desiccation of crops and soil.

### **Environmental Services and Climate Resilience:**

- o Carbon Sequestration: Trees absorb significant amounts of CO<sub>2</sub>, contributing to climate change mitigation. Gujarat aims to increase its green cover.
- o Biodiversity Enhancement: Agroforestry systems create habitats for birds, insects (including pollinators and natural pest predators), and other wildlife, promoting biodiversity.
- o Reduced Chemical Use: Healthier ecosystems can reduce the need for synthetic pesticides and fertilizers.

#### **Meeting Local Needs:**

- o Provides fuelwood, fodder for livestock, small timber for farm implements, and fruits for household consumption and sale. This reduces pressure on natural forests.

### **Employment Generation:**

- o Agroforestry activities, from nursery raising to planting, maintenance, and harvesting, create employment opportunities in rural areas.

### **Promotion in Gujarat**

Gujarat has been a leading state in promoting social and farm forestry, which lays the foundation for agroforestry.

#### **1. Gujarat Forest Department Initiatives:**

- o The Social Forestry Wing of the Gujarat Forest Department has been actively promoting tree planting on non-forest lands since the 1970s.

- o Nursery Production and Seedling Distribution: Large-scale production and subsidized distribution of tree seedlings (including Eucalyptus, Melia, Teak, Neem) to farmers.
- o Extension Activities: Organizing farmer camps (shibirs), awareness programs (Van Mahotsav), and training sessions to educate farmers on the benefits and techniques of agroforestry.
- o Tissue Culture: Promotion of high-quality, fast-growing clones of species like Teak and Melia through tissue culture.

## **2. National Agroforestry Policy 2014 & Sub-Mission on Agroforestry (SMAF):**

- o While a national policy, Gujarat actively participates in its implementation. This policy encourages states to relax restrictions on felling and transport of trees grown on private lands, making tree farming more lucrative for farmers.
- o The SMAF provides financial assistance and technical support for adopting various agroforestry models.

## **3. Agricultural Universities:**

- o Gujarat's agricultural universities (Anand Agricultural University, Junagadh Agricultural University, Navsari Agricultural University, Sardarkrushinagar Dantiwada Agricultural University) conduct research on suitable tree-crop combinations, develop improved germplasm, and disseminate knowledge through their extension networks (KVKs).

## Climate Related Services

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Weather information plays a vital role in agricultural planning, crop protection, and overall farm management. In India, the India Meteorological Department (IMD) serves as the primary and most reliable source of weather forecasts, warnings, and climate data. IMD regularly shares its observations and predictions with State Agricultural Universities and Krishi Vigyan Kendras (KVKs), which further interpret this data and convert it into practical agro-advisories for farmers. Through these advisories, farmers receive guidance on irrigation scheduling, pest and disease management, sowing and harvesting decisions, and measures to reduce weather-related risks.

Farmers who require local and timely weather updates can directly contact their nearest Krishi Vigyan Kendra for personalized assistance. weather information is also easily accessible through television, radio broadcasts, and daily newspapers. In addition to that several mobile applications provided by government agencies now offer real-time forecasts, rainfall updates, alerts for extreme weather, and crop-specific recommendations. These digital tools enable farmers to make informed decisions anytime and from anywhere. Below is a detailed overview of the major weather services, advisory systems, and mobile applications available for the benefit of farmers.

### **1. India Meteorological Department (IMD) - Ahmedabad Centre:**

- o Website: <https://mausam.imd.gov.in/ahmedabad/>

- o What you'll find: This is the regional meteorological center for Gujarat.
  - City Forecast: Weather for major cities in Gujarat.
  - District Forecast: Weather outlook for various districts.
  - State Forecast: Overall weather conditions for Gujarat.
  - Warnings: Alerts for heavy rain, thunderstorms, strong winds, heatwaves, etc. (Look for "Warnings" or "चेतावनी").
  - Rainfall Statistics: Progress of monsoon, cumulative rainfall, daily rainfall maps.
  - Nowcast: Short-term, very immediate weather predictions.

## **2. IMD's Agromet Advisory Services Portal (for general weather relevant to agriculture):**

- o Website: [https://mausam.imd.gov.in/responsive/agromet\\_adv\\_ser\\_state\\_current.php](https://mausam.imd.gov.in/responsive/agromet_adv_ser_state_current.php)
- o What you'll find: While this is a national portal, you can select "Gujarat" from the dropdown menu to get state-specific Agromet Advisory Bulletins. These bulletins often include weather warnings relevant to agriculture.

## **II. Agro Advisory in Gujarat**

Agro advisories combine weather forecasts with specific agricultural recommendations for farmers. These are often issued by agricultural universities in collaboration with IMD.

### **1. IMD's Agromet Advisory Services Portal (Primary Source for Bulletins):**

- o Website (Direct link to Gujarat bulletin example): <https://mausam.imd.gov.in/ahmedabad/mcdata/agromet.pdf> (This link directly takes you to the latest Agromet

Advisory Service Bulletin PDF for Gujarat. The main page where you can select the state is: [https://mausam.imd.gov.in/responsive/agromet\\_adv\\_ser\\_state\\_current.php](https://mausam.imd.gov.in/responsive/agromet_adv_ser_state_current.php))

- o What you'll find: These are the official Agromet Advisory Service Bulletins. They are released weekly (and sometimes more frequently during critical weather events). They contain:
  - Weather Forecast: Short-range and medium-range weather predictions for the state and specific districts.
  - Weather Warnings: Alerts for anticipated adverse weather conditions.
  - Impact-Based Advisories (General): General precautions related to weather.
  - Crop-Specific Advisories: Most importantly, these bulletins provide actionable advice for various crops grown in Gujarat, based on the forecasted weather. This includes recommendations on:
    - Irrigation scheduling
    - Pest and disease management (when to spray, what to watch for)
    - Fertilizer application
    - Harvesting and post-harvest management
    - Sowing/planting advice
    - Livestock management during different weather conditions.
  - Advisories are prepared by various Agricultural Meteorological Field Units (AMFUs) and District Agromet Units (DAMUs) in Gujarat.

## 2. **i-Khedut Portal (Gujarat Government):**

- o Website: [suspicious link removed]
- o What you'll find: While primarily for scheme applications, this portal also sometimes features weather and agro-

advisories under sections like “News,” “Notifications,” or “Farmer Information.” It serves as a central hub for various agricultural services in Gujarat. Look for sections related to “Crop-Weather Watch & Drought Monitoring” or “Weather Nowcast” as seen on sub-portals like <https://krushipragati.co.in/dashboard> which is linked from i-Khedut for rainfall data.

3. **Agricultural Universities of Gujarat:** Gujarat has four prominent agricultural universities that play a crucial role in preparing and disseminating agro-advisories. They often have dedicated Agromet Units.
  - o **Anand Agricultural University (AAU):** <https://www.aau.in/> (Look for “Agromet Advisory Unit” or “Extension Education” sections).
  - o **Junagadh Agricultural University (JAU):** <https://www.jau.in/> (Similar search within their site for advisories).
  - o **Navsari Agricultural University (NAU):** <https://www.nau.in/>
  - o **Sardarkrushinagar Dantiwada Agricultural University (SDAU):** <https://sdau.edu.in/>

What you’ll find on University Sites: These universities, through their Krishi Vigyan Kendras (KVKs) and Agromet departments, often publish localized agro-advisories for their respective regions or districts. They might also conduct farmer awareness programs based on these advisories.

### III. Mobile Applications for Farmers (Agro Advisory)

For real-time and personalized advisories, consider these mobile apps promoted by the government:

#### 1. Meghdoot App:

- o **Developed by:** IMD, ICAR, and Ministry of Earth Sciences.
- o **Availability:** Google Play Store and Apple App Store.
- o **Features:** Provides district-wise crop-specific weather-based agro-advisories to farmers in local languages. It uses the latest weather forecasts and combines them with agricultural expertise.

## 2. Damini App:

- o **Developed by:** Indian Institute of Tropical Meteorology (IITM) Pune and IMD.
- o **Availability:** Google Play Store.
- o **Features:** Primarily for lightning alerts. It gives early warnings about lightning strikes near the user's location, which is crucial for farmers working in open fields, especially during monsoon.

