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NITI Aayog

Empowering Farmers: Natural Farming Training Toolkit & Best Practices Guide

Training Manual for Farmers and Extension Officers

EMPOWERING FARMERS: NATURAL FARMING TRAINING TOOLKIT AND BEST PRACTICES GUIDE

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Training Manual for Farmers and Extension Officers

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Azadi Ka Amrit Mahotsav

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Message

Agriculture continues to be the cornerstone of India's economy and the principal source of livelihood for millions of rural households. At a time marked by climate change, natural resource constraints and evolving global market demands, the transformation of our agricultural systems is not merely desirable but essential. At NITI Aayog, we are committed to advancing cooperative federalism by strengthening collaboration among States, promoting the exchange of knowledge and encouraging context specific innovations that enhance resilience, productivity and long-term sustainability in Indian agriculture.

This training manual on natural farming is both timely and consequential. It offers a comprehensive and practical framework for farmers, extension functionaries and policymakers seeking to adopt approaches that balance productivity with ecological responsibility. By integrating scientific insights with field-based experience, the manual provides adaptable solutions to improve soil health, conserve water resources, reduce dependence on synthetic inputs and foster biodiversity.

India's diverse agro-climatic regions present a wide range of challenges and opportunities. Equipping stakeholders with structured guidance and reliable knowledge is critical to ensuring that State level initiatives can be implemented effectively and scaled responsibly. In this regard, the manual serves as an important instrument for translating policy intent into tangible outcomes at the farm level. It contributes not only to improved agricultural practices but also to the development of resilient food systems capable of withstanding climate variability and market fluctuations.

Natural farming represents a broader shift towards self-reliant and environmentally responsible agriculture. I encourage farmers, trainers, policymakers and researchers to engage actively with this manual, adapt its recommendations to local contexts and collaborate across regions. Through evidence-based practice and collective effort, we can build an agricultural ecosystem that is productive, resilient and sustainable for generations to come.

(Suman Bery)

Place- New Delhi
Dated 20th February 2026

स्वच्छ भारत
एक कदम स्वच्छता की ओर

प्रो. रमेश चन्द
सदस्य
Prof. Ramesh Chand
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सत्यमेव जयते

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Message

Natural farming offers a sustainable alternative to agro-chemicals-based agriculture. It combines traditional knowledge with modern ecological understanding. By minimizing synthetic inputs and relying on natural processes, it improves soil health, nutrient cycling, and soil microbiome diversity, which are essential for sustainable and resilient crop production.

Natural farming practices such as cover cropping, mulching, intercropping, and organic nutrient management enhance water retention, reduce soil erosion, and increase system resilience to climate stresses. These methods also promote biodiversity in both soil and above-ground ecosystems, leading to healthier crops and better returns.

In today's context, where farmers face challenges such as soil degradation, water scarcity, pest pressures, and climate uncertainty, practical, evidence-based guidance is critical. This training manual provides farmers and extension personnel with detailed, actionable instructions on implementing natural farming practices effectively. It bridges the gap between scientific knowledge of natural farming and field-level applications, enabling informed decision-making for sustainable agriculture.

Beyond ecological benefits, natural farming practices help reduce input costs, diversify farm income, and enhance resilience, making them highly relevant for modern farming challenges. The manual presented here is, therefore, not only a guide but a practical tool for building productive, low-input, and ecologically balanced farming systems.

I commend Dr. Neelam Patel (Program Director, Agri-Tech Division) and Mr. Paremal Banafarr, Consultant, NITI Aayog for their efforts in preparing this comprehensive manual. I believe the manual will serve as a valuable resource for farmers, trainers, and agricultural practitioners in natural farming across India.

[Ramesh Chand]

Place: New Delhi
Date : 12.02.2026

स्वच्छ भारत
एक कदम स्वच्छता की ओर

बी. वी. आर. सुब्रह्मण्यम
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Chief Executive Officer

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MESSAGE

As India strides confidently towards the journey to become *Viksit Bharat* by 2047, guided by the vision of "One Earth, One Family, One Future" that we championed during our G20 presidency, sustainable agriculture emerges as a critical pillar for national prosperity and resilience. Natural farming, in this context, offers a scientifically grounded pathway to harmonize agricultural productivity with ecological balance, while empowering our farmers and rural communities.

2. The challenges of climate change, biodiversity loss, and food security demand solutions that blend traditional wisdom with modern scientific innovation. Natural farming exemplifies this synergy eliminating synthetic chemicals, integrating livestock, and nurturing the soil thereby promoting practices that support both human well-being and ecosystem health. It embodies the spirit of *Vasudhaiva Kutumbakam*, reminding us that agriculture is not just production it is stewardship of our natural resources.

3. The National Mission for Natural Farming (NMNF) reflects our commitment to scale these practices nationwide. Through farmer training programs, demonstration centres, and robust institutional support, we are working to mainstream natural farming as a cornerstone of India's agricultural renaissance. Looking ahead, natural farming will be pivotal in achieving environmental sustainability, economic prosperity, and social equity. It offers a roadmap to double farmers' incomes, reduce our carbon footprint, and strengthen rural livelihoods, ensuring a resilient and sustainable future for generations to come.

4. I urge all stakeholders, viz. farmers, policymakers, researchers, and civil society, to come together in promoting natural farming. Together, we can build an agricultural system that is productive, sustainable, and in harmony with nature, truly embodying the vision of "One Earth, One Family, One Future."

5. I compliment Dr. Neelam Patel, Program Director, Agri-Tech Division and Mr. Paremal Banafarr for bringing out this comprehensive training manual on natural farming. It is a timely and invaluable resource for farmers and practitioners across the country.

19/2

Dated: 19th February, 2026

[B.V.R. Subrahmanyam]

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23/02/2026

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The development of this comprehensive Training Module on Natural Farming has been a collaborative effort, and I am deeply grateful to all those who have contributed their expertise, time, and guidance in bringing this manual to fruition. I would like to extend my heartfelt thanks to the CEO of NITI Aayog for his visionary leadership and unwavering support in promoting sustainable agricultural practices.

I am particularly grateful to Prof. Ramesh Chand, Hon'ble Member (Agriculture), NITI Aayog, for his continuous mentorship and handholding throughout the development of this manual. His insights into agricultural science and policy have greatly enriched the content and ensured its practical relevance. My sincere thanks go to Ms. Dipali Rastogi (Principal Secy. Dept. of Panchayat and Rural Development & ACS, GoMP), Dr. C. K. Timbadia (VC- GNFSU), Dr Rajeshwar Singh Chandel (VC, Dr. YSP-UHF), Dr N. Ravisankar (Project Coordinator, AICRP-IFS), Dr. N. Balasubramani (Director, CSA & CCA - MANAGE), for reviewing the manuscript and providing critical inputs that enhanced the scientific rigor and accuracy of the module. I am thankful to RySS (Rythu Sadhikara Samstha) for generously sharing field data, photographs, and practical learnings from natural farming demonstrations, which have been invaluable in making this manual farmer-oriented and context-specific.

I also wish to acknowledge Shri Yugal Joshi, Program Director (Communications) and his team, NITI Aayog, for his support on proofreading, graphics design, and overall presentation, which have greatly improved the readability and usability of the manual. I would like to place on record my sincere appreciation for the outstanding dedication of Mr. Paremal Banafarr, Consultant Grade-I, whose vision and sustained efforts were central to the conceptualization and complete development of this training manual.

I am deeply appreciative of the farmers across India, whose practical experiences, innovations, and traditional knowledge form the backbone of this manual. Similarly, the contributions of various state governments for implementing natural farming initiatives, have provided critical insights and lessons incorporated into this document.

This training module represents a significant step toward mainstreaming natural farming in India, and I hope it serves as a valuable resource for farmers, extension workers, policymakers, and all stakeholders working toward sustainable and resilient agricultural systems.

(Dr Neelam Patel)

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List of Abbreviations / Acronyms

Short Form	Full Form
APCNF	Andhra Pradesh Community Natural Farming
ATMA	State Project Implementation Unit
B:C	Benefit to Cost Ratio
BJM	*Beejamrit*
BPKP	Bharatiya Prakritik Krishi Paddhati
CHC	Custom Hiring Centre
CIKS	Centre for Indian Knowledge Systems
CIPHET	Central Institute of Post-Harvest Engineering and Technology
CSO	Civil Society Organisations
DAS	Days After Sowing
DAT	Days After Transplanting
DGC	Days Green Cover
DHT	Dry Heat Treatment
JM	*Jeevamrit*
DPM	District Project Manager
ETL	Economic Threshold Level
F.A.W.	Fall Army Worm
FFS	Farmer Field Schools
FPO	Farmer Producer Organisation
FYM	Farmyard Manure
GJM	*Ghanjeevamrit*
GM	Genetically Modified
HaNPV	Helicoverpa armigera Nuclear Polyhedrosis Virus
ICAR	Indian Council of Agricultural Research
IPM	Integrated Pest Management
ISBN	International Standard Book Number

Short Form	Full Form
K	Potassium
KVK	Krishi Vigyan Kendra
LNFI	Local Natural Farming Institutions
MANAGE	National Institute of Agricultural Extension Management
N	Nitrogen
NCONF	National Centre for Organic & Natural Farming
NF	Natural Farming
NITI Aayog	National Institution for Transforming India
NMNF	National Mission on Natural Farming
NPM	Non-Pesticide Management
NSKE	Neem Seed Kernel Extract
P_2O_5	Phosphorus Pentoxide
PACS	Primary Agricultural Credit Societies
PK3Y	Prakritik Kheti Khushhal Kisan Yojana
PKVY	Paramparagat Krishi Vikas Yojana
PMDS	Pre-Monsoon Dry Sowing
RDS	Rabi Dry Sowing
RKVY	Rashtriya Krishi Vikas Yojana
RySS	Rythu Sadhikara Samstha
S2S	Seed to Seed
SAMETI	State Agricultural Management and Extension Training Institute
SHG	Self-Help Groups
SPNF	Subhash Palekar Natural Farming
SRI	System of Rice Intensification
SRT	Saguna Rice Technology
VC	Vice-Chairman
VO	Village organisations
ZBNF	Zero-Budget Natural Farming

CHAPTER 1

The Science of Natural Farming

1.1 Introduction

Natural farming is an agricultural production system that eliminates the use of synthetic chemicals and fertilizers, centred around integrating livestock into the crop production system. This method is rooted in agroecology, promoting a diverse farming system that incorporates crops, trees, and animals to protect biodiversity. By adopting natural farming, farmers can increase their income due to a significant reduction in the cost cultivation, while simultaneously improving soil health, protecting the environment, and reducing greenhouse gas emissions. It leverages existing ecological processes within and around the farm to support sustainable agriculture.

On a global scale, natural farming falls under the umbrella of regenerative agriculture, a leading strategy for environmental conservation and sustainability. This farming approach plays a significant role in sustainable crop management by capturing atmospheric carbon in soil and plant matter, thereby reducing its harmful impact on the climate while benefiting agricultural ecosystems.

1.2 The Evolution of Natural Farming

Agriculture has always been and will continue to be important for India. Our sages, saints, and wise men have described the proper collection of seeds, their drying and storage, the removal of weed seeds, ensuring seed quality, and maintaining soil health since the Vedic period. This significant agricultural knowledge remains relevant even today. Historically, sustainability has been one of the core values embedded in Indian culture, encompassing both the day-to-day lives of humans and agricultural practices. The evolution of natural farming in India could be understood with the following historical references.

1.2.1 Historical Texts

(i) ***Krishi-Parashar* (circa 400 BC):** *Krishi-Parashar* is considered the world's first systematic agricultural textbook, written by Maharishi Parashar. This book outlines methods for predicting rainfall based on the movement and position of planets, the distribution of rainfall, indicators of drought, agricultural practices, animal management, nutrient management, seed collection and conservation, agricultural tools like plough design, and methods of crop cultivation (Fig. 1.1). The information it contains is also useful for modern agriculture.

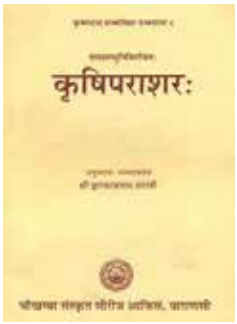

Fig. 1.1: Krishi-Parashar

(ii) **Kautilya's *Arthashastra* (circa 321 BC):** Written by Acharya Kautilya, this book contains one chapter titled '*Sitadhyaksha*'. This chapter specifically discusses the importance of cattle rearing, measuring rainfall, seed treatment and procurement, crop rotation, and the methods and timing of harvesting (Fig. 1.2).

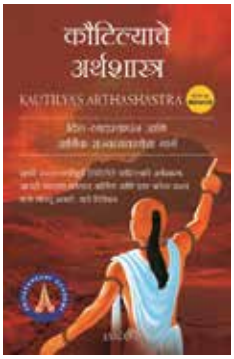

Fig. 1.2: Kautilya's Arthashtra

(iii) ***Kashyapiya Krishi Sukti* (circa 800 AD):** Authored by Sage Kashyap, it is an excellent book (Fig. 1.3) on agriculture. It provides details on rice production

in India's irrigated regions, livestock management, soil quality, and the cultivation of pulses, vegetables, fruits, spices, and ornamental plants on high ground. Special emphasis is also placed on planting trees, preparing gardens, marketing, and mining.

Fig. 1.3: *Kashyapiya Krishi Sukti*

(iv) ***Vrikshayurveda* (circa 1000 AD):** Authored by the physician Surapala, it is a valuable compilation of agricultural knowledge (Fig. 1.4). It includes information on developing gardens, the importance of plants, planting trees near buildings, purchasing seeds and planting materials, testing, treatment, preparing pits, land selection, irrigation methods, nutrition, and the use of manure. Surapala described a unique fermented liquid organic fertilizer solution and plant protection material called 'Kunapala,' which is the world's first-known fermented natural liquid manure. It also provides information on plant nutrition, diseases, protecting plants with natural products, developing gardens, agricultural and horticultural miracles, the use of plant species as indicators for crop and animal production, and descriptions of medicinal plants.

Fig. 1.4: *Vrikshayurveda*

(v) ***Upavanavinoda* (circa 1283-1301 AD): *Upavanavinoda*** (meaning a text on tree and garden-horticulture) is authored by **Sarangadhara**, the **'Sarangadhara-paddhati'** is described (Fig. 1.5). It covers various topics such as the advantages and disadvantages of planting trees near houses, soil, tree planting, seed sowing, pits, spacing between trees, auspicious and inauspicious plants, irrigation (watering), creating gardens, digging wells, Kunapa (liquid manure), miracle plants (exotic plants), natural indicators for the growth of cereal crops, and natural signs for animals and their reproduction.

Fig. 1.5: *Upavanavinoda*

(vi) ***Vishvavallabha* (circa 1577 AD):** Written by Chakrapani Mishra, this is an important manuscript that describes various aspects of agriculture, keeping in mind the needs of the Mewar region. It provides information on groundwater detection, soil testing, planting, water management, nutrition, plant diseases and treatment, and the wonders of plants and seeds (Fig. 1.6). This text is useful for arid, semi-arid, humid, and hilly regions.

Fig. 1.6: *Vishvavallabha*

Fig. 1.7: *Brihatsamhita*

(vii) ***Brihatsamhita (circa 600 AD):*** Authored by Varahamihira, Brihatsamhita covers various subjects such as astronomy, physics, geology, horticulture, and archaeology (Fig. 1.7). In it, Vrikshayurveda is described as a major topic.

(viii) ***Lokopakara*** **(circa 1000 AD):** This 1000-year-old manuscript describes methods and parameters for finding water sources, *Vrikshayurveda*, pest control methods, perfume making, and veterinary medicine (Fig. 1.8.).

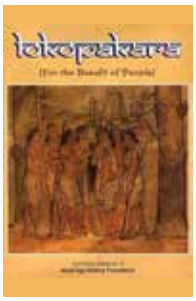

Fig. 1.8: *Lokopakara*

(ix) ***Nuskha Dar Fanni-Falahat*** **(The Art of Agriculture) (circa 1650 AD):** Authored by Prince Dara Shikoh, this text is a synthesis of agricultural techniques from West Asia and India. It mentions the introduction of grafting on related trees and the drip irrigation system, which is also beneficial for modern agriculture (Fig. 1.9).

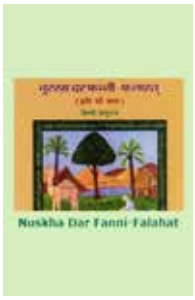

Fig. 1.9: *Nuskha Dar Fanni-Falahat*

(x) ***Krishi Gita*** **(circa 15th century):** Written by the scholar C. Govinda Varrier, this text (Fig. 1.10) describes useful crops grown in the coastal regions of India. It provides information on 124 varieties of rice and numerous other crops, along with their varieties, for various regions.

Fig. 1.10: *Krishi Gita*

It is well-documented in the literature that, before the advent of the Green Revolution, India had a rich and diverse agricultural history, achieving high yields for centuries. Some examples are given here:

1

10th - 13th CENTURY:
Inscriptions from the Chola temples in Ramanathapuram (Tamil Nadu) show that rice yield was 6.6 t/ha. Great biodiversity was recorded in the cultivation of millets, paddy, pulses, vegetables, and fruits.

2

16th CENTURY:
The Ain-i-Akbari by Abul Fazl records wheat productivity under Mughal administration; modern reconstructions suggest yields of around 1–1.3 t/ha for unirrigated wheat in certain regions.

3

19th CENTURY:

i) The Edinburgh Review reported that the productivity of land in India was 3 times higher than in England.

ii) Colonial revenue records from parts of South India indicate that traditional irrigated rice systems could achieve relatively high productivity in localized areas.

iii) The Dictionary of Economic Products of India (British India) stated that the yield of desi cotton in various parts of India was significantly higher than the national average for 2017-18 (505 kg/ha).

In addition, describing relationship between plants and humans, references are also found in various texts from millennia ago and recent history, such as:

- **Rigveda (circa 8000 BC)** mentions the profession of farming and agricultural activities.
- **Lord Rama (circa 5000 BC)** asked Bharata if special care was being taken of all those engaged in agriculture and animal husbandry.
- **Thiruvalluvar (70 BC)**, who wrote the Tamil classic ***Thirukkural*,** provides evidence that in Indian civilisation, farming was considered the noblest profession, before which even royalty bowed.

From ancient times until the pre-British era, farming as a community was a special tradition and held a respected and dignified place in the society. Wealth was measured by natural resources. **'Gau-dhan'** (cow), **'Ashva-dhan'** (horse), **'Gaj-dhan' (**elephant), etc., were all different forms of wealth. **'Vidya-dhan'** (knowledge), like the raw material of artisans, was also a form of wealth. Among all these popular forms of wealth, the most important was **'Dhanya',** i.e., rice/crops. Most transactions in society were conducted through 'Dhanya'.