## 1. Bhuvan - ISRO's Geoportal:

- o **Website:** <https://bhuvan.nrsc.gov.in/>
- o **What it is:** Bhuvan is ISRO's comprehensive geospatial platform, providing a vast array of satellite imagery and thematic maps. While not an "advisory" app in itself, it's the underlying platform for many applications.
- o Relevance to Agriculture/Weather:
  - **Agriculture Section:** Bhuvan has dedicated sections and applications for agriculture, allowing users to view crop acreage, land use/land cover, soil maps, and information related to crop health (often derived from satellite indices).
  - **Weather Section:** You can find satellite-derived weather-related data and visualizations.
  - **Disaster Management:** Real-time information on floods, droughts, and other natural disasters, which is crucial for agricultural planning and relief.
- o **Mobile App (Bhuvan App):** ISRO often develops specific mobile applications or modules that leverage Bhuvan data for various purposes. Search for "Bhuvan App" on your app store but note that it's more of a GIS viewer than a daily weather advisory.

## 2. Mahalanobis National Crop Forecast Centre (MNCFC) Smartphone Apps:

- o **Website:** <https://www.ncfc.gov.in/apps.html>

- o **What it is:** MNCFC, under the Ministry of Agriculture & Farmers Welfare, works closely with ISRO's National Remote Sensing Centre (NRSC) to use satellite data for crop forecasting.
  - o **Relevant Apps:**
    - **Ground Truth Application:** Developed by NRSC/ISRO, this Android app is for field data collection by users (e.g., crop type, condition, GPS coordinates) to support crop assessment using satellite data under the FASAL project. This helps in validating and refining satellite-based agricultural models.
    - **Crop Cutting Experiment Application:** Also developed by NRSC/ISRO, this app helps in collecting data for Crop Cutting Experiments (CCE), crucial for yield estimation, again feeding into satellite-based production forecasts.
  - o **Relevance:** These apps are less for direct farmer advisories but are vital tools in the ecosystem that generates accurate agricultural information, which indirectly helps farmers through policy and advisory formulation.
- 3. Meghdoot App (Joint initiative, heavily uses ISRO data):**
- o **Developed by:** India Meteorological Department (IMD), Indian Council of Agricultural Research (ICAR), and Indian Institute of Tropical Meteorology (IITM).
  - o **Availability:** Google Play Store and Apple App Store.
  - o **ISRO's Connection:** While not an "ISRO app" in name, Meghdoot heavily relies on the meteorological and agricultural data provided by ISRO's satellites. It aggregates contextualized district and crop-wise advisories with forecast and historic weather information.
- 4. Damini App (Lightning Alerts - uses satellite data):**
- o **Developed by:** IITM Pune (an autonomous institution under the Ministry of Earth Sciences, which works closely with IMD and leverages satellite data).

- o **Availability:** Google Play Store.
- o **ISRO's Connection:** Lightning detection often involves ground-based sensors combined with satellite observations (which track cloud top temperatures and dynamics provided by ISRO's satellites). This app provides crucial safety advisories for farmers.

#### 5. **Atmanirbhar Krishi App (KisanMitr Initiative):**

- o **Context:** Launched by the Office of Principal Scientific Adviser, Government of India.
- o **ISRO's Connection:** This app is designed to aggregate data from various government ministries/departments, including IMD, ISRO, ICAR, and others, to provide evidence-based information and early weather alerts to farmers. It aims to integrate various data sources for a comprehensive farmer advisory.

## Schemes for Women Farmers

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Many government and bank-specific schemes aim to empower women in agriculture. Some prominent ones include:

- **Mahila Samridhi Yojana:** This scheme provides financial assistance to poor women, particularly from backward classes, to establish businesses. It is offered by State Channelizing Agencies (SCAs), Regional Rural Banks (RRBs), and Nationalized Banks. Self-help groups (SHGs) can also avail of this, with a maximum loan amount of Rs. 60,000 per woman.
- **Mudra Loan for Women:** Designed for aspiring female entrepreneurs, Mudra loans are categorized into:
  - **Shishu Loan:** Up to Rs. 50,000 for new businesses.
  - **Kishor Loan:** Rs. 50,000 to Rs. 5 lakhs for existing businesses.
  - **Tarun Loan:** Up to Rs. 10 lakhs for well-established enterprises seeking expansion.
- **Stand-Up India Scheme:** This scheme facilitates bank loans between Rs. 10 lakh and Rs. 1 Crore for setting up greenfield projects (new ventures) in manufacturing, services, trading, and allied agricultural activities. It aims to support at least one-woman borrower per bank branch.
- **Udyogini Scheme:** Launched by the Government of India under the Women Development Corporation, this scheme helps women set up enterprises by providing loans, often

with lower interest rates or even interest-free for certain categories (disabled, Dalit, widowed).

- **Self-Help Group (SHG) - Bank Linkage Programme (SHG-BLP) by NABARD:** NABARD plays a crucial role in promoting SHGs, particularly women-led groups, and linking them with banks for credit. This has become a significant financial inclusion program.
  - **Revolving Fund (RF):** SHGs can receive an initial Revolving Fund to strengthen their institutional and financial management.
  - **Community Investment Fund (CIF):** Further capitalization support is provided to SHGs.
  - **Interest Subvention:** DAY-NRLM (Deendayal Antyodaya Yojana - National Rural Livelihoods Mission) provides interest subvention on bank loans to women SHGs, reducing their effective cost of credit.
- **Bank-Specific Agriculture Loan Schemes:** Many public and private sector banks (e.g., PNB, Bank of Baroda, SBI, Canara Bank) offer various agriculture loan schemes that women farmers can access, including:
  - **Kisan Credit Card (KCC):** Provides short-term credit for crop cultivation, post-harvest expenses, and consumption needs. It can also cover investment credit for allied activities.
  - **Loans for Allied Activities:** Loans for dairy, poultry, fisheries, land purchase, farm machinery, irrigation systems, and warehousing.
  - **Schemes for Women:** Some banks have specific schemes for women entrepreneurs or farmers, like “PNB Mahila Udyam Nidhi Scheme” or “PNB Mahila Samridhi Yojna” from Punjab National Bank.

## II. General Eligibility Criteria for Women Farmers:

While specific criteria vary by scheme and bank, common requirements include:

- **Age:** Typically, between 18 and 65 years.
- **Residency:** Indian national, often with a preference for rural areas or small towns.
- **Land Ownership/Lease:** Proof of land ownership or valid lease agreements is often required for agricultural loans. For groups, the concept of “Woman Farmer Certificate” issued by Gram Panchayat or urban local bodies can be important.
- **Income Limits:** Some schemes (like Mahila Samridhi Yojana, Udyogini Scheme) have annual family income ceilings.
- **Credit History:** A good credit score is always beneficial.
- **No Prior Defaults:** Applicants should ideally not have a history of loan defaults.
- **Project Feasibility:** A viable project plan for the farming activity is essential.

### III. Documents Required for Obtaining Bank Finance:

The exact documents may vary, but generally, you’ll need:

- **KYC Documents:**
  - o Identity Proof (Aadhar Card, PAN Card, Voter ID, Passport, Driving License)
  - o Address Proof (Aadhar Card, Utility Bills, Rental Agreement)
  - o Passport-sized photographs
- **Land Records:**
  - o Copies of land records (e.g., 7/12 extract, Record of Rights) certified by revenue authorities.
  - o Latest land tax paid receipts.
  - o Original/certified copies of title deeds (if offering land as security).
- **Income Proof (if applicable):**
  - o Bank statements (past 6-12 months)
  - o Income Tax Returns (ITRs)

- **Project-Specific Documents:**
  - **Detailed Project Report (DPR):** Outlining the purpose of the loan, expected outcomes, and repayment strategy (especially for larger loans or new ventures).
  - **Quotations/Invoices:** For machinery, equipment, or capital expenses.
  - **Feasibility Certificates:** From electricity board for pump sets, water rights certificates, etc., if applicable.
  - **Training/Experience Certificate:** For the activity you seek finance for, if applicable.
- **Caste Certificate:** If applying under schemes for specific categories (e.g., SC/ST).
- **Self-Help Group (SHG) related documents:** For loans availed through SHGs, documents related to SHG registration, member details, and internal financial records will be needed.

#### IV. Steps to Obtain Bank Finance:

1. **Identify Your Need:** Clearly define the purpose of the loan (e.g., crop cultivation, buying equipment, starting allied activity).
2. **Research Schemes:** Explore various government and bank schemes specifically designed for women farmers or agricultural purposes. Websites like MyScheme ([myscheme.gov.in](http://myscheme.gov.in)) can be helpful.
3. **Check Eligibility:** Carefully review the eligibility criteria for the chosen scheme.
4. **Prepare a Project Plan:** Even for smaller loans, having a clear idea of how you'll use the funds and how you'll repay them is crucial. For larger projects, a detailed project report is essential.
5. **Gather Documents:** Collect all necessary KYC, land, income, and project-specific documents.
6. **Approach the Bank:** Visit your nearest bank branch (public sector, regional rural bank, or even some private banks that

have agricultural lending divisions).

7. **Consult with the Bank Official:** Discuss your requirements and the relevant schemes with the agricultural loan officer. They can guide you through the application process.
8. **Fill the Application Form:** Complete the loan application form accurately.
9. **Submit Documents:** Provide all required documents to the bank.
10. **Follow Up:** Stay in touch with the bank to track the progress of your application.
11. **Disbursement and Repayment:** Once approved, the loan amount will be disbursed, and you will need to adhere to the repayment schedule.

#### **Tips for Women Farmers:**

- **Form Self-Help Groups (SHGs):** This is often a highly effective way for women farmers to access credit, as SHGs have a good track record with banks and benefit from various government support programs.
- **Seek Guidance:** Don't hesitate to seek guidance from local agricultural departments, NABARD offices, NGOs working in rural development, or bank officials.
- **Maintain Good Financial Records:** Even for small-scale farming, keeping records of income, expenses, and previous loan repayments can build your creditworthiness.
- **Understand Terms and Conditions:** Before signing any loan agreement, ensure you fully understand the interest rates, repayment tenure, collateral requirements, and any other terms.

By carefully planning and understanding the available resources, women farmers can successfully obtain bank finance to grow their agricultural ventures and improve their livelihoods.

# Women Empowerment through Skill Development and Financial Assistance

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Empowering women through skill training and financial support is one of the most effective strategies for achieving social and economic development. In Gujarat, several government programs and financial schemes have been launched to help women and small entrepreneurs become self-reliant. These initiatives provide training, guidance, and financial assistance to encourage entrepreneurship, enhance skills, and generate sustainable employment opportunities.

## Skill Training and Development

Skill training is an essential tool for women's self-reliance and economic empowerment. Through structured training programs, women gain the opportunity to enhance their abilities, explore new professional avenues, and build successful enterprises.

### Key Skill Development Areas

1. **Textile Industry:** Training in textile processing, weaving, tailoring, and designing.
  2. **Food Processing:** Instruction in innovative food processing techniques, packaging, quality control, and customer service.
  3. **Handicrafts and Grasscrafts:** Techniques for creating baskets, mats, and decorative items using low-cost materials.
  4. **Machine-Based Enterprises:** Training in operating small business equipment such as sewing, jewelry-making, and button machines.
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5. **Online Learning Platforms:** YouTube channels and mobile apps offering accessible online skill-building resources.

### **Empowerment through Training**

These training programs not only provide practical skills but also instill confidence, allowing women to participate effectively in economic activities and contribute to family and community welfare.

### **Major Government Skill Development Initiatives**

1. **Pradhan Mantri Kaushal Vikas Yojana (PMKVY):**

A national-level program providing affordable training in various sectors through certified centers, along with skill certification.

2. **Deendayal Antyodaya Yojana – National Rural Livelihood Mission (DAY-NRLM):**

Helps rural women through SHGs (Self-Help Groups) by offering training in business management, entrepreneurship, and marketing.

3. **Mahila Udyamita Mission:**

Offers professional training in sectors such as tailoring, beautician courses, fashion design, and home-based production.

4. **National Small Industries Corporation (NSIC):**

Supports women entrepreneurs through training centers, marketing assistance, and skill development guidance.

5. **One District One Product (ODOP):**

Promotes region-specific products with support for raw materials, joint services, and market linkages.

### **Financial Assistance and Entrepreneurship Development**

To complement training and skill enhancement, various financial schemes help women and small entrepreneurs establish and expand their ventures. Prime Minister Employment Generation Programme (PMEGP) administered by the Ministry of Micro, Small and Medium Enterprises (MOMSME) through the Khadi

and Village Industries Commission (KVIC), At the state level, the scheme is implemented through State Khadi and Village Industries Boards (KVIBs), Directorates under the Khadi and Village Industries Commission, District Industries Centres, and Banks.

### 1. Shri Vajpayee Bankable Scheme

A scheme to provide financial loans/assistance through nationalized, co-operative, public sector, and private banks to artisans of cottage industries.

#### **Purpose:**

To provide self-employment to unemployed persons in both rural and urban areas of Gujarat. Disabled or visually impaired individuals can also benefit.

#### **Eligibility:**

- Age: 18–65 years
- Education: Minimum 4th standard pass
- Training/Experience: At least 3 months training from a private institute or 1 month from a government-recognized institute, or one year of relevant experience, or hereditary artisan.
- No income limit.

#### **Maximum Loan Limit:**

- Industry Sector: ₹8 lakh
- Service Sector: ₹8 lakh
- Trade Sector: ₹8 lakh

#### **Subsidy Rate:**

Area	General Category	SC/ST/Ex-servicemen/ Women/40%+ Disabled/Blind
Rural	25%	40%
Urban	20%	30%

**Maximum Subsidy Limit:**

Sector	Subsidy Amount (₹)
Industry	1,25,000
Service	1,00,000
Trade (Urban General)	60,000
Trade (Rural General)	75,000
Trade (Reserved)	80,000

For blind or disabled beneficiaries, the maximum subsidy is ₹1,25,000 for any sector.

**7. Manav Kalyan Yojana**

This scheme provides tools/equipment to economically weaker sections to promote self-employment. Beneficiaries include those below the poverty line engaged in small-scale trades such as beauty parlors, dairy, papad making, etc. Annual family income should be up to ₹6,00,000 for both rural and urban areas. Applications must be submitted online at <https://e-kutir.gujarat.gov.in/>.

**Toolkit Assistance (via e-Voucher):**

The beneficiaries receive toolkit assistance for different Frode like.

**List of 10 Trades under the Scheme:**

- o Milk and Curd Seller
- o Embroidery
- o Beauty Parlor
- o Papad Making
- o Vehicle Servicing & Repairing
- o Plumber
- o Painting Work
- o Electrical Appliances Repairing
- o Pickle Making
- o Puncture Kit

## **8. Khatedar Farmer Accidental Insurance Scheme**

Provides financial assistance to the family of a landholding farmer, his/her spouse, or children in case of accidental death or permanent disability.

### **Eligible Beneficiaries:**

All landholding farmers, their children (sons/daughters), and spouses aged 5 to 70 years.

### **Main Conditions:**

The deceased or disabled person must be a registered landholder (solely or jointly). Natural deaths or other non-accidental deaths are excluded.

### **Assistance Standards:**

- Accidental Death or 100% Permanent Disability: ₹2,00,000
- Loss of one eye/limb (50%): ₹1,00,000
- Loss of two eyes/limbs or one eye + one limb (100%): ₹2,00,000

# Book Keeping

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## Introduction:

- It is necessary to keep a record of expenses and yield in agricultural business.
- From this, the following can be understood:
  - o Monitoring good progress or low progress.
  - o It becomes clear which crops generate income.
  - o Where expenses occur? Which can be avoided or reduced becomes clear.
  - o Details of tools – land – tractor and others will remain recorded.
  - o Details of debts – bank – cooperative institution, private lender: how much and when it has to be repaid is also necessary to record.

## Production Details:

- What was the crop-wise yield in the field?