There has also been a widespread tradition of **'Natural Farming'**, which has been supported by advocates such as **Shri Narayan Reddy** (Karnataka), **Shri Shripad Dabholkar** (Maharashtra), **Shri G. Nammalvar** (Tamil Nadu), **Shri Deepak Suchde** (Madhya Pradesh), and **Shri Bhaskar Save** (popularly known as the **'Gandhi of Natural Farming'**, working in Gujarat).

1.2.2 Natural Farming in the Contemporary Context

Zero-Budget Natural Farming (ZBNF): Developed in the 1980s by Indian farmer and agricultural scientist Shri Subhash Palekar, this is a farming system in which the cost of farming is minimised or eliminated. He established ZBNF by experimenting it in his own land after self-studying the Vedas, organic farming, and traditional agricultural science.

However, the initiative by former Governor of Himachal Pradesh, Shri Acharya Devvrat, who is the current Governor of Gujarat and Maharastra, led to the 'natural farming movement' in India. It is the result of his tireless efforts that natural farming has reached all the panchayats and villages of the state in a short period of three years.

Further, the Government of India coined the term **'Bhartiya Prakritik Krishi Paddhati'** (BPKP) for natural farming, although the roots of all terminologies lie in ***Vrikshayurveda***, which is a comprehensive knowledge of natural farming and is in complete harmony with nature (Fig. 1.11).

Fig. 1.11: Natural Farming Field in Eluru, Andhra Pradesh

On 16th December 2021, the Honourable Prime Minister of India, Shri Narendra Modi, while addressing a conference on natural farming, emphasised the adoption of natural farming in India.

"We have to take our agriculture out of the chemistry lab and connect it to the laboratory of nature. When I speak of the laboratory of nature, it is completely science-based.

Today, I urge every state, every state government, to come forward to make natural farming a mass movement. In this Amrit Mahotsav, we can make an effort to connect at least one village from every panchayat with natural farming.

Come, in the Amrit Mahotsav of Independence, let us take a pledge to free Mother Earth from chemical fertilizers and pesticides."

1.3 Definition of Natural Farming

Masanobu Fukuoka's "Natural Farming Method" or "Do-Nothing Farming" is an ecological approach to agriculture developed by the Japanese farmer and philosopher Masanobu Fukuoka. He introduced the four principles of natural farming:

(i) no tilling,

(ii) no fertilizers,

(iii) no weeding, and

(iv) no pesticides.

These four principles were given by Masanobu Fukuoka in his book "The One-Straw Revolution" in 1975.

According to the MoA&FW, Natural Farming is a chemical-free farming system rooted in Indian tradition, enriched with modern understanding of ecology, resource recycling and on-farm resource optimisation. It is considered an agroecology-based, diversified farming system that integrates crops, trees, and livestock with functional biodiversity. It is largely based on on-farm biomass recycling, with a major emphasis on biomass mulching, the use of on-farm cow dung-urine formulations, maintaining soil aeration, and the exclusion of all synthetic chemical inputs.

According to NITI Aayog, Natural farming is a chemical-free and livestock-based farming system that is rooted in ecological principles. This method integrates crops, trees, and animals to maximise biodiversity, thereby maintaining harmony with the environment. Natural farming relies on the natural processes occurring within and around the farm, eliminating the need for external chemical inputs.

1.4 Initiatives taken for Promotion of Natural Farming in India

Natural farming has been indigenous to India and has been practiced in different forms in different regions; the most popular of which is practised in Andhra Pradesh. The practice has also spread, in other forms, to other states, especially those in southern India. In 2019-20, *Bharatiya Prakritik Krishi Paddhati* (BPKP) was launched by the Government of India as a sub-scheme under Paramparagat Krishi Vikas Yojana (PKVY), aimed to promote natural farming that reduces use of externally purchased inputs, promoting traditional indigenous

practices largely based on on-farm biomass recycling, emphasising mulching and using cow dung and urine formulations. As a result of these policies, the number of farmers who practice natural farming has gone up from 40,000 in 2016 to more than 10 lakh farmers in 2025[1]. The total area covered as of now is over 10 lakh hectares.[2] The widespread adoption of natural farming across various states in India is increasing, clearly indicating that they have experienced its benefits.

The Government of India has recently launched the National Mission on Natural Farming (NMNF) with a total outlay of Rs. 2481 crores and farmer support arrangements for the adoption of natural farming, and sensitising of block, district and state-level officers to natural farming through field visits/ demonstrations.[3] The NMNF envisages a planned transition towards a mass movement (*Jan Bhagidari*) to bring 7.5 lakh hectares across 15,000 clusters in gram panchayats as natural farming clusters.[4] The government intends to bring 1 crore farmers under natural farming in the next two years, supported by certification and branding. It also seeks to establish 10,000 need-based bio-input resource centres. It seeks to achieve this through a robust knowledge extension ecosystem of civil society organisations (CSO) such as Self-Help Groups (SHG), Village organisations (VO), Primary Agricultural Credit Societies (PACS), Farmer Producer Organisations (FPOs), etc. Close collaboration with practicing NF farmers/communities, Local NF Institutions (LNFI) is essential for such a transition. The National Centre for Organic & Natural Farming (NCONF) will facilitate the certification and training of Master Trainers.

Nearly 9.40 lakh ha area initiated under Natural Farming in various states. Some states such as Gujarat, Andhra Pradesh, and Himachal Pradesh, have established institutional arrangements to promote natural farming[5]. Andhra Pradesh has implemented large-scale natural farming through the Rythu Sadhikara Samstha (RySS); Himachal Pradesh has done so through the Prakritik Kheti Khushhal Kisan Yojana (PK3Y); and even Uttar Pradesh, Gujarat, Chhattisgarh, and others have supporting programs.

1.5 Benefits of Natural Farming

Since natural farming avoids synthetic pesticides and fertilizers, it eliminates health risks associated with chemical exposure. Thus, it prevents soil degradation and maintains its organic carbon levels, ensuring long-term fertility. It positively impacts soil life, encouraging the growth of beneficial microbes and organisms, such as earthworms (Fig. 1.12), which are crucial for maintaining soil vitality. The produce is also nutritionally richer, contributing to overall well-being. Natural farming, due to its ecological approach, offers numerous benefits, thereby promoting overall health. Some of the key benefits of natural farming are as below:

1. Empirical evidence from multi-state field studies shows that Natural Farming reduces the paid-out cost of cultivation by at least 5–10% across major crops, with substantially higher reductions (up to 20–55%) in several crops and states, primarily due to lower material/input costs.[6]

1 *https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155019&ModuleId=3*
2 *https://naturalfarming.dac.gov.in/NaturalFarming/Concept*
3 *https://www.pib.gov.in/PressReleasePage.aspx?PRID=2077094*
4 *https://www.pib.gov.in/PressNoteDetails.aspx?id=155019&NoteId=155019&ModuleId=3*
5 *https://naturalfarming.dac.gov.in/NaturalFarming/ImplementationProcess*
6 *https://www.niti.gov.in/sites/default/files/2021-03/NaturalFarmingProjectReport-ICAR-NAARM.pdf*

2. Natural Farming leads to higher farmer income by reducing the cost of cultivation, reflected in a consistent improvement in the Benefit–Cost (B:C) ratio across states-ranging from a modest increase of over 15% in Maharashtra to 3–4 times higher B:C ratios in Karnataka, compared to non-Natural Farming systems.
3. Soil Organic Carbon (SOC), which is the main component of soil organic matter and provides water retention capacity, structure, and fertility to the soil, has decreased from 2.5% in 1947 to 0.4%, which is significantly below the acceptable range of 1-1.5%. Natural farming increases SOC by up to 45%.
4. Savings in water and electricity by 50-60%.[7]
5. Reduction in greenhouse gas (GHG) emissions by 55-85%.[8]
6. Natural Farming improves the health of farmers and consumers by avoiding synthetic pesticides and fertilisers, with programme evidence from Andhra Pradesh indicating an *80–100% reduction in chemical pesticide use* under Natural Farming systems[9].
7. Low livestock productivity remains a major concern. Livestock can be made economically viable by integrating them with agroecological farming systems.
8. Natural Farming promotes crop diversification, intercropping and multi-layer cropping systems, which enhance farm income and nutritional security; evidence from Andhra Pradesh's Community Managed Natural Farming programme shows that diversified NF farms earn 20–40% higher net incomes and produce a wider basket of nutritious foods (pulses, millets, vegetables) compared to mono-cropped conventional farms.[10]
9. Growth in soil microorganisms through the use of bio-stimulants.

Fig. 1.12: Earthworms: Valuable Contributors to Soil Health

7 *CSTEP. (2020). Life Cycle Assessment of ZBNF and Non-ZBNF: A Preliminary Study in Andhra Pradesh (CSTEP-RR-2020-02). Centre for the Study of Science, Technology and Policy*
8 *CSTEP. (2020). Life cycle assessment of Zero Budget Natural Farming (ZBNF) and non-ZBNF: Evidence from Andhra Pradesh. Centre for Study of Science, Technology and Policy.*
9 https://www.fao.org/family-farming/detail/en/c/1629947/
10 https://www.fao.org/family-farming/detail/en/c/1629947/

10. Improvement in soil health, leading to better holding of roots in soil, thus reducing the extent of damage in case of a natural disaster. Figure 1.13 shows the comparative extents of damage caused to paddy fields for conventional versus natural farming in Guntur, Andhra Pradesh (December 2023). This may be attributed to the roots and tillers development in soil in natural farming as compared to conventional farming (Fig. 1.14).

11. Natural farming fosters employment opportunities through local enterprises focused on bio-inputs, value addition, and marketing, ensuring that profits circulate within rural communities.

Fig. 1.13: Comparative extent of damage in paddy field during natural disaster for conventional versus natural farming (during cyclone Michaung)

Fig. 1.14: Roots and tillers development in Natural Farming v/s Conventional Farming in paddy

(Source: RySS)

1.6 Conventional Farming v/s Organic Farming v/s Natural Farming

Both natural and organic farming represent sustainable agricultural models, but they differ significantly. Organic farming allows the use of certain organic fertilizers and bio-pesticides produced outside, whereas natural farming completely avoids external inputs, relying instead on natural biological products. By emphasizing self-sustaining ecosystems, natural farming eliminates the dependency on external fertilizers and pesticides, making it a cost-effective and environmentally friendly alternative to conventional and organic farming practices. The differences between conventional farming, organic farming and natural farming are given in Table 1.1.

Table 1.1: Comparison between Conventional v/s Organic v/s Natural Farming

Key Comparative Parameters	Conventional Farming	Organic Farming	Natural Farming
Focus	Input intensive system, focusing on increasing production with less attention on biodiversity conservation	Usage of organic inputs to produce crops and improve soil health, maintain biodiversity and sustainability	Using organic inputs prepared locally at the farm level, and improving soil health, biodiversity conservation and sustainability
Use of Chemicals	Heavy use of synthetic fertilizers, pesticides, herbicides	Uses organic bio-pesticides & organic fertilizers	Use of farm-made bio-stimulants and natural farming inputs
Soil Tillage	Frequent and deep tillage	Reduced or minimal tillage	Reduced or minimal tillage
Soil Health Approach	Neglected; focus on yield	Emphasis on soil organic matter	Emphasis on the healthy soil microbiome and soil health
Inputs Source	Synthetic, industrially produced	Farm-based, externally sourced (certified organic)	Entirely farm-derived; local & natural products (e.g., dung, urine, jaggery and gram flour etc.)
Crop Diversity	Often monoculture	Crop rotation & intercropping	High diversity (8+ crops/year)
Soil Cover	Often bare soil after harvest	Some cover cropping	Maintain living or dead plant cover as mulching
Animal Integration	Minimal or absent	An integral part of the system	An integral part of the system (livestock, poultry, etc.)

Key Comparative Parameters	Conventional Farming	Organic Farming	Natural Farming
Pest & Disease Control	Chemical pesticides, fungicides	Botanical & microbial inputs, biocontrol agents	Pest-resistant cropping systems; botanical extracts; bioinsecticide and biopesticide
Cost of Cultivation	High-cost intensive (due to external inputs)	High cost due to the need for bulk manure and bio-fertilisers to replace chemical fertilisers.	Low-cost intensive as uses on-farm bio inputs application.
Long-term Sustainability	Poor (depletes natural resources)	Moderate to Good	Excellent (regenerative approach)
Impact on Environment	High GHG emissions and biodiversity loss	Lower GHG emissions than conventional farming	Environment-friendly; Minimum GHG emission, soil microbes' conservation, biodiversity protection, natural resources conservation
Farmer Dependency	High (on market inputs)	Moderate (needs certified inputs)	Very Low (self-reliant model)

1.7 Components of Natural Farming

Natural farming is an agricultural farming system that harmonizes farming practices with the natural rhythms and ecosystems of the environment. Its fundamental components include soil health, crop diversity, water management, and natural pest control (Fig. 1.15). Enhancing soil health is crucial and is typically achievable through natural farming inputs such as *Jeevamrit* and *Ghanjeevamrit*, mulching, and the use of green manure, all of which contribute to replenishing organic matter and nutrients. Crop diversity is promoted through techniques such as intercropping and crop rotation, which help to mitigate the risk of pests and diseases besides improving soil health. Water management is centred on practices such as rainwater harvesting and efficient irrigation methods, including drip irrigation, to conserve water resources.

Natural Farming utilises farm-based bio-inputs, including *Beejamrit, Ghanjeevamrit*, *Jeevamrit, Neemastra, and Brahmastra*, to enhance soil and crop health. *Beejamrit*, a seed treatment, provides beneficial microbes and bioactive compounds that protect seedlings and induce systemic resistance. *Ghanjeevamrit,* its dry form, serves as a stable soil amendment. *Jeevamrit*, a microbial-rich "living broth," supplies free-living N-fixers, P-solubilizers, K-mobilizers, and hormone-producing microbes for soil rejuvenation. *Neemastra*, prepared from neem and other botanicals, functions as a broad-spectrum bio-pesticide. Similarly,

Brahmastra, made from diverse plants, contains insect deterrents, antifungal, antibacterial, and antiviral compounds, offering strong crop protection. Together, these inputs sustain fertility while minimizing chemical dependence. In terms of pest control, natural farming leverages beneficial insects, trap crops, and botanical insecticides to manage pest populations without resorting to synthetic chemicals.

Integrating livestock into farming systems is vital for enhancing agricultural sustainability. Maintaining a thriving soil microbiome is crucial for sustaining the health of soil, plants, animals, and humans. To achieve this, farmlands should remain covered with crops for the majority of the year. Cultivating a diverse range of crops helps to improve soil fertility. Minimizing soil disturbance is crucial; therefore, practices like no-till farming or shallow tillage are recommended. One of the key strategies for maintaining soil organic matter is fostering a robust microbiome, which can be further stimulated using biostimulants. Effective pest control should be achieved primarily through improved farming techniques, as outlined in Integrated Pest Management (IPM). Neem-based solutions, sour buttermilk and other botanicals will be regularly used to control insect and disease infestations. According to experienced practitioners, the following core principles are fundamental to successful natural farming.

- ***Beejamrit*:** A seed treatment method that utilizes a mixture of cow dung, cow urine, and lime-based solutions to enhance seed health.
- ***Jeevamrit*:** A natural soil enrichment technique that improves fertility through a blend of cow urine, dung, jaggery, and pulse flour.
- **Mulching:** The practice of covering the soil with organic materials such as crop residues and biomass to retain moisture and improve soil conditions.
- **Plant Protection:** The use of organic sprays made from natural ingredients to prevent pests, diseases, and weeds while also supporting soil fertility.
- **Whapasa:** A method that encourages soil moisture conservation by promoting earthworm activity, which aids in the formation of water vapour condensation within the soil.
- **Mix cropping/ Inter cropping:** This practice involves growing two or more crops simultaneously on the same piece of land to maximise the use of resources and enhance biodiversity.
- **Cover Crop/ 365 Days Soil Cover/Green Manuring:** This involves planting specific crops to keep the soil covered throughout the year, which protects it from erosion, improves soil health, and can be incorporated as green manure to boost fertility.
- **Minimum Tillage/ Zero Tillage:** This approach minimizes or completely avoids disturbing the soil through ploughing, which helps to preserve soil structure, organic matter, and beneficial microorganisms.

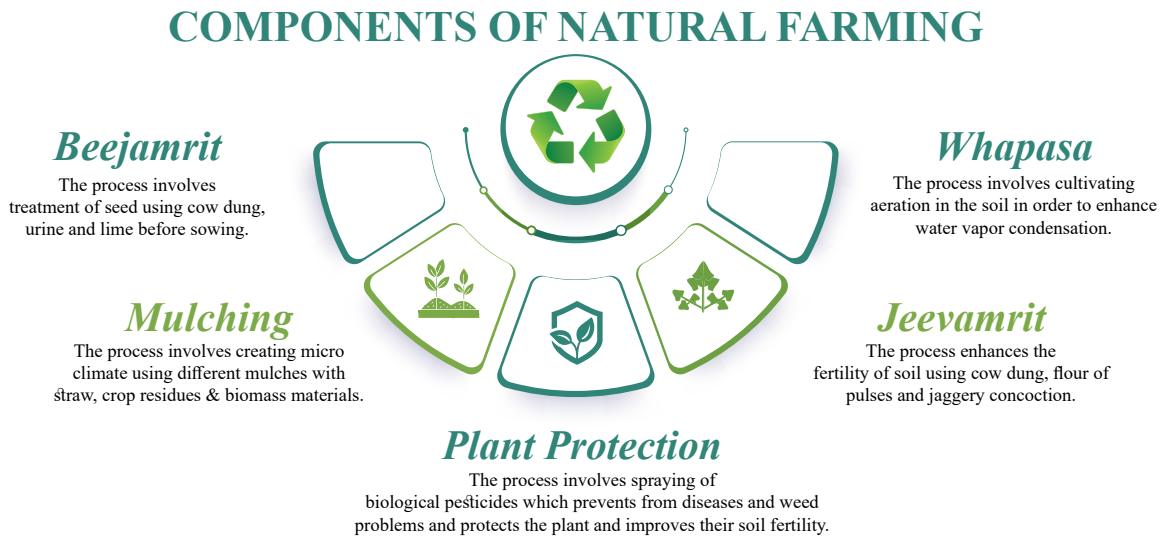

Fig. 1.15: Components of Natural Farming

1.8 Principles of Natural Farming

Natural Farming is recognised as an agroecology-based diversified farming system that integrates crops, trees, and livestock with functional biodiversity. The core objective of this approach is to work in harmony with natural ecosystems, optimizing the use of on-farm resources and minimizing reliance on external inputs. Here are the fundamental principles that guide the practice of natural farming (Fig. 1.16):

1.8.1 Prohibition of Soil Tillage and Inversion: The practice of tilling or ploughing the soil shall be minimised. Natural cultivation of the soil is to be facilitated through the perennial action of plant roots, microorganisms, and burrowing fauna. This preserves the soil's natural structure, enhances water infiltration and retention, prevents erosion, and protects the complex subterranean ecosystem.