At Okha, the fisheries research centre of Junagadh Agriculture University prepared liquid fertilizer from “seaweed.” Testing it on groundnut and paddy crops resulted in 10–15% more production.
  - Total expenditure incurred – seeds, ploughing, pesticides, fertilizers, electricity, diesel, labour cost, etc.
  - Comparing income from produce and expenses will reveal
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the real situation and indicate what improvements are needed.

### Types of Records:

**Table-1 : Chemical Use**

Field	Chemical	Date	Time	Acre	Rate of Use	Notes

**Table-2 : Fertilizer Use**

Field	Field Use/ Date	Soil Test Result	Suggested Use Rate	Date of Use	Acre	Rate of Use	Notes
	N	P	K	Ca	Zn	Fe	

### Sowing / Harvesting:

**Table-3 : Seed Sowing, Planting and Harvesting Record**

Crop	Variety/ Quantity	Location	Seed Sowing Date and Moisture Date (Irrigation)	Planting Date	Harvesting Date	Yield

**Table-4 : Seed Use Record**

Date	Crop	Seed Source	No. of Seeds	Germinated Seeds	Transplant Date/ Location	Notes

- Keep details of which seeds – fertilizers – chemicals were used and in what quantities.
- Not all seeds germinate; therefore, knowledge of germination rate helps determine how many seeds to purchase for future sowing.

### Planting:

- Whether you sow seeds directly or work with transplanting, use this chart.
- Recording plot location and planting date helps plan plot rotation in the future.

- Knowing the fruit maturity date helps plan harvesting in coming years.
- Record specific characteristics of plants to determine what kind of soil management is needed, such as adding amendments or implementing pest control.
- For organic farming, documentation of organic fertilizer sources is also required.

### **Harvest Chart:**

- This chart is useful when planting on a large scale.
- It helps determine whether you have enough produce to take to the market or if you frequently return with surplus.
- Here, “yield” plays a major role.
- If hiring workers, maintain details of labour hours.
- These details are helpful even for small-scale work or if you grow produce through the winter.

### **Pest Management Chart:**

- Keeping this chart helps identify pest risks in both small and large gardens and helps determine which techniques are most effective.

### **Irrigation Chart:**

- Watering is important for crop growth, and both internal and external water conditions of the plot must be considered.
- Information on water usage across irrigation methods is useful for future planning.

### **Equipment Sanitation Chart:**

- This chart is not necessary for all farms.
- For verifying organic input for organic certification, equipment cleanliness is monitored.
- CCOF (California Certified Organic Farmers) recommends keeping such forms for all horticultural tools.

### **Key Factors of Success**

#### **Method:**

- Regular follow-up of accounting and records.

- Regular repayment is necessary for taking large loans in the future.
- Stay familiar with the local loan officer and local business practices.

### **Balance Sheet:**

- Summary of assets, liabilities (debt), and net worth.
- $\text{Net Worth} = \text{Value of Assets} - \text{Value of Liabilities}$
- Current (< 12 months), intermediate (1–10 years), long term (> 10 years), non-farm.
- “The balance sheet is a picture of the farm’s financial position.”

### **2. Cash Flow:**

- Records summary of incoming and outgoing cash.
- Check book accounting.
- Incoming – crop and livestock income, capital asset sales, borrowed money.
- Outgoing – production, capital expenditure, labour payments, household expenses.
- Important due to seasonality.
- Makes it easy to compare estimated and actual cash flow.

### **Income Statement:**

- Summary of income and expenses for a specific period.
- Income – sales, government payments, dividends received.
- Expenses – production costs, interest, tax, insurance, loans.
- Storage management.
- Main purpose is to determine how much income was generated from farm operations.

### **Summary:**

Keeping accounts helps understand losses. For reducing costs, such management is useful for small farmers.

- Where customer services are provided—tractor, sprayer

pump, or transport for hire—proper accounts must be maintained.

- To become a smart farmer, not only water management but financial management is essential, as it is the key to increasing income.

## **Financial Management of Micro Enterprise**

### **What is Microcredit Finance?**

- Small loans, given mainly to low income.
- Microcredit offers access to credit to those people traditionally banks will not lend to because they lack collateral.
- Microcredit is community-driven development, dependent upon the innate creativity and potential of each individual.
- It allows people to start and expand tiny businesses without depending on moneylenders who demand exorbitant interest rates.

### **Justification and Definition of Micro-finance**

Some people excluded from certain financial services.

- Lack collateral or guarantors
- A bad credit history
- Gap in the communication / lack of confidence in the Banks
- Doubt of the bank of the repayment capacity
- Lack of access to financial infrastructure and services in remoted areas
- Lack of land records

### **Microcredit Best Practice: Repayment**

Microfinance is not philanthropy!

- Clients need to pay for the services
- Microcredit clients need to repay the loans
- Interest rate to cover the costs
- REPAYMENT ON TIME GUARANTEES THE SUSTAINABILITY OF THE PROGRAM

## **Microcredit Best practices:**

### **Key success factors**

#### **Methodology**

- Regular follow up
- Requirement of good repayment for future access to a bigger loan
- Local loan officer's familiar with local culture

#### **Balance Sheet**

- Summarizes Assets, Liabilities (Debt), Net Worth
- $\text{Net Worth} = \text{Value of Assets} - \text{Value of Liabilities}$
- Current (< 12 months), Intermediate (1-10 years) Long Term (>10 years), non-farm
- "A Balance Sheet is a snapshot of the farm's financial position"

#### **Cash Flow**

- Summarizes all cash in-flows and out-flows for a period
- Cheque book Accounting
- In-Flows – crops & livestock sales, receipts, sale of capital assets, borrowed money
- Out-Flows – production, capital expenditures, loan payments, living expenses
- Important on farms because of seasonality
- Projected and Actual Cash Flow

#### **Income Statement**

- Summary of revenues and expenses for a specific time period
- Revenue – Receipts from sales, government payments, dividends
- Expenses – Production expenses, interest, taxes, insurance, loans
- Inventory Changes – Accrual adjustment

- Depreciation and Capital Adjustments
- Revenue – Expenses = Net Income
- Main purpose is to determine how much income was generated by the farm operation

### **Projected Financial Statements**

- Lender, farm operation or other factors may require projected financial statements
- To do this review enterprise budgets and financial statements

### **Equipment Inventory**

- Equipment Name
- Model
- Size
- Year Purchased
- Age
- Condition
- Ownership
- Book Value
- Market Value

### **Summary**

It is important to keep accounts to understand where one is making losses. It is a must for managing even & small farmers of helps to reduce costs. The young, educated farmers are also setting up their own micro-enterprise-where it is customer service - providing a tractor or sprayer pump or transporting goods for sale - He must keep proper account.

To become smart farmer, it is not only management of water or farm - it is also management of finance that is key to increase income.

**Sources: Building climate smart farmers (Edition- jan,2018)**

- REPAYMENT ON TIME GUARANTEES THE SUSTAINABILITY OF THE PROGRAM

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#### **Key success factors**

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- Projected and Actual Cash Flow

#### **Income Statement**

- Summary of revenues and expenses for a specific time period
  - Revenue – Receipts from sales, government payments, dividends
  - Expenses – Production expenses, interest, taxes, insurance,
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## GI Tag

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A GI tag, or Geographical Indication tag, is a special label or badge honour given to products that come from a specific place and owe their unique qualities, reputation, or characteristics to that origin.

A certain type of tea that grows only in a specific hilly region, and because of the unique soil, climate, and traditional processing methods used there, it has a flavour found nowhere else. A GI tag would legally protect the name of that tea, so only tea from that region and produced in that specific way can be called by that name.

### Key points:

- **Origin Matters:** The product's special quality is directly linked to its geographical origin (a town, region, or even a country).
- **Qualities/Reputation:** It possesses qualities, characteristics, or a reputation that are due to this origin. This could be anything from a unique taste in food, a specific texture in fabric, or a particular skill used in a handicraft.
- **Collective Right:** It's not owned by one person or company, but by the community of producers in that region who make the product according to certain standards.

### Examples

- **Darjeeling Tea:** Only tea grown in the Darjeeling region of West Bengal can be called Darjeeling Tea.

- **Kanchipuram Silk Sarees:** Known for their unique weaving and designs, originating from Kanchipuram in Tamil Nadu.
- **Alphonso Mango:** A specific variety of mango with a distinct taste, grown in certain regions of Maharashtra.
- **Gir Kesar Mango (from Gujarat!):** The famous Kesar mango grown in the Gir region of Gujarat has a GI tag.
- **Bhalia Wheat (from Gujarat):** A type of wheat grown in the Bhal region of Gujarat, known for its high protein content.

### How a GI Tag is Useful

A GI tag is used in several important ways:

#### 1. Legal Protection:

- o It provides legal protection against others trying to use the product's name or a similar name for goods that don't come from that specific geographical area or don't meet the required quality standards.
- o This prevents fakes and imitations, ensuring that consumers get the genuine product. For example, a "Darjeeling Tea" sold in a market must truly be from Darjeeling.

#### 2. Ensuring Authenticity and Quality for Consumers:

- o When you see a GI tag on a product, it acts as a guarantee of its authenticity. Consumers can trust that the product has the unique qualities associated with its geographical origin.
- o This builds consumer confidence and trust.

#### 3. Promoting Economic Prosperity for Producers:

- o By preventing unauthorized use, the GI tag helps genuine producers maintain a premium price for their products. This is because their products are recognized as unique and high-quality.
- o It helps increase demand for the product, both domestically and internationally, leading to higher income for the farmers, artisans, and other producers in the region.
- o It can boost tourism to the region as people seek out the authentic product.

#### **4. Preserving Traditional Knowledge and Cultural Heritage:**

- o Many GI-tagged products are made using traditional methods passed down through generations. The GI tag helps to preserve these unique skills, knowledge, and cultural practices that are tied to the region.
- o It encourages the community to maintain the specific standards and qualities that make their product special.

#### **5. Rural Development and Livelihoods:**

- o GIs often benefit rural, marginal, and indigenous communities who have been producing these unique goods for centuries. It provides them with a sustainable livelihood.
- o It encourages investment in the region related to the product's production and marketing.

In essence, a GI tag is a powerful tool that protects a region's unique products, helps producers get fair value for their efforts, and ensures that consumers receive authentic, high-quality goods with a special connection to their place of origin.

## Success Stories

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### Alkabben Jitubhai Sojitra

- Village: Dhareshwar
- Taluka: Rajula
- District: Amreli
- Age: 48 years
- Occupation: Farming and Household work
- Education: 7th Standard Pass
- Agricultural Experience: 14 years
- Contact Number: 9328866790



### Initial Situation:

Alkabben was cultivating chickpeas on 5 vighas of land. The crop yield was around 75 maunds, giving an income of about ₹72,000. However, due to the extensive use of chemical fertilizers and pesticides, the cost of cultivation was increasing, keeping the family's financial condition at a moderate level. Additionally, she constantly faced challenges like unseasonal rainfall and labor shortages.

### Training Received Under the Project:

Under the Women Farmer Development Programme managed by NCCSD, Alkabben participated in two training sessions. She learned about natural farming, animal husbandry, and

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preparation and use of organic fertilizers such as Jivamrut, Ghanjivamrut, Amrutpani, Dashparni Ark, and Neem Oil. She also received information about various government schemes, tools, and technical guidance.

### **Changing Farming Methods and Results:**

Alkabben adopted natural farming methods on her farm, which significantly reduced the cost of chemical fertilizers, and the chickpea production increased from 75 to 125 maunds. This increase led to a substantial rise in her income.

### **Personal Development:**

As a result of her success, Alkabben became full of self-confidence and leadership abilities. Now, she has become a source of inspiration for other women as well.

### **Future Plans:**

- To receive more training related to farming and adopt new technology
- To benefit from government schemes
- To guide other women farmers
- To achieve higher production at lower costs through organic farming
- To focus more on environmental protection and water conservation

Alkabben Sojitra's journey proves that with proper guidance, training, and confidence, farming can become a profitable and empowering career.



### **Shilpaben Bharatbhai Radadiya**

- Village: Kumbhariya
- Taluka: Rajula
- District: Amreli
- Age: 39 years
- Occupation: Farming and Household work

- Education: 9th Standard Pass
- Agricultural Experience: 25 years
- Contact Number: 9638825352

Shilpaben, in addition to household work, took care of livestock and farming, and today she has emerged as a successful home-based entrepreneur.

Through ONGC's CSR Project and the joint efforts of NCCSD and VRTI–Amreli, Shilpaben received training and guidance. After two training sessions, she gained full knowledge of technical farming, market access, and how to start a home industry. These trainings not only provided her with information but also ignited her inner confidence.



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### **Inspirational Enterprise:**

Shilpaben started her own home-based business, where she prepares papads, wafers, mouth fresheners, ghee, pickles, and khakhras herself. She sells her products directly from home and delivers to customers when needed. Due to the purity of her products, she receives fair prices – reflecting quality and trust.

### **Today's Shilpaben:**

- Makes all farming decisions herself
- Keeps financial records of her crops
- Is aware of government schemes
- Acts as a leader among women's groups
- Has become a role model for other women

Shilpaben is no longer just a farmer; today she is a “woman bringing change.” She expresses heartfelt gratitude to ONGC and NCCSD for providing her with the platform that helped her start this journey of transformation.

Her story sends a message – when given an opportunity, women too can progress rapidly and bring deep change to society.



## Nehaben, Sanjanaben, Kailashben, Rekhaben

- Village: Amanpur
- Taluka: Jambusar
- District: Bharuch
- Sanjanaben Contact Number: 81410 91555

Name	Age	Occupation	Education	Farming Experience
Nehaben Ajitbhai Thakor	33	Farming	8th Pass	7 years
Sanjanaben Nikulbhai Thakor	23	Farming	10th Pass	2 years
Kailashben Mahendrabhai Sandesariya	37	Farming	5th Pass	8 years
Rekhaben Harshadbhai Pawa	22	Farming	3rd Pass	2 years

**Type of Enterprise:** Agriculture-based Home Industry – Production of Gram Flour (Besan) and Wheat Flakes

Amanpur is a small village in Jambusar taluka of Bharuch district, where most people are engaged in farming. The four women – Nehaben, Sanjanaben, Kailashben, and Rekhaben – had been involved in agriculture for many years, cultivating crops like chickpeas and wheat. Traditionally, they sold their crops directly in the market, which gave them low profits.



They realized that if they added value to their farm produce, they could increase their income and become self-reliant. To make this idea a reality, they received support from NCCSD’s Women Farmer Development Project and Aatapi Seva Foundation.

Aatapi Seva Foundation has been working for the social and economic development of women in Jambusar taluka for many years. The organization regularly conducts training programs to teach women different skills. These four women from Amanpur participated in the “New Women Farmer” training program organized by NCCSD.



In this training, women were taught about modern farming techniques, crop management, and especially how to add value to agricultural produce. During the sessions, they learned how to make products like besan from chickpeas and flakes from wheat. They understood the importance of value addition and decided to create new products from their own crops.

After completing the training, the four women decided to start a home industry together. Each of them contributed a small portion of their savings and purchased necessary equipment, such as a small machine for cleaning grains, a small grinder, and packaging materials. NCCSD also provided them with initial guidance and motivation.

#### **Marketing Strategies Used by the Women:**

- **Local Markets:** They set up stalls in nearby village fairs and weekly markets in Jambusar and neighboring villages.
- **Retail Shops:** They contacted local grocery store owners and started supplying their products.
- **Direct Sales:** They sold directly to residents of their and neighboring villages, building strong customer relationships.
- **Aatapi Seva Foundation Network:** The foundation helped promote their products through its network.
- **Exhibitions and Fairs:** They participated in agricultural fairs and local exhibitions to increase product recognition.

#### **Challenges and Success:**

While starting the business, they faced challenges such as limited capital, lack of technical knowledge, market competition, and insufficient understanding of packaging and branding. However,

continuous guidance from the Women Farmer Development Project and their own dedication helped them overcome these challenges.