1.8.2 Exclusion of Synthetic Fertilizers and Prepared Composts: The application of all synthetic chemical fertilizers and externally prepared composts is prohibited. Soil fertility shall be maintained exclusively through on-farm biomass recycling. This is achieved through practices such as leaving crop residues and other organic matter on the soil surface to decompose naturally, which enriches the soil over time. The use of synthetic pesticides, herbicides, and fungicides is strictly forbidden. A healthy and balanced ecosystem provides inherent control of pests and diseases. The focus shall be on fostering biodiversity to create a resilient agricultural environment where natural predators and strong plant vitality mitigate pest and disease outbreaks.

1.8.3 Integrated Weed Management without Tillage or Herbicides: Weed management shall be conducted without disturbing soil surface or the use of chemical herbicides. Weeds are best managed through methods that do not disturb the soil, such as the application of straw mulch and the cultivation of ground cover crops, which suppress weed growth while also contributing to soil health.

1.8.4 Non-Pruning of Fruit-Bearing Trees: Fruit trees shall be allowed to grow according to their natural habit, without artificial pruning. This principle is based on the observation that natural, unpruned growth leads to healthier, more resilient trees with a balanced form.

1.8.5 Prioritisation of On-Farm Resource Utilisation and Biomass Recycling: Emphasis shall be placed on the comprehensive use of on-farm resources. All organic materials, including crop residues and animal manure, should be recycled back into the the crop production system. Mulching the soil surface is a critical practice to protect it, conserve moisture, and create a favourable habitat for soil microorganisms.

1.8.6 Promotion of Biodiversity and Polyculture Systems: The cultivation of a diverse range of crops, trees, and the integration of livestock is to be actively promoted. Monoculture is discouraged in favour of polyculture systems where multiple plant species are grown in proximity, enhancing the resilience and balance of the farm ecosystem.

1.8.7 Utilisation of Indigenous and Locally Adapted Seeds: The use of locally sourced and traditional seeds is mandated. This practice ensures that crop varieties are well-suited to local climate and soil conditions, thereby contributing to the preservation of agricultural biodiversity. Reliance on commercially produced hybrid or genetically modified seeds is to be avoided.

1.8.8 Role of Biodiversity in Natural Farming: Natural Farming systems that integrate legumes, crop mixtures, and biological inputs significantly enhance rhizosphere biodiversity, microbial activity, and nutrient uptake efficiency, while reducing reliance on synthetic fertilisers, e.g., legume intercropping in strawberries (BMC Plant Biology, 2025). Intercropping with legumes has been demonstrated to improve crop productivity, reduce input costs, and enhance soil fertility (Frontiers in Sustainable Food Systems, 2022). Additionally, practices in Southeast India, characterised by the use of on-farm biomass and mulching, improve soil quality and crop outcomes compared to both conventional and organic systems (Agronomy for Sustainable Development, 2023). Such biodiversity-rich systems promote long-term agroecosystem resilience, foster sustainable nutrient cycling, and reduce dependency on synthetic inputs.

1.8.9 Integration of Livestock, Agroforestry, and Beekeeping: Integrative farm systems that combine livestock, trees, crops, and beekeeping offer multiple ecological and economic benefits essential to natural farming. Livestock provide manure and urine, which feed soil micro-organisms, enhance organic matter, and aid in bio-input production. Agroforestry systems, by incorporating multipurpose native trees, enhance microclimatic stability, increase carbon sequestration, and continuously supply biomass for mulching and inputs, while also providing fodder and mitigating heat stress in animals. Beekeeping and maintaining diverse pollinator communities improves pollination services, increasing crop yields and quality, especially in orchards and mixed cropping systems. Such integration helps

close nutrient loops, reduces dependence on external inputs, enhances biodiversity, mitigates climate risks, and improves income stability for farmers (Dinesha et al., 2022).

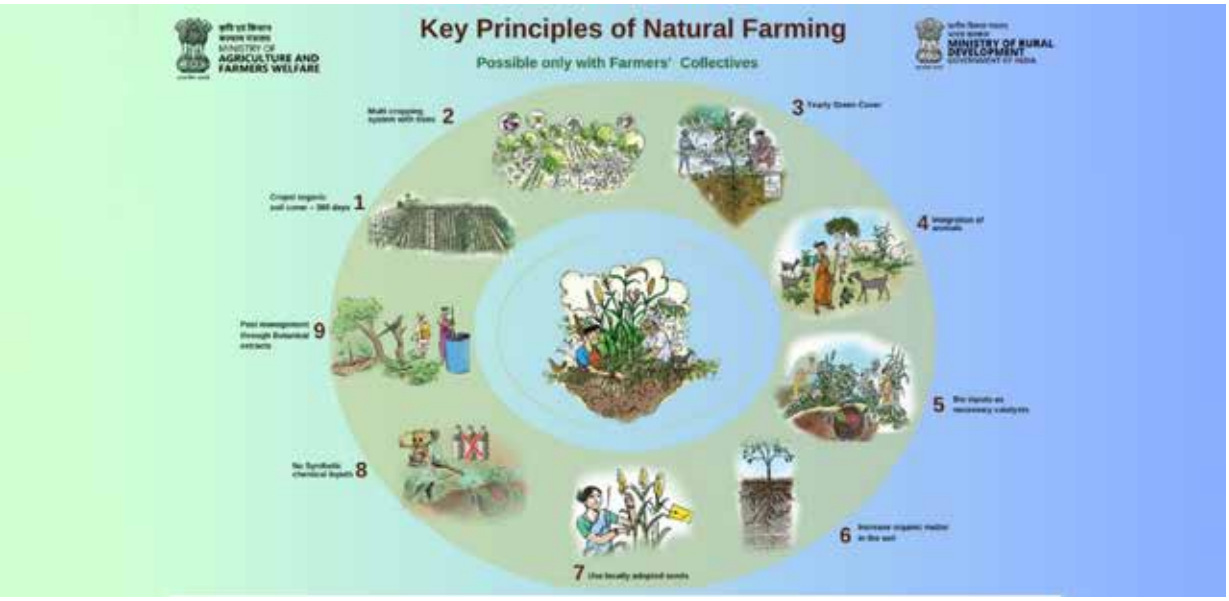

Fig. 1.16: Principles of Natural Farming

(Source: MoA&FW, GoI)

1.9 Cost of Cultivation in Natural v/s Conventional Farming

Reduction in the cost of cultivation is the key factor for incentivising farmers to adopt natural farming over conventional farming. Reduced cultivation costs result in enhanced Benefit- Cost (B:C) ratios for farmers (Table 1.2).

Table 1.2: Cost economics of kharif rice cultivation (4th year) in 2023

S. No	Particulars	Natural Farming	Conventional Farming
Economics of paddy cultivation, without bund extension			
1.	Yield per acre in quintals	33.75	31.5
2.	Minimum Support Price for one quintal Paddy in Rs.	2040	2040
3.	Gross Income in Rs.	68850	64260
4.	Cost of cultivation for Paddy (excluding costs incurred in bund establishment)	20850	29120
5.	Net Income in Rs.	48000	35140
6.	Benefit: Cost Ratio	2.3:1	1.2 :1
Economics of Paddy with bund extension			
1.	Yield per acre in quintals	33.75	31.5

S. No	Particulars	Natural Farming	Conventional Farming
2.	Minimum Support Price for one quintal Paddy in Rs.	2040	2040
3.	Cost of cultivation Rs. (i) For Paddy (ii) Bund formation (iii) Seeds & Seedlings expenses Total Cost of cultivation	 20850 6000 2000 -------- 28850	 29120
4.	Gross Income Rs. (i) Income from Paddy (ii) Additional income from the bund plantations Total Gross Income Rs.	 68850 28050 -------- 96900	 64260
5.	Total Net Income Rs.	**68050**	**35140**
6.	Benefit: Cost Ratio	2.4 :1	1.2 : 1

(Source: RySS)

References & Additional Readings

- Agronomy for Sustainable Development. (2023). Natural farming improves crop yield in SE India when compared to conventional or organic systems by enhancing soil quality. Agronomy for Sustainable Development, 43, 31. https://doi.org/10.1007/s13593-023-00884-x
- BMC Plant Biology. (2025). Biostimulation through natural biological inputs on fruiting, nutrient availability and rhizosphere microbiome in legume intercropped 'Sweet Charlie' strawberry (Fragaria × ananassa Duch.). BMC Plant Biology. https://doi.org/10.1186/s12870-025-07017-4
- Dinesha, S., Raj, A., Bhanusree, M. R., Balraju, W., Rakesh, S., Goutham Raj, W., Jha, R. K., Neeraj, & Krishna Kumar. (2022). *Agroforestry Assisted Natural Farming in India: Challenges and Implications for Diversification and Restoration of Agroecosystem*. *International Journal of Environment and Climate Change*, 12(12), 1053-1069.
- Katayama, [et al.]. (2022). Impact of Natural Farming cropping system on rural households -Evidence from Solan District of Himachal Pradesh, India. Frontiers in Sustainable Food Systems, 6, 878015. https://doi.org/10.3389/fsufs.2022.878015

CHAPTER 2

Seed Selection & Treatment

2.1 Introduction

Seeds are an essential and vital input for sustained agricultural productivity and production growth since 90 % of food crops are grown from seeds (Schwinn, 1994). The selection of seeds directly affects the yield. When a seed is sown, microorganisms (such as fungi, bacteria, and viruses) and soil insects exploit it as a food source. Some microbes/insects can injure seeds or plants by causing disease, resulting in economic damage to plant stands and general plants (Taylor & Harman, 1990). In this chapter, you will learn about:

(1) Best practices in seed selection

(2) Various methods of seed treatment in natural farming

2.2 Seed Selection

Using mixed seeds can reduce the market value of crops. It is essential to source seeds from reliable suppliers to ensure purity, high germination rates, uniformity in size, colour, and weight, and freedom from seed-borne diseases. The following best practices are recommended for seed selection[11] (Fig. 2.1.):

(i) Locally adapted seeds are preferable as they are better suited to the specific environmental conditions.

(ii) Incorporating local seed systems and land races supports agro-biodiversity and strengthens resilience against drought, pests, and diseases.

(iii) Saving and exchanging indigenous seeds within farmer groups reduces input costs, enhances self-reliance, and ensures economic sustainability.

(iv) It is recommended to use personally selected or organic, untreated seeds.

(v) Ensure seeds do not originate from neighbouring farms to prevent cross-contamination.

(vi) Be aware of the breeding characteristics of different crops. Cross-pollinating species, such as maize, can spread pollen via wind or insects over distances of 1 to 3 km.

(vii) Some seeds can persist in the soil for 5 to 20 years, necessitating precautions to prevent GM crops from contaminating natural farming land.

11 *https://nconf.dac.gov.in/uploads/books_manual/02-Days-Master-Trainer-Training-Module-English.pdf*

Fig. 2.1: Comparison Between Healthy and Unhealthy Seeds

2.3 Seed Treatment

Proper seed treatment techniques create a more favourable environment for seed germination and early plant growth. The purpose of any seed treatment is to improve seed performance in one or more of the following ways:

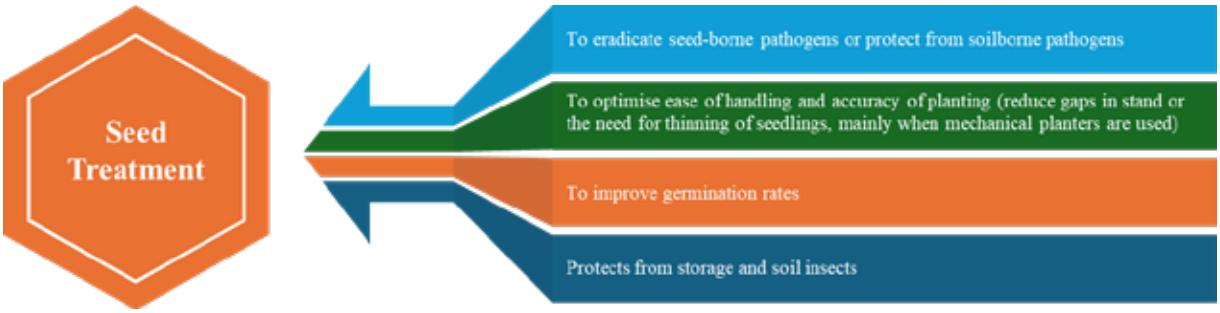

Fig. 2.2: Objectives of Seed Treatment

Seed treatment (Fig. 2.2) encompasses both the methods and substances used to enhance seed health before planting. It involves applying physical, chemical, or biological agents to seeds to protect them from pathogens, insects, and other pests that could harm seeds, seedlings, or mature plants. Before discussing these methods, it is necessary to understand some common seed and seedling diseases. During the sowing stage, several plant diseases can affect seed viability and seedling development, including:

- Seed Rot: Decay of seeds before they can germinate
- Damping-off and Seedling Blight: Soft rot affecting stem tissues near the soil surface, often accompanied by water-soaked seedling tissues (Fig. 2.3.).

Fig. 2.3: Comparison of Healthy Seedling and Damping off Seedling

- Seedling Wilt: Young plants lose firmness and appear droopy or limp.
- Root Rot: Rootlets become water-soaked, brown, and begin to disintegrate (Fig. 2.4).

Fig. 2.4: Root Rot

- Loose and Covered Smut: Fungal infections affecting small grain crops.

2.3.1 Methods of Seed Treatment

Indigenous methods for seed treatment in India utilise locally available bioresources and traditional wisdom to prepare seeds for healthy germination and growth. Farmers often use mixtures like *Beejamrit* (a blend of cow dung, cow urine, lime, and water) to coat seeds, which act as natural disinfectants and growth promoters. Other practices include dusting seeds with ash or powdered neem leaves to deter storage pests or soaking them in turmeric solution to prevent fungal infections. These techniques are simple, low-cost, and tailored to local agro-climatic conditions, ensuring seeds are protected while maintaining their natural vitality. They are discussed below.

(i) *Panchagavya*-Based Seed Treatment

Panchagavya is an organic concoction used as a potent growth promoter and plant immunity booster. The name itself is derived from Sanskrit, where 'Pancha' means five and 'Gavya' means derived from the cow. It is prepared from a blend of five key products from the cow: dung, urine, milk, curd (yoghurt), and ghee (clarified butter). These core ingredients are often mixed with enhancers like jaggery and banana and allowed to ferment, creating a solution rich in beneficial microorganisms, essential nutrients, and natural growth regulators. Derived from traditional Indian wisdom, *Panchagavya* is a versatile preparation used for seed treatment, as a foliar spray, and for soil enrichment, aiming to improve seed germination, promote healthy growth, and increase the plant's resistance to diseases.

Table 2.1: *Panchgavya*-Based Seed Treatment[12]

S. No.	Crop	Concentration of *Panchgavya* Solution	Time of soaking/submerging before sowing/planting
1.	Maize	20 ml in 980 ml of water	2 hours before
2.	Pearl and finger millet	35 ml in 1 litre of water	7-8 hours before
3.	Paddy	35 ml in 1 litre of water	30 hours before
4.	Groundnut	30 ml in 1 litre of water	4-6 hours before, followed by shade drying
5.	Vegetable seeds	20 ml in 1 litre of water	30 minutes before
6.	Lady finger	10-20 ml in 990/980 ml water	6 hours before
7.	Banana	1.5 litres in 50 litres of water	30 minutes before
8.	Cardamom	100 ml in 5 litres of water	30 minutes before, followed by mixing of ash and shade drying

(Source: TNAU)

12 *https://agritech.tnau.ac.in/org_farm/orgfarm_farming_practices_treatment_crop_millets.html*

(ii) ***Beejamrit*-Based Seed Treatment**

Beejamrit is a microbial mixture prepared from indigenous cow dung, cow urine, and lime (chuna) (Fig 2.5). It is used to treat seeds, saplings, or other planting material. All components are mixed together and kept for 24 hours during which the mixture must be stirred twice daily (morning and evening) in a clockwise direction to keep the microbes active. After preparation, seeds are treated with this mixture, dried in the shade (Fig. 2.6), and then sown. This is an ancient agricultural technique that protects seeds from seed-borne diseases. The fermented organic solution is rich in beneficial microbes, which enhance germination capacity and protect against pests or fungal attacks. Benefits of *Beejamrit* usage are:

- Protection from seed-borne diseases
- Increased germination rate
- Protection from fungi and pests
- Boosts beneficial soil microbes

Usage: 20 litres of *Beejamrit* can treat up to 100 kg of seeds.

Method: Sprinkle the seeds evenly over the area, mix them by hand, and then dry them in the shade before sowing.

Special Note: For pulse crops, only dip the seeds briefly and then dry immediately.

Seed treatment involves coating the seeds in *Beejamrit*, thoroughly mixing them, and then drying them before sowing. For leguminous crops with thin seed coats, quickly dip and dry them to avoid damage.

For the detailed method of preparation of *Beejamrit*, refer to Chapter 6.

Fig. 2.5: *Beejamrit* preparation

Fig. 2.6: Seed Treatment using *Beejamrit*

References & Additional Readings

- Centre for Indian Knowledge Systems. (n.d.). Centre for Indian Knowledge Systems. Retrieved from https://www.ciks.org/
- Subhashini Sridhar, S. Ashok Kumar, R. Abarna Thooyavathy and K. Vijayalakshmi. Seed Treatment Techniques, Centre for Indian Knowledge Systems (CIKS) Seed Node of the Revitalising Rainfed Agriculture Network.
- Tamil Nadu Agricultural University. (2014, December). *Seed (organic groundnut seed practices)*. TNAU Agritech Portal. https://agritech.tnau.ac.in/org_farm/orgfarm_prac_agri_groundnut_seed.html
- Tamil Nadu Agricultural University. (2014, November). Organic farming practices for groundnut: Seed. Retrieved from
- Tamil Nadu Agricultural University. (n.d.). Organic farming practices for paddy: Seed. Retrieved from https://agritech.tnau.ac.in/org_farm/orgfarm_prac_agri_paddy_seed.html

CHAPTER 3

Water Conservation Methods in Natural Farming

3.1 Introduction

In this chapter, the focus is on water conservation methods in natural farming, with special emphasis on biological approaches that harmonise with the landscape. For areas with a gentle slope of around 2%, agronomic and agroforestry practices offer an effective and sustainable solution. By keeping the soil surface covered through crops, mulches, or tree canopies, these methods reduce the direct impact of raindrops, enhance water infiltration, and improve the soil's capacity to retain moisture. This not only reduces runoff and prevents erosion but also ensures better water availability for crops. Compared to structural interventions, these techniques are low-cost, eco-friendly, and often more efficient in the long run. The following sections outline key agronomic strategies that help conserve both soil and water, while supporting resilient and productive farming systems.