- **Support from NCCSD:** The training, guidance, and encouragement from NCCSD gave them the right direction.
- **Quality Products:** They maintained high product quality, which built customer trust and brought a 25–30% increase in their income.
- **Affordable Pricing:** Their fair pricing helped attract customers.
- **Teamwork and Unity:** The four women worked together and supported each other, making the process smoother.
- **Understanding Local Demand:** They catered to the needs and preferences of local customers, which helped them create the right products.

Despite initial difficulties, they stayed patient and continued toward their goal.

This initiative by the four women of Amanpur has become an inspiration not only for themselves but for the entire village. Their home industry has made them economically self-reliant and able to better support their families. Their success has also motivated other village women to start their own home-based enterprises.



**Ramilaben, Nayanaben, Parvatiben, Jayaben**

- Village: Nahar
- Taluka: Jambusar
- District: Bharuch
- Ramilaben Contact Number: 98798 11379

Name	Occupation	Age	Education
Ramilaben Jagdishbhai Makwana	Farming	50	10th Pass
Nayanaben Jayendrabhai Makwana	Farming	42	10th Pass
Parvatiben Rameshbhai Makwana	Farming	45	7th Pass
Jayaben Dashrathbhai Makwana	Farming	42	6th Pass

Nahar village – a peaceful, green village where women have taken a remarkable step toward self-reliance. Under the ONGC and NCCSD Women Farmer Development Training, they received guidance from NCCSD and Aatapi Seva Foundation on topics like animal husbandry, home industry, farming, government schemes, crop planning, land and water management.

### **Training and Beginning:**

During training, the women learned how to make skin-friendly soaps using natural and herbal ingredients like neem, tulsi, aloe vera, and sandalwood. Interestingly, most of these raw materials were already available on their farms, reducing costs and increasing confidence in the activity.



### **Establishment of the Home Industry:**

The women collectively set up small production units for soap making. Initially, they faced challenges in management, marketing, and packaging, but with unity and determination, they made it possible.

### **Journey of Success:**

Now, their handmade herbal soaps are in high demand not only in their own village but also in surrounding areas. People are increasingly turning to natural, chemical-free, and skin-friendly products.

### **Symbol of Women Empowerment:**

Thus, the women of Nahar village have proved that with proper guidance, training, and confidence, even rural women can become successful entrepreneurs. Their enterprise is not just a source of income but a living example of women's empowerment.



### **Manishaben Kiritbhai Rathod**

- Village: Piludra
- Occupation: Farming and Animal Husbandry
- Contact Number: 96243 70226

Manishaben Kiritbhai, from a humble farming family in Piludra village, used to practice traditional animal husbandry and farming with her husband. Despite their hard work, the income from dairy farming was not satisfactory – especially because manual milking consumed time and energy, sometimes reducing milk quality too.



**Introduction to Change:**

One day, Manishaben heard about the ONGC and NCCSD Women Farmer Development Training. With determination and a desire for change, she joined the training.

Through Aatapi Seva Foundation, she received training on various topics such as animal husbandry, home industry, farming, government schemes, crop planning, and resource management. She learned how the use of a milking machine could save time, increase production, and improve animal comfort.

**Steps and Results:**

After discussing with her husband, she bought a milking machine. Though there were initial difficulties, with patience and training-based knowledge, both learned to use it effectively.

**Visible Results Today:**

- Saves time during milking
- Produces more and cleaner milk
- More time available for animal care
- Extra time to focus on farming activities

**Inspiration for the Village:**

Manishaben’s success story spread throughout Piludra. Many women are now inspired by her and willing to adopt technology. Today, she is not only a successful dairy farmer but also a living symbol of women’s empowerment.

## Support Behind the Success:

This success was made possible by the valuable support of Aatapi Seva Foundation and NCCSD – who have equipped many women like Manishaben with knowledge, technology, and confidence.

“Change is possible – if the idea gets direction and effort receives support.”

Manishaben’s life is a true example of that.



## Mamataben Juvanbhai Dodiya

- Village: Agiyali
- Taluka: Shihor
- District: Bhavnagar
- Age: 35 years
- Occupation: Farming and Household work
- Education: 7th Standard Pass
- Farming Experience: 10–12 years
- Contact Number: 9737413352



## Initial Situation:

Before the project began, Mamataben cultivated onions on 1.5 vighas of land. The yield was about 300 maunds, giving an income of ₹50,000. However, due to the heavy use of chemical fertilizers and pesticides, cultivation costs were high, keeping her family’s financial condition moderate. She also faced challenges like unseasonal rainfall and labor shortages.

## Training Received:

Under the Women Farmer Development Programme run by NCCSD, Mamataben attended two training sessions. She learned natural farming, animal husbandry, preparation and use of Jivamrut, Ghanjivamrut, Amrutpani, Dashparni Ark, and Neem Oil, and received information about government schemes and tools.

### **Changed Farming Method and Results:**

She adopted natural farming methods, which reduced chemical costs significantly. In the current season, onion production increased from 300 to 410 maunds, bringing clear income growth. She now sorts her crops properly and sells them according to market demand for better returns.

### **Personal Development:**

This success has boosted her self-confidence and leadership skills. Now she inspires other women as well.

### **Future Plans:**

- To take more training and adopt new technologies
- To benefit from government schemes
- To guide other women
- To produce more at less cost through organic farming
- To work more toward environmental protection and water conservation

Mamataben Dodiya's journey proves that with proper guidance, training, and self-confidence, farming can become a profitable and empowering career.



### **Jashuben Mohanbhai Patel**

- Village: Vedaj
- District: Navsari

Jashuben Mohanbhai Patel received training from Dr. Ramanbhai Patel under the Women Farmer Development Project run by ONGC and NCCSD. During the training, she learned about animal husbandry, home industry, farming, government schemes, crop planning, and land and water management.

Jashuben now makes papads, pickles, lemon syrup, and tutti-frutti at home. She makes about 5 kg of papads daily, which

sell easily from home. During the season, she also prepares 5 maunds of pickles daily, which she sells successfully.

With full support from her family, she manages her enterprise efficiently. Today, through this home industry, Jashuben has achieved self-employment and steady income from home.

Her life has become an inspiration for many rural women, showing that with proper guidance and confidence, success is within reach.



### **Rinaben Chetanbhai Patel**

- Village: Nani Pethan
- District: Navsari
- Age: 38 years
- Education: B.E. Civil Engineer
- Farming Experience: 15 years
- Contact Number: 9924716908

Rinaben Chetanbhai Patel received training under the Women Farmer Development Project managed by ONGC and NCCSD and guided by Dr. Ramanbhai Patel. She was trained in animal husbandry, home industry, farming, government schemes, crop planning, and resource management.

Despite being a civil engineer by education, Rinaben understood the real needs of rural areas and started her own beauty parlor and clothing store. Today, she earns well and also provides employment opportunities to other women.

Her business operates year-round, providing a steady income and setting an example of women's self-reliance in the village.

Rinaben's efforts show that an educated and determined woman can lead rural development in a new direction.



## Mawani Manjulaben Harilalbhai

- Village: Varjadi
- Taluka: Mandvi
- District: Kutch
- Age: 58 years
- Occupation: Farming and Animal Husbandry
- Education: 6th Standard Pass
- Farming Experience: More than 25 years



### Mawani Manjulaben Harilalbhai – A Determined Farmer and the Story Behind Success

In Varjadi village of Mandvi taluka, Kutch district, lives a truly inspiring woman, Manjulaben Harilalbhai Mawani. Moving beyond traditional farming and animal husbandry, she adopted scientific and natural methods that transformed her life. Though educated only up to 6th standard, at 58 years of age she continues to explore new techniques and has become an inspiration to other women.

Initially, she practiced conventional farming, growing indigenous crops. Over time, she began using fertilizers and pesticides, but due to uncertain weather and pest attacks, crops often failed. Animal husbandry was also limited due to lack of facilities; low milk prices and poor veterinary care made it barely sustainable.

Manjulaben received her first agricultural training at the rural level under the ONGC and NCCSD Women Farmer Development Project through VRTI. During the training, she was guided on topics like animal husbandry, indigenous animal treatments, natural farming, home industries, government schemes, crop planning, and land and water management.