Crop diversification is recognised as a strategy to improve water resilience in agriculture. By promoting the cultivation of less water-intensive crops through crop rotation, mix crop, or intercropping, water resources can be conserved. The *Mera Pani-Meri Virasat* Scheme in Haryana exemplifies the implementation of crop diversification to ensure water conservation. The scheme aims to save a substantial amount of water through sustainable agricultural practices.

3.2 Contour farming

Contour farming involves planting crops in horizontal rows along the natural contours of a slope. Its applications are mainly in the hilly agroecosystems and sloppy lands (Fig. 3.1). All operations are performed along the contour line.

The success of these practices depends on rainfall patterns, soil characteristics, and land topography. The benefits of this are as below:

3.2.1 Runoff and erosion management: Constructing ridges and furrows along the contour slows down water flow, minimizing runoff and preventing soil erosion. Additionally, it helps retain essential nutrients, thereby reducing their loss from the soil.

Figure 3.1: Contour Farming

3.2.2 Soil Moisture Conservation: In regions with low rainfall, contour farming enhances water infiltration, promoting moisture retention. In high rainfall areas, it prevents excessive soil erosion and runoff.

3.2.3 Soil Fertility and Crop Yield Improvement: Preserves soil nutrients and moisture, contributing to better crop growth and productivity.

A step-by-step guide to execute contour farming while doing NF is given below.

- Preparation: Mark contour lines using an A-frame or laser level.
- Recommended Crops:
  - » Contour Bunds: Vetiver grass, napier, citronella (deep-rooted, prevent erosion).
  - » Main Crop Area: Finger millet, foxtail millet, pigeon pea.
- Management: Keep bunds vegetated year-round to act as natural barriers.

3.3 Choice of Crops

Appropriate crop selection is crucial for achieving sustainable and productive agricultural systems. Natural farmers prioritise crops well-suited to natural production methods, promoting biodiversity and enhancing soil health. Crop selection is crucial for soil and water conservation, influenced by factors such as rainfall intensity, market demand, climate, and farmer resources. The various effects of crop selection are discussed below:

3.3.1 Biomass, Canopy Cover, and Root System: Crops with dense biomass, broad canopy cover, and deep root systems help shield the soil from heavy rainfall, reducing runoff and preventing soil and nutrient loss.

3.3.2 Crops that Contribute to Erosion: Tall or widely spaced crops like sorghum, maize, and pearl millet leave the soil exposed, making it more susceptible to erosion.

3.3.3 Crops that Prevent Erosion: Close-growing crops with thick canopy cover and strong root systems, such as cowpea, green gram, black gram, and groundnut, are ideal for minimizing soil erosion.

3.3.4 Optimal Seed Rate: Using a higher seed rate promotes denser canopy formation, providing better soil coverage and protection.

Selecting crops based on water requirements, root depth, and sunlight preference ensures optimal water use. The guidelines for the selection of crops are given in Table 3.1:

Table 3.1: Crop Suitability as Per Water and Light Conditions

Crop Type	Examples	Water Requirement	Root System	Sun Preference
Low Water Crops	Millets (Bajra, Ragi), Pulses (Green gram, Black gram)	Low	Shallow to medium	Full sun
Shade-Loving Crops	Turmeric, Ginger, Colocasia	Medium	Shallow	Partial shade

Crop Type	Examples	Water Requirement	Root System	Sun Preference
Shadow-Sensitive Crops	Onion, Garlic, Mustard	Medium-High	Shallow	Full sun

Guidelines:

- Avoid paddy and sugarcane in drought-prone areas unless using SRI (System of Rice Intensification) with mulching.
- Intermix deep-rooted and shallow-rooted crops to utilise water efficiently.

3.4 Crop Rotation

Crop rotation is the practice of growing different types of crops in succession on the same field to gain benefits for soil and crop systems (Fig. 3.2). The beneficial effects of this are a decrease in the incidence of weeds, insects, and plant diseases. Besides, it also enhances the soil's physical, chemical, and biological properties. While monocropping exhausts the soil of its nutrients and depletes its fertility, crop rotation helps prevent this from happening.

The use of leguminous crops in rotation practices is commonly known (Fig. 3.3). The advantages of including legumes include reduced soil erosion, restored fertility, improved soil and water conservation, and nitrogen supplementation through nitrogen fixation.

Incorporating crop residue is often beneficial in the field as it improves organic matter content in the soil and enhances overall soil health. Besides, it also reduces water requirements.

High canopy cover crops are also used in this method, as they help sustain soil fertility, suppress weed growth, decrease pest and disease infestation, and increase input use efficiency and system productivity. It also helps reduce soil erosion.

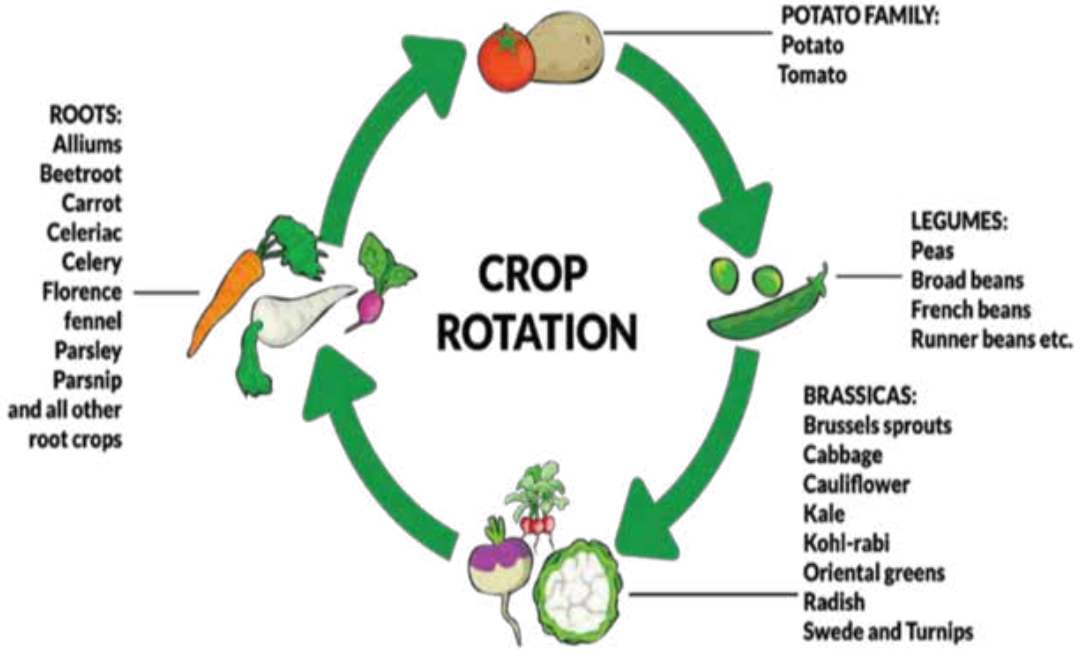

Fig. 3.2: Crop Rotation Model

Fig 3.3: Leguminous Crops for Sustainable Crop Rotations

Crops' rotation conserves soil moisture, breaks pest cycles, and improves soil structure.

Example Rotation: Maize → Cowpea → Sorghum → Green manure

Rotation Principles:

- Alternate deep-rooted crops (e.g., cotton, pigeon pea) with shallow-rooted crops (e.g., mung bean, green gram).
- Introduce short-duration legumes after water-intensive crops to replenish soil nitrogen and retain moisture.
- Rotate crops with different growth periods to prevent excessive water demand at one time.

3.5 Cover Crops

Cover crops are close-growing crops with high canopy density, grown to protect the soil against erosion. Cover crops entail benefits such as soil protection from erosion by providing ground cover. Effective cover crops develop a canopy that intercepts raindrops, reducing soil surface exposure to erosion. Legume crops produce better biomass compared to row crops, offering enhanced soil protection. They also provide better protection against runoff and soil loss compared to cultivated fallow and sorghum crops. Some examples of effective cover crops are cowpea, green gram, black gram, and groundnut. The guidelines for selecting cover crops are as follows:

3.5.1 Timing

- Sow cover crops immediately after harvest of main crops or between rows of orchard trees.

- In multi-cropping systems, choose short-duration cover crops to avoid competition with the main crop.

3.5.2 Selection Criteria

- **Legumes:** Cowpea, Green gram, Black gram, Groundnut, Sunhemp, Dhaincha – for nitrogen fixation and biomass.
- **Non-legumes:** Sorghum or millet residues – for additional mulch, especially in drylands.
- Consider root depth, canopy density, and water requirements for your field conditions.

3.5.3 Planting Methods

- **Broadcasting:** Scatter seeds evenly over the field, then lightly rake or press them into soil.
- **Row sowing:** Plant along existing field rows for better spacing and growth uniformity.
- **Intercropping:** Plant cover crops between rows of main crops to protect soil without affecting main crop yield.

3.5.4 Management Practices

- Maintain cover crops until full canopy development (30–50 days).
- Incorporate biomass into soil after flowering for green manure.
- Avoid burning residues; instead, chop and mulch to improve soil moisture and microbial activity.

3.5.5 Monitoring and Maintenance

- Check for pests and diseases; most cover crops are hardy, but early intervention is better.
- Ensure uniform growth to maximise soil coverage.

Table 3.2 gives a summary of few cover crops with their applications.

Table 3.2: Choice of Cover Crops and Benefits

Cover Crop	Type	Duration, days	Benefits	Ideal Use
Cowpea	Legume	45-60	N-fixation, biomass, erosion control	Post-harvest or intercrop
Green gram	Legume	30-45	Quick biomass, moisture retention	Between rows, small fields

Cover Crop	Type	Duration, days	Benefits	Ideal Use
Black gram	Legume	30-50	N-fixation, suppresses weeds	Short-duration cover crop
Groundnut	Legume	60-70	High biomass, erosion control	Dryland fields

Source: ICAR (2011); FAO (2017).[13]

3.6 Intercropping

Intercropping involves cultivating two or more crops simultaneously in the same field with a definite or alternate row pattern (Fig. 3.4). The benefits of intercropping are better soil coverage (thus, reducing direct impact of raindrops), erosion control and nutrient management (crops with different rooting patterns help in efficient nutrient use and prevent nutrient competition). The key considerations to be considered in intercropping are:

- **Time and Spatial Dimensions:** Intercropping involves both time-based and spatial planning.
- **Erosion Permitting and Resisting Crops:** Should be intercropped to optimise soil protection.
- **Rooting Patterns:** The crops should have different rooting patterns to maximise soil and nutrient benefits.

Fig. 3.4: Intercropping Practice

The different types of intercropping techniques are discussed below. Fig. 3.5 shows an example of intercropping.

- **Row Intercropping:** Crops are grown in specific rows.
- **Strip Intercropping:** Crops are grown in strips.
- **Relay Intercropping:** Different crops are sown at different times to overlap their growing periods.

13 *ICAR. Green manuring and cover crops. https://krishi.icar.gov.in/jspui/handle/123456789/2276*
FAO. Cover crops and crop residues for soil health. https://www.fao.org/3/i8210en/I8210EN.pdf

With the above key considerations and techniques, Table 3.3 summarises a few examples for crop selection in natural farming intercropping.

Table 3.3: Crop Selection in Natural Farming Intercropping

Main Crop	Intercrop	Rooting Pattern	Sunlight Requirement	Benefits
Maize	Cowpea	Deep + Shallow	Full sun	Nitrogen fixation, soil cover
Finger millet	Sunhemp	Medium + Deep	Full sun	Green manure, erosion control
Sorghum	Green gram	Deep + Shallow	Full sun	Soil fertility, moisture conservation
Banana	Turmeric	Deep + Shallow	Partial shade	Efficient land use, soil cover

Source: ICAR (2014); FAO (2013).[14]

Fig. 3.5: Different Types of Intercrops

3.7 Strip Cropping

Cultivating various crops in alternating strips across a field is called strip cropping. It involves growing erosion-resistant crops with deep root systems and high canopy density. These crops protect soil from raindrop impact, reduce runoff velocity, and increase concentration time, resulting in higher soil moisture and crop production. The benefits of strip cropping are primarily for runoff and erosion control, as it reduces runoff velocity and checks erosion

14 *Indian Council of Agricultural Research (ICAR). Cropping systems and intercropping practices in Indian agriculture.* https://icar.org.in/content/cropping-systems
Food and Agriculture Organisation (FAO). (2013). Intercropping for sustainable crop production. FAO, Rome. https://www.fao.org/3/i2215e/i2215e.pdf

processes. This way, even nutrient loss from the field can be minimised, and soil fertility is maintained. Strip cropping is exemplified in the five-layer model in natural farming, which promotes diverse and resilient cropping systems (Fig. 3.6.).

Fig. 3.6: Strip Cropping

The different types of strip cropping are discussed below.

3.7.1 Contour Strip Cropping

This method involves planting alternating strips of crops that either allow or resist erosion along the natural contours of a slope. The advantages of this technique are that it reduces the force of raindrops hitting the soil, preventing erosion. Additionally, it shortens the slope length and slows water movement, thereby decreasing soil loss and managing runoff. It enhances rainwater absorption into the soil profile, improving soil moisture levels.

3.7.2 Field strip cropping

Field Strip Cropping involves growing crops in parallel strips across uniform slopes, but not on exact contours. It is suitable for farms with regular slopes that are not suitable for contour strip cropping. With respect to soils, it is ideal for soils with high infiltration rates, where contour strip cropping may not be practical. The benefits of this technique include soil conservation (as it reduces soil erosion by dividing the field into manageable strips) and water management (it enhances water infiltration and reduces runoff).

3.7.3 Wind Strip Cropping

Wind Strip Cropping involves planting tall, close-growing crops in alternately arranged, straight, long, relatively narrow, parallel strips. These strips are laid out across the direction of the prevailing wind, regardless of the contour. The benefits of this technique are wind protection, wherein tall crops act as windbreaks, protecting the soil and shorter crops from wind erosion. Besides it helps in soil conservation by

reducing erosion and efficient land use as alternating strips optimise the use of land for different crop types. The crops cultivated using this technique are usually tall-growing crops, such as maize, pearl millet, and sorghum, as well as short-growing crops that are compatible and grow close to the ground.

3.7.4 Permanent or Temporary Buffer Strip Cropping

Buffer Strip Cropping involves growing permanent strips of grasses, legumes, or a mixture of both in highly eroded areas and areas that do not fit into the regular crop rotation. The benefits of this technique are erosion control, as the vegetation in buffer strips helps prevent soil erosion by wind and water. Besides, it enhances soil structure, organic matter, and reduces nutrient runoff from the soil. It provides a habitat for beneficial organisms, contributing to natural pest control. The applications of this technique are particularly useful in highly eroded areas or those prone to erosion. For example, in steep slopes, it is often used with contour strip cropping.

3.7.5 Crop Selection in Natural Farming Strip Cropping

Table 3.4 summarizes various crop selection permutations for strip cropping in natural farming.

Table 3.4: Crop Selection for Natural Farming Strip Cropping

Strip Type	Main Crop	Companion Strip	Rooting Pattern	Benefits
Contour	Finger millet	Cowpea	Medium + Shallow	Soil cover, nitrogen fixation, erosion control
Field	Okra	Sunhemp	Shallow + Deep	Fertility enhancement, runoff reduction
Wind	Sorghum	Gliricidia	Deep + Deep	Wind protection, moisture retention
Buffer	Banana	Marigold + Cowpea	Deep + Shallow	Biodiversity, pest control, erosion protection

Source: ICAR (2014); FAO (2013).

3.8 Mulching

Mulching involves covering the soil surface with live crops or straw (dead plant biomass) (Fig. 3.7). It is a very important technique with multifaceted benefits such as moisture conservation, increased water infiltration, soil temperature regulation around plant roots, erosion prevention, soil structure improvement, runoff reduction, and weed growth control. It also prevents the formation of a hard crust after rain. It creates a ‘dust mulch’ on the soil surface using blade harrows or intercultural operations. This breaks the continuity of soil moisture capillary tubes, reducing evaporation losses. The applications of this are usually in high-rainfall regions to minimise soil and water loss and in low-rainfall areas to conserve soil moisture. The different types of mulch are discussed below.

Fig. 3.7: Mulching

3.8.1 Crop Residue Mulch

The materials required for this type of mulching are dried vegetation, farm stubble, and dried biomass waste (Fig. 3.8). It protects the soil by covering and shielding it from severe sunlight, cold, and rain. It also provides seed protection by saving it from birds, insects, and animals. Thereby, it conserves moisture and enhances soil fertility, along with protecting soil organisms and supporting their growth. Crop residue mulch suppresses weed growth and also maintains soil temperature.

Fig. 3.8: Crop Residue Mulch

3.8.2 Live Mulch

Crop residue mulching can also be done with live mulch. Live mulching involves developing multi-cropping or inter-cropping patterns of short-duration crops within the rows of a main crop (Fig. 3.9). For example, combine monocotyledons (monocots) and dicotyledons (dicots) in the same field to provide a full range of essential nutrients. Monocot such as wheat and rice provide nutrients such as potash, phosphate, and sulphur whereas dicots such as pulses are nitrogen-fixing plants that enhance soil nitrogen levels.

Fig. 3.9: Live Mulch

Timing of Mulching: Apply mulch before or at the start of the rainy season when the soil is most susceptible to erosion.

Thickness: Keep the mulch layer moderate to allow seeds and seedlings to grow through it. In vegetable gardens, wait until young plants are stronger before applying mulch to prevent any negative effects from decomposition.

Application Methods:

- If mulching before sowing or planting, maintain a thin layer to ensure seedlings can emerge.
- For established crops, apply mulch after soil preparation.
- Mulch can be placed between rows, around individual plants (especially for trees), or evenly across the field.

Some mulching practices in NF are summarised in Table 3.5.