She experimented with natural remedies using neem, custard apple leaves, lime, and salt to treat animal diseases. As a result, her animals became healthier, milk production increased, and she saved ₹250 every 45 days that was earlier spent on calling the veterinarian. She also began using Jivamrut and

organic fertilizers, reducing chemical use. The soil quality improved, crop yields stabilized, and profits increased with a 25% reduction in costs.

Manjulaben not only transformed her own life but also became a mentor for other women. By following her indigenous methods, many nearby families have improved their farming and livestock management. She actively participates in training programs and works to solve local issues.

Today, she earns a stable income from both farming and animal husbandry. She is self-reliant, respected in her family, and plays a leadership role at every level. Her future plans include deepening her work in natural farming, collaborating with government programs, and training other women.

Manjulaben's success proves that with patience, curiosity, and training, even a small amount of support can change lives. She is now such a strong woman farmer that she has become an inspiration for other villages in Kutch.

**Manjulaben says:**

"The guidance received from NCCSD and VRTI has been a blessing for our farming and animal husbandry. Today, we are working successfully using natural methods. Our costs have reduced by 25%, crop and milk production have increased,

**Sources: Sunny Patel, Amit Bhai,  
Jahir Diwan, Jagdish Bhai, Maheshbhai**

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

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## **Building Self-Reliant and Skilled Farmers**

In the new millennium, the world is facing the challenge of climate change, increasingly unpredictable weather events, and their serious adverse effects. Due to the increase in greenhouse gases, global warming has led to climate change and alterations in weather. Although global warming is an international phenomenon, its adverse effects are visible at the local level. Villages, farmlands, and farmers have been seriously affected. Floods, cyclones, delayed rains, drought, unseasonal or heavy rains in a single day, heat and cold waves, snow — all these cause crop failure, reduced productivity of livestock and fisheries, and increased mortality. Such adverse events are increasing day by day, and therefore it is necessary to pay attention to mitigating these adverse impacts.

In this context, Dr. Kirit Shelat thought of establishing a voluntary organization **National Council for Climate Change, Sustainable Development and Public Leadership (NCCSD)**. This idea was discussed in detail at a meeting held in Delhi in May 2010. Justice Shri B. P. Singh, Dr. M. S. Swaminathan, Shri Purushottam Rupala, Dr. Y. S. Rajan, and Shri Kantisen Shroff joined Dr. Kirit Shelat in the discussion. They welcomed the idea and agreed to be part of it.

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At that time, Param Pujya Pramukh Swami Maharaj was in Delhi. Justice B. P. Singh, Dr. Kirit Shelat, and others met him to seek his blessings for this effort. Param Pujya Pramukh Swami gave his blessings and said:

“This is a very good initiative. Our biggest challenge is climate change and its adverse impacts, In rural areas, agriculture and animal husbandry are the livelihood of poor families. I am confident that your efforts will help them achieve sustainable livelihoods.”

The organization started in September 2010. Dr. Kirit Shelat became the Executive President and Justice Shri B. P. Singh its President.

N.C.C.S.D. began its work by organizing ‘**policy formulation and capacity-building training programs with dialogue**’ for farmers and youth. The focus was on preparing public leadership—both elected and non-elected—and farmers at the grassroots to face the challenges of climate change.

NCCSD participates in the **Conference of Parties (COP)** organized by UNFCCC to address the challenges of climate change. It works at the International level to explain how agriculture can reduce the adverse effects of climate. As a result, in the **Paris Agreement**, the importance of food security, food productivity, technology transfer, and capacity building was acknowledged. **The FAO** also appreciated this idea and created a special purpose organization named the **Global Alliance for Climate Smart Agriculture**.

NCCSD initiated efforts with **Florida State University (FAMU), USA** for technology transfer to build skilled farmers. Twenty-six scientists from the USA visited farmers in Gujarat and trained them. It publishes annual guides for farmers and stakeholders in agriculture—recently, the book “**Amritkaal Atmanirbhar – Skilled Farmers and Farming in Climate Change**” was published.

NCCSD introduced the concept of “**Building Climate Smart Farmers**” – an approach to doubling farmers’ income. For policy development and government consultations, NCCSD regularly organizes think tank seminars and capacity-building programs

for farmers, rural youth, university students, and government officials. NCCSD has published more than 25 publications and takes pride in publishing the book **“Mahan Rishi Mahant Swami Maharaj; Sahumate Sahaj Jeevan Sanatan Dharma.”**

Under the **“Mahila Khedut Vikas” (Women Farmer Development)** project, 2,500 women farmers from 10 villages in 5 districts of Gujarat are receiving training in agriculture. A project for guiding farmers in agricultural management under changing climates—using drones, satellite imagery, and AI—is being implemented in collaboration with the **Indian Institute of Remote Sensing Training Institute, Dehradun.**

Coastal areas suffer the most from adverse impacts of climate—hence, a project is being implemented to make seaweed a source of additional income.

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# ONGC

## (Oil and Natural Gas Corporation)

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The Oil and Natural Gas Corporation (ONGC) is India's largest producer of crude oil and natural gas, playing a key role in the country's energy security and overall development. Under the Ministry of Petroleum and Natural Gas, Government of India, this "Maharatna" public sector company contributes over 70% of India's domestic crude oil production and a major share of natural gas output.

### **Contribution to Energy Security and Development**

ONGC secures India's energy needs by exploring and exploiting hydrocarbon resources across 26 sedimentary basins in the country. It has discovered eight out of India's nine producing basins, adding billions of tonnes of oil and gas reserves. Through its international arm, ONGC Videsh (OVL), the company operates 32 oil and gas projects in 15 countries, diversifying India's energy sources and reducing risks of import dependency.

Along with conventional hydrocarbon exploration and production, ONGC is actively advancing toward a green energy future. It has set a target of achieving carbon neutrality and aims to generate at least 10 GW of renewable energy by 2040. This includes investments in solar and wind energy, and exploration of unconventional sources such as Coal Bed Methane (CBM), shale gas, and geothermal energy. Its partnerships with organizations like SECI (Solar Energy Corporation of India) and initiatives

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in Carbon Capture, Utilization, and Storage (CCUS) projects highlight its commitment to sustainable energy transition.

ONGC's operations also stimulate significant economic development. It supports a vast ecosystem of ancillary industries, creates direct and indirect employment opportunities, and contributes substantially to the national exchequer through taxes and dividends. Its technological advancements and research institutions further promote innovation and capacity building in India's energy sector.

### **Corporate Social Responsibility (CSR) Activities**

ONGC is deeply committed to Corporate Social Responsibility (CSR), utilizing 100% of its earmarked CSR budget, which often exceeds ₹500 crore annually. Established in 2014, the ONGC Foundation leads these initiatives with a vision of empowering underprivileged sections of society.

ONGC's CSR activities are diverse and impactful, aligning with various UN Sustainable Development Goals (SDGs):

- **Healthcare:** Significant investments in healthcare infrastructure, including multi-specialty hospitals and mobile medical units, provide affordable medical services to remote and underprivileged communities. Projects like the 300-bed multi-specialty hospital in Assam and support for the National Cancer Institute are notable examples.
- **Education and Livelihood Enhancement:** ONGC promotes access to quality education through school infrastructure development, scholarships, and computer literacy programs, with a focus on girls and disadvantaged groups. Skill development and vocational training initiatives empower communities for self-employment and improved livelihoods. The "ONGC Super 30" program, which provides coaching for engineering entrance exams to economically weaker students, is a notable initiative.
- **Environmental Sustainability:** Initiatives include tree plantation drives, water conservation projects, promotion of renewable energy, and support for clean technologies and waste management.

- **Community Development and Rural Infrastructure:** ONGC undertakes rural development projects, including construction of community centres, support for organic farming, and provision of essential facilities for rural populations.
- **Gender Equality and Women Empowerment:** Programs focusing on improving the health and education levels of women and girls, such as the “Sakhi” menstrual hygiene project, contribute to women’s empowerment.

Through these extensive CSR efforts, ONGC not only fuels India’s economy but also actively contributes to the social welfare and sustainable development of its communities.