Table 3.5: Mulching Practices in NF

Main crop	Mulch type	Source	Benefits
Paddy (SRI)	Dry Mulch	Paddy straw	Moisture retention, weed suppression
Maize	Green Mulch	Cowpea, Dhaincha	Soil fertility, moisture retention
Vegetables (Tomato, Brinjal)	Live Mulch	Cowpea	Nitrogen fixation, soil cover
Orchard Trees (Mango, Banana)	Crop Residue Mulch	Groundnut or sorghum residues	Soil cover, erosion control, organic matter

3.9 Micro Irrigation in Natural Farming

Micro-irrigation encompasses systems like drip and sprinkler irrigation, which deliver water directly to the plant root zone, minimizing evaporation and runoff. In India, where agriculture accounts for approximately 80% of water usage, adopting micro-irrigation is crucial for enhancing water-use efficiency and ensuring sustainable crop production (NITI Aayog, 2023).

3.9.1 Drip Irrigation

The scientific principles of drip irrigation are as follows:

(i) **Water Use Efficiency:** Drip irrigation systems (Fig. 3.10) can achieve water-use efficiencies exceeding 90%, compared to 40–50% in traditional flood irrigation methods.[15]

(ii) **Soil Health:** By delivering water directly to the root zone, drip irrigation minimizes soil erosion and preserves soil structure, promoting healthier root development.

(iii) **Nutrient Management:** The integration of fertigation allows for precise application of nutrients, enhancing nutrient uptake and reducing leaching losses.

15 *Indian Agricultural Research Institute (IARI). (2016). Water management technologies for sustainable agriculture. New Delhi: IARI.*

Fig. 3.9: Drip Irrigation

Studies have shown that drip irrigation can increase crop yields by up to 45% in water-stressed regions of Uttar Pradesh, with significant improvements in crops like sugarcane and vegetables. Scientific evidence indicates that drip irrigation improves crop yields and water productivity and reduces irrigation water use relative to conventional irrigation systems, particularly in water-stressed regions (Yang et al., 2023)[16]. Table 3.6 summarizes some crop applications in NF for drip irrigation.

Table 3.6: Drip Irrigated Crops Grown Under NF

Crop Type	Recommended Use	Benefits of NF Practices
Vegetables	Tomato, Brinjal, Chilli, Okra etc.	Efficient water use, reduced weed growth, enhanced nutrient uptake
Fruits	Banana, Mango, Papaya, Citrus etc.	Supports canopy growth, facilitates mulching with residues
High-Value Crops	Capsicum, Cucumber, Strawberry, Herbs etc.	Reduces labour, enhances uniform growth, and prevents stress during dry spells

3.9.2 Sprinkler Irrigation

The scientific principles that govern sprinkler irrigation technologies are given below:

(i) **Uniform Distribution:** Sprinklers provide even coverage, reducing water wastage and promoting uniform crop growth (Fig. 3.11).

(ii) **Adaptability:** Suitable for undulating terrains, making it versatile for various field conditions.

16 *Yang, P., et al. (2023). Review of drip irrigation impacts on crop yield and water use efficiency. Water, 15(9), 1733.* https://doi.org/10.3390/w15091733

(iii) **Water Conservation:** Can reduce water usage by 20-40% compared to flood irrigation methods (Just Agriculture, 2021).

Fig 3.11: Sprinkler Irrigation

Sprinkler irrigation can increase crop yields by up to 30% in regions like Rajasthan, where water scarcity is prevalent. The adoption of sprinkler systems in semi-arid regions has led to a 35% reduction in water usage, thereby improving water availability for other agricultural activities (NITI Aayog, 2023). Table 3.7 summarizes some crop applications in NF for sprinkler irrigation.

Table 3.7. Sprinkler irrigation in crops grown under NF

Crop Type	Crops	Benefits of NF Practices
Field Crops	Maize, Millets, Pulses	Maintains soil moisture, reduces evaporation, and enhances nutrient uptake
Vegetables	Cabbage, Cauliflower, Leafy greens	Even growth minimizes water stress, integrates with mulching
Orchards	Citrus, Guava, Papaya	Soil moisture conservation improves fruit set, supports cover crops under trees

References & Additional Readings

- Directorate of Agriculture, ATMA & SAMETI. (n.d.). Lecture Outline Framework: Natural Farming- Curriculum. Gandhinagar, Gujarat
- NITI Aayog. (2023). EFFICIENCY OF MICRO-IRRIGATION IN ECONOMIZING WATER USE IN INDIA: LEARNING FROM POTENTIAL AND UNDER EXPLORED STATES (Report). Government of India. Retrieved from https://www.niti.gov.in/sites/default/files/2023-03/Efficiency%20of%20Micro-Irrigation%20in%20economizing%20water%20use%20in%20India%20Learning%20from%20potential%20and%20under%20explored%20states.pdf (niti.gov.in)
- TNN. (2025, June 12). *Drip & sprinkler to boost groundwater recharge in state*. *The Times of India*. Retrieved from https://timesofindia.indiatimes.com/city/lucknow/drip-sprinkler-to-boost-groundwater-recharge-in-state/articleshow/121787404.cms

CHAPTER 4

Soil Health Management Through Natural Farming

4.1 Introduction

Soil is a fundamental resource for food production and a crucial asset for farmers. The success of farming relies on soil quality, as it supplies water and vital nutrients to crops. When soil is rich and healthy, combined with adequate water and sunlight, it supports productive farming and helps achieve desired yields. Natural Farming treats soil as a living, multifunctional system, where soil organic matter, or humus, serves as a critical reservoir supporting nutrient retention, water-holding capacity, and soil structure (FAO, 2015). Incorporating farmyard manure or compost significantly enhances microbial activity and diversity, thereby increasing soil resilience and nutrient cycling through the activation of indigenous microbes (Semenov et al., 2021). Long-term use of organic amendments (e.g., FYM applied at ≥15 t/ha) markedly increases soil organic carbon, dissolved organic carbon, and key nutrient pools under pearl millet–wheat rotations (Sheoran et al., 2025). Soil pH, a key determinant of nutrient availability, can be effectively managed using natural amendments: lime in highly acidic soils-and manure or straw in moderately acidic soils-not only raise pH by 12-17%, but also improve cation exchange capacity, organic matter, and crop yield (Zhang et al., 2023). A balanced soil ecosystem, therefore, emerges from the synergy of organic carbon enrichment, microbial vitality, and pH correction, all achieved without synthetic inputs.

Indian Natural Farming experiments have reported measurable improvements in soil health parameters. ICAR–NAARM field studies under Zero Budget Natural Farming in Andhra Pradesh recorded an increase of 8–21% in soil organic carbon, 13–27% higher microbial biomass carbon, and significantly higher soil enzymatic activity compared to conventional farming systems. Similarly, long-term NF trials in soybean–maize and wheat–mustard systems reported 1.3–1.8 times higher populations of beneficial soil microbes and improved soil aggregation and moisture retention under Natural Farming practices.[17]

Soil studies[18] in soybean-maize and wheat-mustard systems show that Natural Farming supports a rich, balanced microbial community. Beneficial bacteria such as *Clostridium, Brevundimonas, Sphingomonas, Bacillus, Streptomyces*, and *Geobacter* are found in higher numbers under NF. These microbes play many important roles: *Clostridium* and *Geobacter* help in carbon cycling and decomposition, *Azoarcus* and *Anaeromyxobacter* support biological nitrogen fixation, while *Sphingomonas* and *Brevundimonas* suppress soil-borne pathogens. *Hydrogenophaga* and *Sorangium* contribute to detoxification by breaking down harmful substances. Bacillus and Streptomyces act as natural biocontrol agents against pests and diseases. A special feature of Natural Farming is that no single harmful microbe is allowed to dominate. Instead, the soil is filled with a wide variety of good microbes, keeping the system balanced and stable. This evenness enhances the soil's strength, fertility, and long-term productivity. In simple terms, Natural Farming creates a living soil where millions of tiny workers constantly support the crop. This natural support system reduces the need for

17 *ICAR–NAARM & NITI Aayog (2021). Adoption of Natural Farming and its Effect on Crop Yield and Soil Health.* https://www.niti.gov.in/sites/default/files/2021-03/NaturalFarmingProjectReport-ICAR-NAARM.pdf

Government of Andhra Pradesh & FAO (2022). Agroecological transitions: Community Managed Natural Farming in Andhra Pradesh. https://www.fao.org/family-farming/detail/en/c/1629947/

18 *All India Network Programme on Natural Farming (AINP-NF), ICAR-Indian Institute of Farming Systems Research, Modipuram, Indian Council of Agricultural Research (ICAR). (2025). Natural farming research status and future strategy. ICAR-IIFSR, Modipuram.*

chemical fertilizers and pesticides while keeping the soil resilient, healthy, and sustainable for future generations of farmers.

4.2 Soil Management

The application of operations, practices, and treatments to protect soil and enhance its performance, including soil fertility and mechanics is known as Soil Management. Key components of soil management are soil conservation, soil amendment and optimal soil health. Soil management is tailored to the specific conditions of each site, including variations in tillage and inputs based on soil conditions and available resources is called site- specific management.

Practice of soil management includes seedbed preparation, weed management and sustainability. Soil management can potentially lower or optimise production costs within an individual farm and assist in adjustments according to soil conditions, such as soil texture, moisture content, and soil pH, contributing to increased yields at reduced unit costs.

Natural farmers using conservation and minimum tillage can adjust tillage practices to reduce soil disturbance, and adjustments are made according to soil conditions, promoting soil health and stability.

4.2.1 PMDS/ Pre-season Dry Sowing (PSDS) Methods

Pre Monsoon Dry Sowing (PMDS) is a process of growing diversified crops during the off-season to keep the land covered with living roots so that microbes stay active for 365 days (Fig. 4.1). Over a period of time, the project is working towards ensuring the conversion of all PMDS NF practitioners into growing crops all round the clock, as a 365-day green cover (365 DGC).

Fig 4.1: Pre-Monsoon Dry Sowing in Rainfed Areas

In all crops, except paddy, poly-cropping (15-20%) is being widely encouraged, in addition to the main crop (80-85%)[19] . The concept of PMDS graduated from an initially practised *Navadhanya* (9-12) mode, to a very diverse 30-plus crop species (comprising all major crop groups such as Cereals, Pulses, Millets, Oilseeds, Spices & Condiments, Vegetables- Leafy, Tubers, Creepers & Others) being supplied together now, as a seed kit. The seed compositions are worked out for different districts based on the availability of seeds. The seed kit comprises 30-35 types of seeds, 12-13 kg costs about Rs. 1100 required for one acre. They are sown before monsoons with:

- Residual moisture (rainfed black soil) of preceding *rabi* crop (one week before harvest)
- Residual moisture (Irrigated system) of preceding *rabi* crop (one week before harvest)

The above-mentioned seeds are broadcast one week before the harvest of the main crop. During harvest, they are trampled into the soil, and wherever possible, a 1–2-inch mulch is provided. The ideal mulch material is observed to be groundnut shells, followed by crop residues, and then paddy straw (less preferable).

The offseason rains will help sustain life wherever feasible. *Jeevamrit* at 1-2% can be sprayed at least for part of the land. If the plants survive beyond 25 days, the benefits of microbial activity will accrue. If the irrigation facility is available, life-saving irrigation may be provided. With climate emergencies and the increasing frequency of global warming, the occurrence of offseason rain has increased manifold.

19 *Devvrat, A. (2023). Natural farming; University Publication No. GNFOAU:1:2023:1000. Gujarat Natural Farming and Organic Agricultural University. 1-174*

In bone-dry soils, PMDS seed should be pelletised and sown. The process of Palletisation is explained in the videos enclosed as a hyperlink. Efforts to ensure the survival of plants as long as possible till on onset of monsoons should be continued as above

The PMDS crop foliage is being utilised in 2 distinct methods-

(i) Incorporation of PMDS crop directly into the soil prior to the sowing of the main crop (7 to 10 days gap)

(ii) Utilisation of PMDS crop foliage as fodder and mere incorporation of crop roots

Under both systems of PMDS, in the first crop of *kharif* Paddy, yields are found to be on par with conventional methods, i.e., a chemical mode saving of ₹7,000 to ₹ 10,000 per acre.

The following salient biometric observations have come up in farmers' field where the concept of Navadhanya (PMDS) has been adopted continuously for more than 2 years

- Significantly increase in root-shoot ratio (0.312-PMDS, chemical-0.242).
- Increase in the number of beneficial insects and reduction of harmful insects due to diversified seed mix.
- Reduction in weeds in comparison with the conventional method.
- Highest Cost-Benefit ratio in the PMDS incorporated field compared to the chemical field.
- It was noted that there were incremental yield increases in paddy in the adoption of PMDS practice from 1st year to 4th year.

Several other benefits have also been observed by PMDS practitioners:

- Reduction in the cost of cultivation on account of reduced application of fertilisers and pesticides.
- Reduction in Pest and disease incidence.
- PMDS crop became resistant to lodging even in heavy rains.
- Reduction in the number of irrigations.
- Increase in yield with a higher benefit-cost ratio.
- Additional income from leafy vegetables in addition to self-consumption.
- Increase in the quantity and fat content of milk due to the use of PMDS as fodder for the cattle.
- Improvement in cattle health.
- Increase in soil carbon content.

A detailed study of the various soil health enriching inoculants such as *Jeevamrit, Ghanjeevamrit*, etc. can be found in Chapter 6 along with their applications and methods for usage.

References & Additional Readings

- BMC Plant Biology. (2025). Organic manure and fertilizer N management strategies improve soil health at different growth stages of pearl millet under pearl millet-wheat sequence. BMC Plant Biology, 25, 117. https://doi.org/10.1186/s12870-025-06128-2
- Brady, N., & Weil, R. (2008). *The nature and properties of soils* (14th ed.). Upper Saddle River, NJ: Prentice Hall.
- FAO. (2015). The importance of soil organic matter. Food and Agriculture Organisation of the United Nations. Retrieved from http://www.fao.org/3/a0100e/a0100e05.htm
- Gugino, B. K., Idowu, O. J., Schindelbeck, R. R., van Es, H. M., Moebius-Clune, B. N., Wolfe, D. W., . . . Abawi, G. S. (2009). *Cornell soil health assessment training manual* (2.0 ed.). Ithaca, NY: Cornell University.
- Jaswal, R., Sandal, S. K., Sahu, K. K., & Sharma, A. (2022). Effect of tillage on growth and productivity of rainfed maize grown with Zero Budget Natural Farming system in Himachal Pradesh. Himachal Journal of Agricultural Research, 48(01), 37–43.
- Katayama, S., et al. (2022). Impact of Natural Farming cropping system on rural households-Evidence from Solan District of Himachal Pradesh, India. Frontiers in Sustainable Food Systems, 6, 878015. https://doi.org/10.3389/fsufs.2022.878015
- Magdoff, F., & van Es, H. (2009). *Building soils for better crops: Sustainable soil management* (3rd ed., Handbook Series No. 10). Beltsville, MD: Sustainable Agriculture Network.
- Semenov, M. V., Krasnov, G. S., Semenov, V. M., Ksenofontova, N., Zinyakova, N. B., & van Bruggen, A. H. (2021). Does fresh farmyard manure introduce surviving microbes into soil or activate soil-borne microbiota?. Journal of Environmental Management, 294, 113018.
- Sheoran, S., Prakash, D., Raj, D., Yadav, P. K., Singh, R., Gupta, R. K., ... & Khan, S. (2025). Organic manure and fertilizer N management strategies improve soil health at different growth stages of pearl millet under pearl millet-wheat sequence. *BMC Plant Biology*, *25*(1), 117.
- Tugel, A., Lewandowski, A., & Happe-vonArb, D. (Eds.). (2000). *Soil biology primer* (Rev. ed.). Ankeny, IA: Soil and Water Conservation Society.
- Zhang, S., Zhu, Q., de Vries, W., Ros, G. H., Chen, X., Muneer, M. A., ... & Wu, L. (2023). Effects of soil amendments on soil acidity and crop yields in acidic soils: A world-wide meta-analysis. *Journal of Environmental Management*, *345*, 118531. https://doi.org/10.1016/j.jenvman.2023.118531

CHAPTER 5

Pest and Disease Management

5.1 Introduction

Pest management focuses on cultivating healthy crops that can naturally withstand pest and disease pressures. Natural farming regulates pest populations through natural processes, while the use of locally adapted crop varieties further reduces the risk of infestation. Soil fertility plays an essential role, as balanced nutrient levels and suitable pH strengthen plant defences against infections and favourable climatic conditions, adequate water supply and optimal temperatures support plant health. Practices such as maintaining crop diversity, improving soil health, and managing water resources work together to create resilient farming systems that minimise the occurrence of pests and diseases without relying on synthetic pesticides.

5.2 Prevention

Natural farming emphasises a proactive and preventative approach to pest and disease management, focusing on creating resilient agricultural ecosystems rather than reacting to outbreaks. This methodology begins with the foundational selection of suitable plant varieties that are well-adapted to local environmental conditions and exhibit natural resistance to prevalent pests and diseases. The use of carefully inspected healthy seeds and planting materials is crucial to prevent the introduction of pathogens.

A cornerstone of this approach is the implementation of diverse cropping systems, such as mixed cropping and regular crop rotation, which disrupts pest and disease cycles and encourages a habitat for beneficial insects. Furthermore, practices like green manuring and the use of cover crops enhance soil biological activity and fertility.

Central to this preventative strategy is the meticulous management of soil health. This includes the application of moderate fertilisation to promote steady, strong plant growth and increasing soil organic matter to boost beneficial microorganisms that suppress pathogenic fungi. Appropriate soil cultivation methods and effective water management further contribute to maintaining optimal soil conditions. The conservation and promotion of natural enemies of pests is another key strategy to maintain ecological balance. Tactical measures, such as selecting the optimal planting time, ensuring sufficient spacing between plants to improve aeration, and diligently removing infected plant parts and residues, are vital for preventing the spread and recurrence of diseases.

5.3 Monitoring of Pests, Insects and Diseases

Effective management of weeds, illnesses, and pests (Fig. 5.1) starts with routine monitoring. Information about the pests, diseases, and weeds in the area, village, or agricultural fields, as well as the harm they do, is required to manage them.

Fig. 5.1: Pest Surveillance

5.3.1 Pest Attack on Crops

Effective pest management begins with the correct identification of the causal agent. Crop pests can be broadly classified into several major categories based on their biological nature and the damage they cause. The typical signs of pest attacks on crop plants are described in Table 5.1, 5.2 and 5.3.