## Books Published by NCCSD

No.	Book Title	Author(s)	Year
1	Gurubodh 5	M.V. Padma	2025
2	Gurubodh 4	M.V. Padma	2025
3	મહિલા ખેડૂત વિકાસ માર્ગદર્શિકા - ૨	Dr Kirit. N. Shelat	2025
4	મહિલા ખેડૂત માર્ગદર્શિકા - ૩	Dr Kirit. N. Shelat	2025
5	મહિલા ખેડૂત વિકાસ - માર્ગદર્શિકા	Dr Kirit. N. Shelat, Dr.A. R. Pathak	2024
6	Inspired Interaction with Artistic intelligence About Gateways to self-Realisation	Narayan Guruji, Meta Lumin	2024
7	Future Agriculture- Viksit Bharat	Dr Kirit. N. Shelat, Shrikant S. Kalamkari, Dr A. R. Pathak, Dr Odemari Mbuya	2024
8	Water Security for Agriculture Atmanirbhar Bharat Water-smart & climate-smart Action	Dr Kirit. N. Shelat, Dr Shrikant S. Kalamkar, Suresh Acharya	2024
9	Ethical Ways to Eternal spirit Sanatana Dharma	Narayan Guruji	2023
10	અમૃતકાળમાં આત્મનિર્ભર હનવામાન બદલાવમાં કુશળ ખેતી (Second Edition)	Dr Kirit. N. Shelat, Dr Odemari Mbuya, Dr A. R. Pathak	2023
11	Atmanirbhar Bharat-Energy Security	Dr Kirit. N. Shelat, Dr Odemari Mbuya, Suresh Acharya	2022
12	મહાન ઋષિ મહંત સ્વામી મહારાજ - હિન્દી	Dr Kirit. N. Shelat	2022
13	Mahan Rushi Manhant Swami Maharaj (English Edition)	Dr Kirit. N. Shelat	2021
14	આત્મનિર્ભર કૃષિ સહભાગીદારોની ભૂમિકા	Dr Kirit. N. Shelat, Nisha Shah	2020

No.	Book Title	Author(s)	Year
15	Atmanirbhar Bharat- Self Reliant and Climate Smart Farmers	Dr Kirit. N. Shelat, Dr.Odemari Mbuya, Dr A. R. Pathak, Suresh Acharya	2020
16	Climate Smart Farmers.	Mbuya, Dr A. R. Pathak, Suresh Acharya.	
17	Atmanirbhar Farmer of Gujarat	Dr Kirit. N. Shelat, Manish Bhardhvaj	2020
18	મહાન ઋષિ મહંત સ્વામી મહારાજ - સહુ માટે સહજ જીવન	Dr Kirit. N. Shelat	2019
19	વિકસતું ગુજરાત સહયાત્રા (Gujarati Edition)	H. R. Patankar, Dr Kirit. N. Shelat	2019
20	Developing Gujarat My Memories	H. R. Patankar, Dr Kirit. N. Shelat	2018
21	कृषि की आय दोगुनी करने के लिए कुशल किसान का निर्माण	Dr Kirit. N. Shelat, Dr Odemari Mbuya	2018
22	Building Climate Smart Farmers (English Edition)	Dr Kirit. N. Shelat, Dr Odemari Mbuya	2018
23	અમૃતકાળમાં આત્મનિર્ભર હનવામાન બદલાવમાં કુશળ ખેતી (First Edition)	Dr Kirit. N. Shelat, Dr Odemari Mbuya, Dr A. R. Pathak	2018
24	Yug Purush Pujay Prmukh Swami Maharaj - a life dedicated to others (English Revised)	Dr Kirit. N. Shelat	2017
25	Climate Smart Agriculture, The Way Forward, The Indian Perspectives	Dr Kirit. N. Shelat, Dr Odemari Mbuya	2017
26	International Conference on Food, Water, Energy Nexus in Arena of Climate Changes	Dr Vyash Pandey, Dr N. V. Soni, Mr V. B. Vaidy, Dr Nikhil Joshi, Dr. A. K. Mishra	2016

No.	Book Title	Author(s)	Year
27	બદલાતા હવામાનમાં કુશળ ખેતી જળ- ઊર્જા -કૃષિ ઉત્પાદનનું સંકલન, બમણી આવકના ઉપાયો	Dr Kirit. N. Shelat	2016
28	બદલાતા હવામાનમાં કુશળ ખેતી (Hindi Edition)	Dr Kirit. N. Shelat	2016
29	બદલાતા હવામાનમાં કુશળ ખેતી માટે ટકાઉ મૂલ્યવર્ધક અન્ન-કૃષિ ઉત્પાદન માટેની સાંકળ	Dr Kirit. N. Shelat	2015
30	Climate Change Modelling, Planning and Policy for Agriculture	Anil Kumar Singh, Jagdish Chandhra Dagar, Ayyanadar Arunachalam, Gopichndra R, Dr Kirit N Shelat	2015
31	Yug Purush Pujay Prmukh Swami Maharaj- a life dedicated to others (Gujarat Revised)	Dr Kirit. N. Shelat	2014
32	બદલાતા હવામાનમાં કુશળ ખેતી (Gujarati Edition)	Dr Kirit. N. Shelat	2014
33	NCCSD Theme Book		2013
34	Leadership And Greener Agriculture IN The Arena of Climate Change	Dr Kirit. N. Shelat	2012
35	ખેતીની આવક બમણી કરવા માટે સમક્ષ ખેડૂતનું નિર્માણ	Dr Kirit. N. Shelat, Dr Odemari Mbuya	2012
36	Yug Purush Pujay Prmukh Swami Maharaj- a life dedicated to others (Marathi)	Dr Kirit. N. Shelat	2012
37	જૈવિક વિવિધતા કૃષિ અને પશુપાલન જૈવિક વૈવિધતા અંગેનું સંદર્ભ સાહિત્ય	Dr Kirit. N. Shelat, Shree Shalin Shah, Shree Chelabhai Patel, Shree B. T. Dabhi, Dr Sanjay Deshmukh, Dr Depayn De	2011

No.	Book Title	Author(s)	Year
38	Sustainable Development, a green solution to Global Warming, The Shroff Experience	Dr Kirit. N. Shelat, Kathan Kothari	2010
39	Yug Purush PujayPrmukh Swami Maharaj- a life dedicated to others (English Revised)	Dr Kirit. N. Shelat	2009
40	Leadership By Choice Not By Chance (English)	Dr Kirit. N. Shelat	2009
41	ન્યાયમૂર્તિ શ્રી નાનુભાઈ શેલત સ્મૃતિગ્રંથ	Dr Kirit. N. Shelat	2008
42	Yug Purush PujayPrmukh Swami Maharaj- a life dedicated to others (Telugu)	Dr Kirit. N. Shelat	2008
43	What Ails Our Agriculture? The Gujrat Experience	Dr Kirit. N. Shelat	2007
44	Yug Purush PujayPrmukh Swami Maharaj- a life dedicated to others (Hindi)	Dr Kirit. N. Shelat	2006
45	Yug Purush PujayPrmukh Swami Maharaj- a life dedicated to others (Gujarati)	Dr Kirit. N. Shelat	2005
46	Yug Purush PujayPrmukh Swami Maharaj- a life dedicated to others (English)	Dr Kirit. N. Shelat	2004
47	ગુજરાતના વિકાસના નકશા	Dr Kirit. N. Shelat	2004
48	Mapping Development	Dr Kirit. N. Shelat	2003
49	EVOLUTION OF RURAL DEVELOPMENT (Dedicated to ILA K. Shelat)	Dr Kirit. N. Shelat	1988



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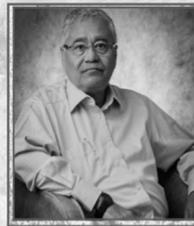
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As Honourable Prime Minister Shri Narendra  
Modi said –  
“Nari Shakti is the foundation of New India.”



Nari Shakti (women power) is now a national mission, empowering every woman, urban or rural, young or elderly—to live with dignity, safety, and self-reliance.”

– Hon'ble Prime Minister Shri Narendra Modi



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