Table 5.1: Types of Crop Pests

Pest Type	Description
Insects	• Biting and chewing pests: caterpillars, weevils • Piercing and sucking pests: aphids, psyllids • Boring pests: borer, leaf miner
Mites	Tiny pests that cannot be seen with the naked eye.
Nematodes	Microscopic pests that mainly attack plant roots.

Insects can be further categorised by their behaviour and visibility, which directly influences how they are scouted and managed in the field. Understanding these characteristics helps farmers to develop more effective monitoring strategies.

Table 5.2: Characteristics of Insects

Type of Prey	Examples
Slow-Moving	caterpillars
Fast-Moving	fruit flies
Hidden	stem borer
Easy to Observe	caterpillars, weevils

Recognizing the specific signs of damage on a crop is crucial for identifying the pest responsible. This table outlines the common visual symptoms that correspond to infestations by various types of pests.

Table 5.3: Signs of Pest Damage

Pest	Symptoms
Caterpillar or Weevil	Leaves with holes or missing parts.
Aphid	Curled leaves.
Fruit Fly Larvae	Damaged or rotten fruits.
Stem Borer Larvae	Withering plants.
Borer Attack	Branches or trunks with holes.
Mite Infestation	Mites cause leaves and fruits to become yellowish.
Nematode Infestation	Nematodes attack plant roots, causing plants to turn yellow, wither, and die.

5.3.2 Disease Attacks on Crop Plants

The various causes of crop diseases are summarised below:

- **Fungi:** Responsible for an estimated two-thirds of infectious plant diseases. This includes:
  - » White and true rusts, smuts, needle casts, leaf curls, mildew, sooty moulds, and anthracnose.
  - » Most leaf, fruit, flower spots, cankers, blights, wilts, scabs, roots, stems, fruit, and wood rots.
  - » Effects: Parts of plants or the total crop plant can wither and die.
- **Bacteria:** cause four main problems, such as
  - » **Enzyme Production:** Breaks down plant cell walls, causing rot.
  - » **Toxin Production:** Damages plant tissues, leading to early plant death.
  - » **Sticky Sugars:** Block plant channels, preventing water uptake and leading to rapid plant death.
  - » **Hormone Mimicry:** Causes overgrowth of plant tissue, forming tumours.
- **Viruses:** Mainly cause systemic diseases:

- » Symptoms: Chlorosis or colour change in leaves and other green parts, light green or yellow patches forming mosaic patterns.
- » Effects: General reduction in plant growth and vigour.

5.4 Management Practices

Regular and careful monitoring of pest and disease levels during critical crop growth times is essential for early intervention. It can be done in the following ways:

- **Scouting**:
  - » Regular field scouting helps in early detection and intervention.
  - » Common scouting patterns include zigzag or M-shaped routes through fields to ensure all areas are visited.
- **Use of Natural Plant Extracts**:
  - » Avoid unnecessary use of natural plant extracts to prevent harming pest predators and parasitoids.
  - » Over-application can lead pests to develop resistance.
- **Scouting Patterns:**
  - » Predetermined zigzag or M-shaped routes ensure comprehensive field coverage.
  - » Convenient and effective for teaching and implementation.

5.5 Curative Methods

This section outlines strategies to conserve natural pest enemies by minimizing pesticide use, diversifying crops, and creating supportive habitats like hedges, beetle banks, and flower strips to attract beneficial organisms. Some methods to biologically control natural enemies of pests are as follows:

- **Minimise Natural Pesticides:** Reduce the use of natural pesticides to avoid harming beneficial organisms that prey on pests.
- **Allow Some Pests:** Permit certain pests to remain in the field as they serve as food or hosts for natural enemies.
- **Diverse Cropping Systems:** Implement mixed cropping systems to create a more diverse ecosystem that supports beneficial insect life and reduces pest pressure.
- **Host Plants for Natural Enemies:** Include plants that provide food or shelter for natural enemies, such as flowers that beneficial insects feed on.
- **Enhance Floral Diversity:** Increase floral diversity within and along the boundaries of crop fields to support a broader range of beneficial organisms. There are many possibilities to enhance floral diversity within and along the boundaries of crop fields.

For habitat enhancement of the natural pest predators, the following techniques are employed-

- **Hedges** - Use indigenous shrubs known to attract pest predators and parasitoids by offering nectar, pollen, alternative hosts and/ or prey. Most flowering shrub species have this property. However, care should be taken not to use plant species that are alternative hosts of pests or diseases.
- **Beetle banks** - Strips of grass in the neighbourhood of crop fields harbour different natural pest enemy groups like carabids, staphylinid beetles and spiders. To lower the risk of weeds and plants known as host plants of crop pests and diseases, one to three native grass species can be sown in strips of 1 to 3 m.
- **Flower strips** - Three to five native flowering plant species can be sown in well-prepared seed beds, arranged in strips of 1 to 3 m on the boundary of the crop field. After flowering, seeds can be collected to renew the strip or create new ones.
- **Companion plants** - Companion plants can also attract natural pest enemies within a crop. These companion plant species can be used in the flower strips in the same way. A few (1 or 2 per 10 m^2) flowering companion plants within a crop serve as a 'service station' for natural pest enemies.

5.5.1 Mechanical Control

(i) Mass-Trapping Techniques

Mass-trapping of pests is an additional control measure (Table 5.4). They can often be quickly built with cheap materials. Some examples include:

Table 5.4: Mass-Trapping Techniques

Trap Type	Target Pests	Operational Principle & Placement	Key Considerations
Light Traps	Night-flying insects, including armyworms, cutworms, and stem borers.	An ultraviolet light source attracts insects at night. The insects fly into baffles and are directed down a funnel into a collection reservoir. The reservoir should be emptied daily, with weekly inspection and cleaning of the light source and funnel.	Deployment is most effective immediately following moth emergence, preventing egg-laying. These traps are non-selective and attract both pest and non-pest species, increasing local insect density.
Colour & Water Traps	Adult thrips.	Utilizes sticky traps in shades of blue, yellow, or white. Water traps require a minimum depth of 6 cm, a surface area of 250–500 cm^2, and a surfactant (detergent). Traps should be positioned approximately one meter above the crop canopy.	Bright colours are significantly more effective than dark shades. Cylindrical trap designs outperform flat surfaces in efficacy.

Trap Type	Target Pests	Operational Principle & Placement	Key Considerations
Yellow Sticky Traps (Fig. 5.2.)	Whiteflies, aphids, and leaf-mining flies.	Consists of yellow plastic surfaces coated with a viscous adhesive, like grease or used motor oil. Traps are positioned approximately 10 cm above the plant foliage.	Regular cleaning is necessary to maintain effectiveness. Placement must be strategic, as the colour yellow attracts both target pests and beneficial insects.
Pher-omone Traps (Fig 5.3)	Moths and other insects are attracted to species-specific pheromones (e.g., pink bollworm, brinjal shoot & fruit borer, fall armyworm)	Uses synthetic sex pheromones to lure male insects into a trap (commonly funnel, delta, or water traps). Traps are placed at crop canopy height, typically 10–15 per hectare for monitoring.	Pheromones are species-specific-choose the correct lure. Replace lures every 2–4 weeks as per the manufacturer's instructions. Used mainly for monitoring and mass trapping, not standalone control.
Bait Traps	Flies.	Perforated plastic bottles containing a liquid bait (e.g., water, cattle urine, fruit flesh, or decomposing fish, mixed with a surfactant). Traps are hung from tree branches.	Traps should be inspected every three days to monitor effectiveness and replenish the bait as required.

Fig. 5.2: Yellow Sticky Trap

Fig. 5.3: Pheromone Trap

(i) Fruit Bagging for Protection

- Prevents fruit flies from laying eggs and shields produce from physical damage.
- Works well for fruits like melons, mangoes, guavas, avocados, and bananas.

- A simple and cost-effective method involving newspaper bags or plastic covers.
- Bags should be securely tied, ensuring fruits do not touch the material.
- For mangoes, bagging should begin around 55–60 days after flowering.

5.6 Weed Management

In natural farming, when Farmyard Manure (FYM) is a vital farm input, it enhances the chance of adding weeds to the farming system. Sunlight is required for germinating weed seeds, but when mulching is applied on the field's surface, the sun rays cannot reach the weed seeds, and these germinated seeds will dry after yellowing. The remaining weeds should be removed during ploughing. However, for fruit plants older than 3 years, the weed should be removed by hoeing, not ploughing. The weeds should be removed or chopped before they reach the lowest branch of the fruit tree, and can be used as mulch (Achaddan). Additionally, it is well-researched that specific crop-weed and weed-weed suppression mechanisms are observed through smothering action and allelopathic effects. Suitable crop cycles have also been studied to demonstrate how certain species possess inherent weed suppression properties. For example, wheat crops grown after a green manure application of Dhaincha (Sesbania aculeata) and Sunflower showed considerable control over the weed Phalaris Minor. However, when introducing weed species for competitive control, care is to be taken, as they may also be invasive. As part of sustainable crop intensification and mulching, these materials can be used suitably based on local Agro-climatic conditions for weed management.

Natural Farming systems effectively suppress weed pressure through ecological strategies, such as crop diversification, mulching, and enhancing natural seed predation. Increased crop diversity at field and landscape scales can reduce weed infestation by up to 6% and increase weed seed predation by 16%, thereby moderating weed population dynamics (Allan et al., 2023). In Natural Farming, minimum tillage combined with surface mulch significantly improves soil moisture, suppresses weeds, and enhances crop emergence and water use efficiency compared to conventional tillage (Jaswal et al., 2022). Farmer surveys further highlight that managing weeds remains a key practical challenge in NF adoption, emphasizing the need for integrated, context-specific practices (Sarada & Suneel Kumar, 2018). Collectively, these biodiversity-supportive approaches reduce dependence on external inputs, enhance soil health, and promote long-term resilience of agroecosystems.

5.6.1 Companion Crop of Weeds

The roots of dicot weeds their leaves; at senescence, when the leaves fall, the micronutrients stored in the leaves are released. At senescence, when the leaves fall, the micronutrients stored in the leaves are released and made available to fruit trees. The root nodules of dicot weeds have rhizomes.

Plant indicators are the plants that represent a measure or index of the environment. Some crops are known to be specific for symptoms of a particular deficient nutrient element exhibiting characteristic symptoms. Such crops are called indicator crops

because of the deficiency of that element(s). This is mainly due to the greater demand for the component of the respective Indicator Crops. The various nutrient elements are indicated against their indicator crops in Table 5.5.

Table 5.5: Indicator Crops for the Nutrient Deficiency in Soil

Nutrient Element	Indicator Crops
Nitrogen	Cereals like maize, sorghum and pulses
Phosphorus	Tomato, maize, cereals, lucerne
Potassium	Potato, banana, cotton, lucerne
Magnesium	Cotton (leaf reddening)
Zinc	Maize, paddy ("*khaira*" disease), citrus, beans
Sulphur	Cereals, lucerne, tea (yellowing)
Copper	Citrus, cereals
Iron	Sugarcane, sorghum, citrus, and ornamental plants
Manganese	Citrus, sunflower, sugar beet
Calcium	Cauliflower, tomato (blossom end rot of fruits), sugar beet
Molybdenum	Cauliflower (Whip tail)

5.6.2 Preventive Measures

Preventive measures for weed management include the following:

- **Choosing Suitable Varieties:**
  - » Opt for plant varieties that are well-suited to local environmental conditions, including temperature, nutrient availability, and resistance to pests and diseases.
- **Ensuring Healthy Seeds and Planting Materials:**
  - » Use seeds and planting materials that have been carefully inspected to prevent the introduction of pathogens and weeds.
- **Implementing Diverse Cropping Systems:**
  - » Adopt mixed cropping to minimise pest and disease outbreaks by reducing the availability of host plants while encouraging beneficial insects.
  - » Rotate crops regularly to decrease soil-borne diseases and improve soil fertility.
  - » Utilise green manuring and cover crops to enhance soil biological activity, fostering beneficial organisms.
- **Moderate Fertilisation:**
  - » Apply moderate fertilisation to promote steady growth, making plants less vulnerable to infections. Avoid excessive fertilisation, which can result in salt damage to roots and secondary infections.

- **Organic Matter Input:**
  - » Increase organic matter in the soil to boost micro-organism density and activity, decreasing populations of pathogenic fungi and stabilizing soil structure for improved aeration and water infiltration.
- **Soil Cultivation Methods:**
  - » Use suitable soil cultivation methods to facilitate the decomposition of infected plant parts, regulate weeds that host pests and diseases, and protect microorganisms that regulate soil-borne diseases.
- **Water Management:**
  - » Implement good water management practices to maintain soil moisture and health.
- **Conservation and Promotion of Natural Enemies:**
  - » Promote the conservation of natural enemies of pests to maintain ecological balance.
- **Optimal Planting Time and Spacing:**
  - » Select the optimal planting time to avoid the vulnerable life stage of plants coinciding with high pest density.
  - » Maintain sufficient distance between plants to reduce disease spread and ensure good aeration, allowing leaves to dry off faster and hindering pathogen development.
- **Removal of Infected Plant Parts:**
  - » Remove infected plant parts (leaves, fruits) from the ground to prevent disease spread and eliminate residues of infected plants after harvesting.

5.7 Step-By-Step Weed Management Schedule

1. **Before Sowing:**
   - Solarise soil if possible (cover with polythene for 2–3 weeks).
   - Ensure proper drainage to avoid weed proliferation.
2. **At Sowing:**
   - Use mulching or intercrop legumes to suppress early weeds.
3. **Early Crop Stage (15–30 days):**
   - Light manual weeding.
   - Apply biomass mulch after first irrigation/rain.
4. **Mid-Season:**
   - Spot weeding only where necessary.
   - Allow beneficial weeds (nectar-bearing, non-invasive) to remain.

5. **Post-Harvest:**
    - Allow weeds to grow and enrich soil.
    - Use as green manure for the next crop.

References & Additional Readings

- Allan, E., et al. (2023). Both long-term grasslands and crop diversity are needed to limit pest and weed infestations in agricultural landscapes. Proceedings of the National Academy of Sciences, 120(15), e2300861120. https://doi.org/10.1073/pnas.2300861120
- Jaswal, R., Sandal, S. K., Sahu, K. K., & Sharma, A. (2022). Effect of tillage on growth and productivity of rainfed maize grown with Zero Budget Natural Farming system in Himachal Pradesh. Himachal Journal of Agricultural Research, 48(01), 37–43. Retrieved from https://hjar.org/index.php/hjar/article/view/172117
- Lecture Outline Framework: Natural Farming -Curriculum, ATMA & SAMETI Directorate, Gujarat
- Sarada, O., & Suneel Kumar, G. V. (2018). Perception of the farmers on Zero Budget Natural Farming in Prakasam District of Andhra Pradesh. The Journal of Research, PJTSAU, 46(1).
- Training manual for Organic Agriculture by Food and Agriculture Organisation of the United Nation (FAO). 2015

CHAPTER 6

Bio-Input Production Methods

6.1 Introduction

On-farm inputs enable a stable level of organic matter in the soil, numerous benefits, including improved soil structure, stimulated biological activity, and increased water retention, ultimately enhancing overall plant health. These formulations can also protect crops from pests and diseases by acting as repellents or stimulating the plant's natural defence mechanisms. The contribution of such inputs is an essential agroecological lever for preserving agricultural soil quality. A key principle of this approach is the **on-farm creation** of these inputs, empowering farmers to become self-reliant. To support a seamless transition and ensure consistent access, an alternative and supportive pathway is the **Bio-Input Resource Centre (BRC)**. These BRCs function as local hubs where farmers can procure ready-to-use, quality-assured inputs or receive training to produce them independently. This chapter details several key formulations. The preparation methods discussed can be utilised by farmers for their own **on-farm creation** or can be scaled by **BRCs** to serve the broader community.

Inputs in Natural Farming (On-Farm Production & Bioinput Resource Centres)							
Beejamrit	*Jeev-amrit*	*Ghanjeev-amrit*	*Brah-mastra*	*Neem-astra*	*Agni-astra*	*Dashparni Ark*	Other Pest Control Formul-ations

Fig. 6.1: Overview of Inputs in Natural Farming

6.2 On-Farm Production Technology of Bio-Inputs

6.2.1 *Beejamrit*

It coats the seed with beneficial microorganisms that defend it against harmful pathogens present in the soil and on the seed coat, ensuring robust germination and a healthy seedling (Fig. 6.2). The technical composition, preparation protocol and functional mechanism of *Beejamrit* are detailed in Table 6.1 and the different compositions estimated in *Beejamrit* are given in Table 6.2.

Fig. 6.2: *Beejamrit* Preparation

Table 6.1: *Beejamrit* Formulation: Ingredients, Microbial Dynamics and Agronomic Role

Aspect	Details
Definition	A liquid microbial inoculant made from fresh cow dung, cow urine, lime, and soil. It is used as a seed treatment to provide a protective coating of beneficial microbes that improve germination and protect seedlings from pests and diseases.
Ingredients	Cow Dung: 5 kg, Cow Urine: 5 litres, Lime: 50 grams, Bund Soil: 100 gms, Water: 20 litres.
Preparation	1. Wrap 5 kg of cow dung in a cloth and hang it in 20 litres of water for 12 hours. 2. Separately, mix 50 g lime in 1 litre of water and let it settle overnight. 3. The next day, squeeze the dung bundle in the water three times to release its essence. 4. Add the bund soil, the 5 litres of cow urine, and the settled lime water to the solution and stir well. Keep them aside for 24 hours 5. Twice a day, stir the mixture with a wooden stick.
Application	Apply the solution as a coating to seeds by hand and let them dry completely before sowing. For thin-coated leguminous seeds, a quick dip followed by drying is sufficient.
Mode of Action	*Beejamrit* functions through a dual mechanism: **1) Microbial Inoculation:** Beneficial microbes colonise the seed and root zone (rhizosphere), enhancing nutrient availability and suppressing pathogens. **2) Chemical Elicitation:** Bioactive metabolites prime seeds for systemic defense and pathogen resistance.
Functional Microbes	Contains high populations of: • **Free-living nitrogen fixers (FNFs):** *Azotobacter*, *Azospirillum* (~10^9 CFU/mL). • **Phosphate-solubilizing bacteria (PSBs):** *Bacillus*, *Pseudomonas* (~10^8 CFU/mL).
Bioactive Compounds & Their Functions	• **Antimicrobial/Antifungal:** Pinocembrin, Enterolactone, Cicloprofen. • **Insect Repellent/Insecticidal:** Mevastatin, Gitoxigenin, Prednisolone. • **Herbicidal:** 4-tert-butylcalixarene. • **Seed Longevity:** Columbianetin, Lomatin. • **Plant Defence & Growth:** Clupanodonic acid, Erioflorin, Nagilactone, Catalpol. • **Antioxidant:** Ubiquinol.
Optimal Use Period	Most effective when used fresh (within 2–3 days of preparation) for the highest microbial activity. Prolonged storage reduces the presence of fungi and actinomycetes, causing the pH to drop.

Aspect	Details
Effect of Cow Breed	Using ingredients from native breeds may lead to higher initial counts of fungi and actinomycetes.

Table 6.2: Different compositions estimated in *Beejamrit*

Parameter	Unit	Value
N	%	0.72-2.38
P	%	0.12-0.14
K	%	0.23-0.49
Bacteria count	CFU/ml ($x10^8$)	5.37-6.10
Fungal count	CFU/ml ($x10^4$)	3.42 -4.05
Actinomycetes count	CFU/ml ($x10^5$)	2.90 -3.85

(Source: The All India Coordinated Research Project on Integrated Farming System)

6.2.2 *Jeevamrit*

Jeevamrit is an important liquid formulation in natural farming. It is not a fertilizer in the conventional sense, but a potent microbial culture designed to inoculate the soil with beneficial microorganisms (Fig. 6.3). This living solution enhances nutrient availability for plants and stimulates biological activity, building a vibrant and healthy soil ecosystem.

Fig. 6.3: Use of *Jeevamrit* as a Foliar Spray

The technical composition, preparation protocol and functional mechanism of *Jeevamrit* are detailed in Table 6.3 and the different compositions estimated in *Jeevamrit* are given in Table 6.4.

Table 6.3: *Jeevamrit* Formulation: Ingredients, Microbial Dynamics and Agronomic Role

Aspect	Details
Definition	A liquid microbial culture used in Natural Farming to enrich the soil and improve plant health. It is prepared by fermenting cow dung, cow urine, jaggery, pulse flour, water, and sometimes soil.
Ingredients	Fresh Cow Dung: 10 kg, Cow Urine: 8-10 litres, Jaggery: 1.5 - 2 kg, Pulses Flour: 1.5 - 2 kg, Uncontaminated Soil: 500 gm, Water: 180 litres.
Preparation	1. Mix all ingredients in 200 litres of water and stir thoroughly. 2. Allow the mixture to ferment in the shade for 2 to 3 days. 3. During fermentation, stir the solution in a clockwise direction for two minutes with a wooden stick twice daily (morning and evening) and cover the container with gunny sacks.
Application	• Apply every fortnight, either by spraying directly on crops or by adding it to irrigation water (at a rate of 200 litres per acre). • The prepared solution can be stored and used within 7 days in the summer season and 8-10 days in the winter season.
Microbial Composition	• Contains high counts of Nitrogen-fixers (~10^8–10^9 CFU/mL), Phosphorus-solubilisers, Potassium-mobilizers, and IAA-producing bacteria, with peak populations reached around 48 hours. • **Dominant Genera include:** *Bacillus*, *Pseudomonas*, *Aeromonas*, and *Ochrobactrum*.
Bioactive Compounds & Their Functions	• **Antifungal/Fungistatic:** Diffractaic acid, Benzoic acid. • **Antibacterial:** Daphnin. • **Insecticidal/Insect Repellent:** α-Selinene, ar-Turmerone, 1,4-Cyclohexanediol. • **Herbicidal:** Retinoic acid. • **Plant Growth & Stress Tolerance:** Stigmasterol.
Chemical Properties	**pH:** The initial pH of the solution is typically between 7.5 and 8.5.

Table 6.4: Different compositions estimated in *Jeevamrit*

Parameter	Unit	Value
N	%	0.25-1.40
P	%	0.13-0.42
K	%	0.26-0.31

Parameter	Unit	Value
Bacteria count	CFU/ml ($x10^8$)	25.47-26.53
Fungal count	CFU/ml ($x10^3$)	1.82 – 2.75
Actinomycetes count	CFU/ml ($x10^3$)	4.97-5.88

(Source: The All India Coordinated Research Project on Integrated Farming System)

6.2.3 *Ghanjeevamrit*

In addition to the liquid *Jeevamrit*, natural farming utilizes a solid version known as *Ghanjeevamrit* (Fig 6.4). Unlike its liquid counterpart, which is used for immediate nutrient and microbial delivery, *Ghanjeevamrit* can be stored for several months and is ideal for applying as a basal dose during land preparation or as a top dressing for crops. This provides a slow and steady release of beneficial microbes and nutrients directly into the root zone. The technical composition, preparation protocol and functional mechanism of *Ghanjeevamrit* are detailed in Table 6.5 and the different compositions estimated in *Ghanjeevamrit* are given in Table 6.6.

Fig. 6.4: *Ghanjeevamrit* Preparation Training

The benefits of *Ghanjeevamrit* are:

- **Nutrient Activation:** Helps the soil to activate its available nutrients and microorganisms, making them accessible to the crops.
- **Increased Earthworm Count:** Increases the number of earthworms in the soil, which is beneficial for soil fertility.
- **Nutrient Content:** *Jeevamrit* contains many nutrients such as nitrogen, phosphorus, calcium, and other micronutrients.
- **Higher Yield:** Enhances the availability of nutrients through faster decomposition of bulky organic manures and boosts microbial activity in the soil.

- **Microbial Richness:** Many formulations are rich in beneficial microflora and can act as efficient plant growth promoters.

Table 6.5: *Ghanjeevamrit* Formulation: Ingredients, Microbial Dynamics and Agronomic Role

Aspect	Details
Definition	A dry, solid, and storable form of *Jeevamrit* used as a soil amendment for long-term enrichment. It is made by briefly fermenting cow dung, urine, jaggery, pulse flour, and soil, and then drying the mixture.
Ingredients	Cow Dung: 100 kg, Jaggery: 1 kg, Gram Flour: 2 kg, Healthy Soil: 1 handful, Cow Urine: 5 litres.
Preparation	1. Thoroughly mix powdered jaggery and gram flour into the cow dung. 2. Add the handful of healthy soil and mix again. 3. Add just enough cow urine to make the mixture moist but not wet. 4. Spread the mixture in the shade to dry for 48 hours, covering it with a jute bag. 5. Once completely dry, crush and sieve the material before storing it in gunny bags.
Application	Apply at least 1000 kg per hectare at the time of sowing. An additional 50 kg per acre can be applied between crop lines during the flowering period as a nutrient boost.
Mode of Action	*Ghanjeevamrit* works through two primary mechanisms: **1) Microbial Inoculation:** Boosts soil microbial diversity and improves nutrient cycling by introducing beneficial microbes. **2) Chemical Elicitation:** The bioactive compounds suppress pathogens, regulate plant growth, and enhance stress tolerance.
Key Components	**Functional Microbes:** • Rich in free-living Nitrogen-fixers (*Azotobacter*, *Azospirillum*) and Phosphate-solubilizers (*Bacillus*, *Pseudomonas*). **Bioactive Compounds:** • **Antimicrobial:** Phenol derivatives. • **Growth & Stress Resilience:** Stigmasterol and related sterols. • **Enzyme Inhibition/Metabolism Regulation:** Phlorobutyrophenone. • **Antioxidants & Vitamins:** Butylated hydroxytoluene (BHT), Ascorbic acid 2,6-dihexadecanoate. • **Carbon Source/Signaling:** n-Hexadecanoic acid.

Aspect	Details
Chemical Properties & Use	**pH:** Typically ranges from 6.3 to 7.1. Dung from native cow breeds provides better acidity buffering. **Optimal Use:** Microbial activity peaks within the first 2 days of moist incubation (i.e., upon application to the soil). The drying process stabilizes it for long-term storage.

Table 6.6: Different Compositions Estimated in *Ghanjeevamrit*

Parameter	Unit	Value
N	%	1.05-1.80
P	%	0.16-0.30
K	%	0.68-0.85
Bacteria count	CFU/ml ($x10^8$)	29.65-30.52
Fungal count	CFU/ml ($x10^4$)	5.98-6.88
Actinomycetes count	CFU/ml ($x10^5$)	4.01-4.86

(Source: The All India Coordinated Research Project on Integrated Farming System)

6.2.4 *Brahmastra*

Brahmastra is a powerful, broad-spectrum botanical solution that acts as both an insecticide and a repellent. The formulation works by combining the bitter and alkaloid-rich properties of several potent plant leaves, which are extracted into cow urine (Fig. 6.5). This mixture must be boiled to release the active compounds, making it stronger than simple fermented solutions.

Fig. 6.5. *Brahmastra* Preparation

The ingredients, preparation method and application of *Brahmastra* are detailed in Table 6.7 and the different compositions estimated in *Brahmastra* are given in Table 6.8.

Table 6.7: *Brahmastra* Formulation: Ingredients, Preparation Method and Application

Aspect	Details
Purpose	A broad-spectrum insecticide and repellent.
Ingredients	Cow Urine: 20 litres, Neem Leaves Paste: 2 kg, Karanja Leaves Paste: 2 kg, Custard Apple Leaves Paste: 2 kg, Datura Leaves Paste: 2 kg, Castor Leaves Paste: 2 kg.
Preparation	Mix all the different leaf pastes into the 20 litres of cow urine in a large vessel. Boil this mixture on a low flame until it foams once or twice. After it has foamed, stop boiling and allow the mixture to cool in the shade for 48 hours. After 48 hours have passed, filter the solution through a muslin cloth.
Application & Storage	Dilute 6-8 litres of *Brahmastra* in 200 litres of water for a standard foliar spray on one acre. The ratio can be adjusted based on pest severity. This solution should be used within one month.[20]

Table 6.8: Different Compositions Estimated in *Brahmastra*

Parameters	Unit	Value
Organic C	%	0.67± 0.07
Total Phenolics	ppm	1351± 33
Total Flavonoids	ppm	73.3± 10.4
Total Tannins	ppm	32348± 733
Total Alkaloids	ppm	253± 7
Total Gibberellins	ppm	8066± 276

(Source: The All India Coordinated Research Project on Integrated Farming System)

Adjusting the Ratio: The ratio may be adjusted depending on the severity of the pest attack as follows:

- 100 litres of water + 3 litres of *Brahmastra*
- 15 litres of water + 500 ml of *Brahmastra*
- 10 litres of water + 300 ml of *Brahmastra*

6.2.5 *Neemastra*

One of the most fundamental and widely used pest management solutions in natural farming is *Neemastra*. This formulation is particularly effective as a first line of defense against common sucking pests, such as aphids, jassids, and whiteflies, as well as the early stages of small caterpillars. The preparation involves a simple

20 https://naturalfarming.dac.gov.in/uploads/studymaterial/GenericProtocolsforNFbyICAR.pdf?utm

fermentation process, combining neem with the microbial properties of cow dung and cow urine (Fig 6.6).

Fig 6.6. *Neemastra*

The complete list of ingredients, preparation method and application are detailed in Table 6.9 and the different compositions estimated in *Neemastra* are given in table 6.10.

Table 6.9: *Neemastra* Formulation: Ingredients, Preparation Method and Application

Aspect	Details
Purpose	To control various sucking pests like jassids, aphids, and whiteflies, as well as small caterpillars.
Ingredients	Water: 200 litres, Cow Dung: 2 kg, Cow Urine: 10 litres, Neem Leaves Paste or Seed Pulp: 10 kg.
Preparation	Mix all the ingredients together in a large drum. Stir the mixture clockwise with a long stick. Cover the drum with a gunny bag and keep it in the shade for 48 hours to ferment. Stir the solution every morning and evening in a clockwise direction. After 48 hours, filter the solution through a muslin cloth.
Application & Storage	Apply the prepared solution directly to the crops as a foliar spray without needing any further dilution. This formulation can be stored for up to 6 months.

Table 6.10: Different Compositions Estimated in *Neemastra*

Parameters	Unit	Value
Organic C	%	0.92 ±0.03
Total Phenolics	ppm	1196 ±77
Total Flavonoids	ppm	508 ±13

Parameters	Unit	Value
Total Tannins	ppm	15659 ±354
Total Alkaloids	ppm	2.39 ±0.39
Total Gibberellins	ppm	8393 ±144

(Source: The All India Coordinated Research Project on Integrated Farming System)

6.2.6 *Agniastra*

For managing more persistent pests that may not be controlled by simpler formulations, farmers can prepare *Agniastra*. This formulation incorporates hot and strong ingredients like green chilli, tobacco, and garlic (Fig 6.7), making it a powerful solution for more resilient insect pests.

Fig 6.7: *Agniastra* Ingredients

The complete list of ingredients, preparation method and application are detailed in Table 6.11.

Table 6.11: *Agniastra* Formulation: Ingredients, Preparation Method and Application

Aspect	Details
Purpose	A stronger insecticide for more resilient pests.
Ingredients	Cow Urine: 10 litres, Neem Leaves Pulp: 5 kg, Tobacco Powder: 1 Kg, Green Chilli Paste: 500 gm, Garlic Paste: 500 gm

Aspect	Details
Preparation	Mix all the ingredients in a clay pot or another suitable vessel. Stir the solution clockwise, cover it with a lid, and boil the mixture until it begins to foam. Remove the vessel from the heat and let it cool in the shade for 48 hours, stirring it twice a day during this period. After 48 hours, filter the solution through a thin muslin cloth.
Application & Storage	Dilute 6-8 litres of this formulation in 200 litres of water for a standard foliar spray. The concentration can be adjusted based on pest severity. This solution can be stored for up to 3 months.

Adjusting the Ratio:

The ratio may be adjusted depending on the severity of the pest attack as follows:

- 100 litres of water + 3 litres of *Agniastra*
- 15 litres of water + 500 litres of *Agniastra*
- 10 litres of water + 300 litres of *Agniastra*

6.2.7 *Dashaparni Ark*

The name *'Dashaparni'* literally translates to 'ten leaves,' which highlights its core principle: combining the pest-repellent properties from a diverse range of plants to create a powerful solution. This multi-ingredient concoction (Fig 6.8) is designed to act as a broad-spectrum repellent, effective against a wide array of agricultural pests. Due to its detailed recipe and specific, multi-step preparation method that involves a long fermentation period, the complete list of ingredients and step-by-step instructions are outlined in Table 6.12.

Fig 6.8. *Dashaparni Ark* Ingredients

Table 6.12: *Dashaparni Ark* Formulation: Ingredients, Preparation Method and Application

Aspect	Details
Purpose	A very broad-spectrum repellent effective against a wide range of pests.
Ingredients	Liquids: Water (200 litres), Cow Urine (10 litres). Solids: Cow Dung (2 kg), Turmeric Powder (500 gm), Ginger Paste (500 gm), Garlic Paste (500 gm), Green Chilli Paste (1 kg), Tobacco Powder (1 kg), Asafoetida (10 gm). Leaves: Paste from any 10 different bitter or repellent plant leaves (2-3 kg each).
Preparation	First, mix the water, cow urine, and cow dung, then cover and set it aside for 2 hours. Next, add the turmeric, ginger, and asafoetida, stir well, and leave it overnight. The following day, add the tobacco, chilli, and garlic pastes, stir, and leave for 24 hours. The next morning, add the paste of the 10 types of leaves. Stir everything thoroughly and allow the mixture to ferment for 30-40 days, stirring twice daily. After 40 days, filter the mixture with a muslin cloth.[21]
Application	Dilute 6-8 litres of the prepared solution in 200 litres of water and use it as a foliar spray on one acre.

6.2.8 Some Other Pest Control Formulations

Many natural farmers and NGOs have developed innovative formulations that effectively control various pests. Although none of these formulations have been subjected to scientific validation, their wide acceptance by farmers speaks of their usefulness. Farmers can try these formulations, as they can be prepared on their farms without making purchases.

For ease of use, these preparations can be grouped into two main categories based on their complexity and preparation time. The first group consists of simple recipes that are quick to prepare and ideal for addressing common, immediate needs. These are detailed in Table 6.13.

Table 6.13: Simple Formulations for Pest Control and Plant Health

Formulation Name	Primary Use / Target Pests	Key Ingredients	Preparation & Application
Diluted Cow Urine	A general growth promoter that also helps manage pathogens and insects.	Cow Urine and Water.	This is a simple dilution. Mix one part fresh cow urine with 20 parts water. Use the resulting solution directly as a foliar spray on the crops.
Fermented Curd Water	For the management of common sucking pests like whiteflies, jassids, and aphids.	Fermented curd water, also known as buttermilk or Chaach.	No special preparation is needed. The fermented liquid is used directly in its natural state. It should be applied as a foliar spray on affected plants.

21 https://naturalfarming.dac.gov.in/uploads/studymaterial/GenericProtocolsforNFbyICAR.pdf?utm

Formulation Name	Primary Use / Target Pests	Key Ingredients	Preparation & Application
Neem-Cow Urine Extract	Effective against a variety of sucking pests and mealy bugs.	Neem Leaves: 5 kg, Cow Urine, Cow Dung: 2 kg, and Water.	First, crush the 5 kg of neem leaves in a sufficient quantity of water to make a paste. To this paste, add the cow urine and 2 kg of cow dung. Allow this mixture to ferment for 24 hours, stirring it intermittently. After fermentation, filter and squeeze the extract. Dilute the final extract to a total volume of 100 litres with water and use it as a foliar spray to cover one acre.
Tutikada rasam[22]	A simple insect repellent made from a common plant.	*Datura* Leaves and Cow Urine.	This is a simple boiled preparation. Boil the *Datura* leaves in cow urine for a period of 2 to 3 hours. After boiling, allow the mixture to cool down completely. Once cool, filter it through a cloth and it is ready to be used as a foliar spray.
Jungle Ki Kanddi[23]	A liquid nutrient and microbial tonic for foliar application.	Indigenous Cow's Dung Powder (*kanddi*): 5 kg, and Water: 200 litres.	Place 5 kg of *kanddi* powder into a muslin cloth bag. Hang this bag so it is suspended in the center of a 200-litre drum of water and let it sit for 48 hours, stirring the water twice daily. After 48 hours, remove the bag, squeeze it thoroughly into the water, dip it back in, and squeeze again. Repeat the process three times. Filter the solution before spraying and use it within 48 hours.

The second group includes more advanced formulations that often require multiple ingredients, longer fermentation periods, or boiling to create potent, broad-spectrum solutions for more persistent pest issues. The methods for creating these are outlined in Table 6.14.

22 *https://www.niti.gov.in/sites/default/files/2021-03/NaturalFarmingProjectReport-ICAR-NAARM.pdf*
23 *https://naturalfarming.dac.gov.in/uploads/studymaterial/StudyMaterialforMasterTrainers.pdf?utm*

Table 6.14: Advanced Formulations for Broad-Spectrum Pest Control

Formulation Name	Primary Use / Target Pests	Key Ingredients	Preparation & Application
Mixed Leaves Extract (variation of *Brahmastra*)	A potent extract effective against sucking pests and pod or fruit borers.	Neem Leaves: 3 kg Cow Urine: 10 litres Custard Apple Leaves: 2 kg Papaya Leaves: 2 kg, Pomegranate Leaves: 2 kg Guava Leaves: 2 kg.	This is a two-part preparation. First, crush the 3 kg of neem leaves in the 10 litres of cow urine. In a separate container, crush the other leaves in water. Mix the two preparations and boil them at intervals until the total volume is reduced by half. Allow the mixture to sit for 24 hours, then filter it. Dilute 2 to 2.5 litres of this extract in 100 litres of water for application over one acre. It can be stored for up to 6 months.
Chil-li-Garlic Extract	A strong extract effective against leaf roller, stem borer, fruit borer, and pod borer.	*Ipomea* Leaves: 1 kg, Hot Chilli: 500 gm, Garlic: 500 gm, Neem Leaves: 5 kg, Cow Urine: 10 litres.	Crush all the solid ingredients the *Ipomea* leaves, hot chilli, garlic, and neem leaves together in the 10 litres of cow urine to form a suspension. Boil this suspension five times, or until its volume is reduced to half. After it has cooled, filter and squeeze the extract. Dilute 2 to 3 litres of the finished extract in 100 litres of water and use for foliar spraying over one acre.
Broad Spec-trum Formulation (Variation of *Bramhastra* / *Neemastra*)	A multi-purpose pesticide effective against a wide variety of insects.	Fresh Neem Leaves: 3 kg, Neem Seed Kernel Pow-der: 1 kg, Cow Urine: 10 litres, Green Chillies: 500 gm, Garlic: 250 gm, Water.	This is a multi-day process. First, mix the crushed neem leaves and neem seed kernel powder with 10 litres of cow urine in a copper container and allow it to ferment for 10 days. After 10 days, boil this suspension until it is reduced by half. Separately, grind the green chillies and garlic in water and let them sit overnight. The next day, mix the boiled neem extract with the chilli and garlic extracts and filter thoroughly. Use 250 ml of this concentrate in 15 litres of water for spraying.

Formulation Name	Primary Use / Target Pests	Key Ingredients	Preparation & Application
Sonthastra	A general growth promoter and pest repellent.	Ginger Powder (Sonth): 200 gm, Milk (without cream): 2 litres, Water: 202 litres total.	This preparation requires two steps. First, boil 200 grams of ginger powder in 2 litres of water until the volume reduces by half, then let it cool. Separately, slowly boil 2 litres of milk and remove the cream after it has cooled. Add both the ginger solution and the creamless milk to 200 litres of water. Mix thoroughly and cover the solution for two hours to facilitate ion exchange. Filter the final solution and spray it within 48 hours.

6.3 Bio-Inputs Resources Centres

Bio-Input Resource Centre (BRC) are conceptualised to cater to the emerging needs of inputs for the transition from conventional farming to natural farming. A Bio-Input Resource Centre (BRC) serves as a valuable hub for supplying sustainable and eco-friendly agricultural inputs. It acts as a comprehensive resource and knowledge centre for the use of bio-inputs in the transition to natural farming, as well as a centre for the production, marketing, and sale of bio-inputs. These are produced within the village cluster using sustainable methods, ensuring quality and accessibility for local farmers. A BRC may be promoted as a 'One Stop Facilitation Centre (OSFC)' for natural farming inputs for the farmers of a village or a cluster of contiguous villages.

BRCs can be established by an FPO, SHGs, PACS, dairies, *gaushalas* etc. Additionally, individual farmers with livestock and access to byproducts (such as cow dung and urine) may also set up BRCs (Fig 6.9). FPO/SHG/PACS/Dairy/Gaushala may source the raw materials such as cow urine and dung. Local communities/panchayat/block officials may fix raw material costs. Quality of the inputs may be assured through testing by the laboratories of State Agricultural Universities (SAUs), ICAR Institutes, private universities or any other laboratory notified by the Central or State Government as specified in FCO.

Fig 6.9: A Bio-Input Resource Centre Run by Mrs. Konda Usharani from Andhra Pradesh

(Source: RySS)

Every selected block should estimate the demand for inputs and viability for BRCs in consultation with the local communities and estimate the number of BRCs as needed. A farmer friendly app maybe developed in a regional language wherein the farmers can register and mention their requirements. The BRCs can also register and connect with farmers. Every model BRC can cater to 500-1000 farmers, and eventually, 10,000 farmers, in turn, will reach out to around 50 lakh-1 crore farmers in 3 years. BRCs may establish biofertilizer production units and other similar enterprises to promote the concept of waste to wealth and circular economy. Market development assistance (MDA) and similar benefits may be extended to willing BRCs. The following is an indicative list of inputs that maybe prepared at a BRC:

- *Beejamrit*
- *Jeevamrit*
- *Ghanjeevamrit*
- *Neemastra*
- *Agniastra*
- *Brahmastra*
- *Dashparni Ark*

Fig. 6.10: A BRC in Andhra Pradesh

(Source: RySS)

6.3.1 Infrastructure for BRCs

The working area required for BRCs is minimum 500 square metres of open space. Besides, a closed space for housing equipment, handling preparations, mixtures, storage, etc. is required. The equipment required at a BRC should include a grinder, mixer, fermentation/formulation tanks (as needed), storage and transportation tanks, sprayers, and other necessary tools. Besides this, a BRC should also have an administration, sales and accounting unit as well as waiting lobby for the farmers / buyers, equipped with AV display screen, sufficient furniture, various AV material on local crop advisories, application of bio-inputs and information related to natural farming. Power connection and water supply facilities are required in both the working and service area.

The fermentation tanks of BRC, cow dung and cow urine requirement for various products are as given in Table 6.15. (Note: On an average, one cow sources 10 kg of dung and 7 litres of urine per day)

Table 6.15: Cow Dung and Cow Urine Requirement for Various Products in Fermentation Tanks of BRCs

Input	Tanks and capacity	Cow dung	Cow urine
Beejamrit	1 tank x 1000 litres	165 kg	165 litres
Jeevamrit	6 tanks x 5000 litres	1500 kg	1500 litres
Ghanjeevamrit	-	5000 kg	250 litres
Neemastra *Brahmastra* *Agniastra*	1 tank x 1000 litres	9 kg	1485 litres
Dashparni Ark	1 tank x 1000 litres	8.5 kg	43 litres
Total	**9 tanks**	**6682.5 kg**	litres

(Source: Authors' Calculations)

6.3.2 Models for Preparations of Various Bio-Inputs at BRCs

(i) *Jeevamrit*

Model-1:

- Number of cows required: 10-25
- 6 tanks (each with a capacity of 5000 litres)
- Can cater need up to 150 acre or 50-100 farmers at a time on daily basis and 500 to 1000 farmers in one month
- Requirements for 1 tank (5000 litres): 250 kg cow dung
  250 litres cow urine
  45 kg jaggery
  45 kg gram flour
  4250 litres water
- Requirements for 6 tanks: 1500 kg cow dung
  1500 litres cow urine
  270 kg jaggery
  270 kg gram flour
  25500 litres water

The cost for establishing the automation plant for *Jeevamrit* production with 6 tanks and the recurring costs are as given in Table 6.16 and Table 6.17.

Table 6.16: Costs involved for establishing the automation plant for *Jeevamrit* production

S. No.	Particulars	Cost in Rs.
1.	Construction cost of cowshed	60,000
2.	Cost of water tank, mixing tank and *Jeevamrit* tanks	2,40,000
3.	Installation of electric motors 2hp (3 nos.)	30,000
4.	Air compressor	15,000
5.	Mud pump	15,000
6.	Accessories and fittings	40,000
7.	Total cost of automation plant for *Jeevamrit* preparation	4,00,000

(Source: Authors' Calculations)

Table 6.17: Recurring costs in an automated plant for *Jeevamrit* preparation (5000 litres).

S. No.	Particulars	Cost in Rs.
1.	Cost of jaggery @ 50 Rs/kg (45 x50)	2,250
2.	Cost of gram flour @ 60 Rs/kg (45x 60)	2,700
3.	Electricity	300
4.	Labour	150
5.	Total cost for 5000 l	5400

(Source: Authors' Calculations)

Thus, the per litre cost for production of *Jeevamrit* is approximately 1 Rupee. The flow diagram for production is as given in Fig.6.11.

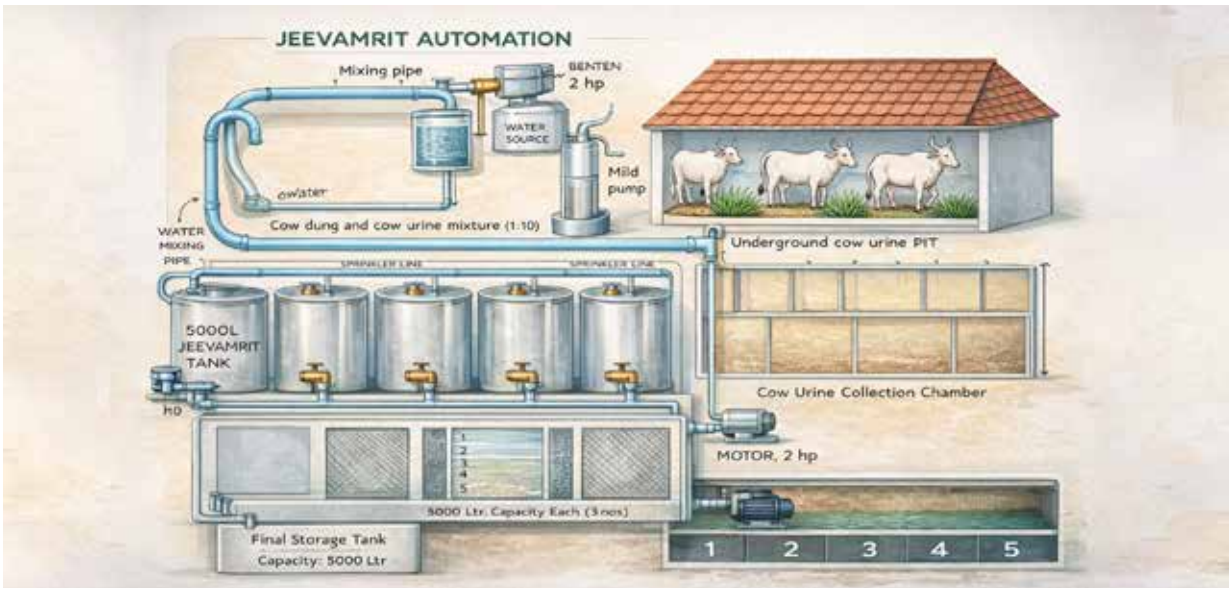

Fig. 6.11: Sketch of Automation Plant for *Jeevamrit* Production

Process flow of *Jeevamrit* automation plant

- Step-1: Collection of cow urine: The cowshed shall be constructed with enough slope on the floor to collect cow urine in the underground collection chamber through an underground pipe.
- Step-2: Mixing cow urine, dung, and water: Collected cow urine is mixed with cow dung and water using a mud pump and a 2 HP motor.
- Step-3: *Jeevamrit* preparation: The mixture of cow urine, dung, and water is passed to the *Jeevamrit* tank. Jaggery, soil, and gram flour are added to the mixture. The mixture is then stirred for three days with the help of an air compressor.
- Step-4: Filtering and storing *Jeevamrit*: *Jeevamrit* is ready for use after three days of stirring. The mixture is passed through three filters to remove any impurities and then stored in a separate storage tank for future use.

Some sample photos of an automated *Jeevamrit* preparation unit are shown from Fig.6.12 to 6.14.

Fig. 6.12: Cow Shed and Mixing of Cow Dung and Urine

Fig. 6.13: *Jeevamrit* Tanks


Fig. 6.14: *Jeevamrit* Filtration and Storage Tank

Model-2:

- Number of cows 50 - 100
- 6 tanks (each with capacity of 10000 litres)
- Can cater up to 300 acre or 100-200 farmers at a time and 1000 to 2000 farmers in one month.
- Requirements for 1 tank: 500 kg cow dung
  500 l cow urine
  90 kg jaggery
  90 kg gram flour
  8500 l water
- Requirements for 6 tanks: 3000 kg cow dung
  3000 l cow urine
  540 kg jaggery
  540 kg gram flour
  51000 l water

The estimated cost of production for 1 tank with capacity of 10000 l is as given in Table 6.18.

Table 6.18: Recurring cost for *Jeevamrit* preparation (10000 litres)

S. No.	Particulars	Cost in Rs.
1.	Cost of jaggery @ 50 Rs/kg (90 x50)	4,500
2.	Cost of gram flour @ 60 Rs/kg (90 x 60)	5,400

S. No.	Particulars	Cost in Rs.
3.	Electricity	1000
4.	Labour	500
5.	Total cost for 10000 l for 1 time	11,400

The cost for the production of *Jeevamrit* per liter is approximately Rs 1.14.

Model-3:

This model is suitable for FPOs, cooperatives and SHGs who are not rearing livestock. Cow dung and urine may be collected from the FPO/SHG members @ Rs. 0.70 - 1 /kg. The cost of establishment for automation plant of *Jeevamrit* and the recurring costs of production are as given is Table 6.19 and Table 6.20.

Table 6.19: Establishment costs involved in *Jeevamrit* production Model-3.

S. No.	Particulars	Cost in Rs.
1	The construction cost of the water tank, mixing tank and *Jeevamrit* tanks	2,40,000
2	Installation of electric Motors 2 hp (3 nos.)	30000
3	Cost of Air compressor	15000
4	Cost of Mud Pump	15000
5	Cost of accessories and fittings	40000
6	Total cost of automation plant for *Jeevamrit* preparation	3,25,000

(Source: Authors' Calculations)

Table 6.20: Establishment costs involved in *Jeevamrit* production Model-3.

S. No.	Particulars	Cost in Rs.
1.	Cost of cow dung collection @ 1 Rs/kg	250
2.	Cost of cow urine collection @ 1 Rs/l	250
3.	Cost of jaggery @ 50 Rs/kg (45 x50)	2250
4.	Cost of gram flour @ 60 Rs/kg (45x 60)	2700
5.	Electricity	3
6.	Labour including transportation	700
7.	Total cost for preparing 5000 l *Jeevamrit* for 1 time	6,153

(Source: Authors' Calculations)

The cost of production of *Jeevamrit* per liter in this model is approximately Rs. 1.23.

(ii) *Ghanjeevamrit*

Ghanjeevamrit can be produced with the following proposed model:

Model-I: For preparation of 100 kg *Ghanjeevamrit* (Table 6.21)

Table 6.21: Raw materials required for preparation of 100 kg *Ghanjeevamrit*

S. No.	Particulars	Quantity
1.	Indigenous cow dung	100 kg
2.	Indigenous cow urine	5 litres
3.	Jaggery	1 kg
4.	Gram flour (pigeon pea, gram, green gram or black gram)	2 kg

- Ready for use in 2 days and can be stored upto 1 year.
- Dosage: When sowing or planting any crop, 320 kg/acre in the first year, 200 kg/acre in the second year and 80 kg/acre in subsequent years.
- BRCs can prepare and store this in off season.
- No specific infrastructure required other than an area for mixing and storage.

Model-II: For preparation of 5000 kg *Ghanjeevamrit*

For 5000 kg *Ghanjeevamrit*, the requirement is of-

- 5000 kg cow dung
- 250 l cow urine
- 50 kg jaggery
- 100 kg gram flour

The associated costs may be referred to, from the Tables in *Jeevamrit* models.

(iii) *Neemastra*

The proposed model for the preparation of 1000 litres *Neemastra* at BRC is as follows:

- 1 tank of 1000 l
- 9 kg cow dung
- 45 l cow urine
- 45 kg paste of neem leaves
- 900 l water

(iv) ***Bramhastra***

1000 litres of *Bramhastra* can cater to approximately 125 – 200 acres. The proposed model for *Bramhastra* preparation of 1000 litres is as given below:

- 1 tank of 1000 l:700 l of cow urine
- 70 kg of neem leaves
- 70 kg of karanj leaves
- 70 kg of sitafal leaves
- 70 kg of datura leaves

(v) *Agniastra*

1000 l of *Agniastra* can cater to approximately 125 – 200 acres. The proposed model for *Agniastra* preparation of 1000 litres as as follows:

- 1 tank of 1000 l
- 740 l of cow urine
- 18.5 kg of chilli paste
- 18.5 kg of garlic paste
- 37 kg of neem paste
- 37 kg of chewing tobacco

(vi) Dashparni Ark

The proposed model for preparation of 1000 litres *Dashparni Ark* is as below (Table 6.22). We need a 1000 litres tank. 1000 l *Dashparni Ark* can cater up to 125 acres.

Table 6.22: Raw materials required for preparation of *Dashparni Ark* in 1000 l tank

S. No.	Ingredients	S. No.	Ingredients
1.	850 l of water	13.	8.5 kg of belpatra leaves
2.	43 l cow urine	14.	8.5 kg of mango leaves
3.	8.5 kg cow dung	15.	8.5 kg of dhatura leaves
4.	2 kg turmeric powder	16.	8.5 kg of basil leaves
5.	2 kg ginger paste	17.	8.5 kg of guava leaves
6.	45 gram asfoetida powder	18.	8.5 kg of desi bitter gourd leaves
7.	4.25 kg of chewing tobacco powder	19.	8.5 kg of papaya leaves
8.	4.25 kg of spicy chilli paste	20.	8.5 kg of turmeric leaves
9.	2 kg of garlic paste	21.	8.5 kg of ginger leaves
10.	8.5 kg of neem leaves	22.	8.5 kg of acacia leaves
11.	8.5 kg of karanj leaves	23.	8.5 kg of custard apple leaves
12.	8.5 kg of castor leaves	24.	800 grams of ginger powder

Note: The first 5 ingredients are mandatory. The rest of the ingredients must be taken depending on the availability from 6 to 24.

6.4 Schemes for Setting up of BRCs

The following ongoing schemes maybe converged for the setting up of BRCs:

- National Mission on Natural Farming (NMNF): NMNF targets establishing 10,000 BRCs as local hubs for producing, supplying, and training in natural farming inputs like bio-fertilizers and botanical extracts. Each Bio-Input Resource Centre (BRC) receives financial assistance of ₹1 lakh.
- Central Sector Scheme "Formation and Promotion of 10,000 new Farmer Producer Organisations (FPOs)" of Rs. 6865 crore by Ministry of Agriculture and Farmers' Welfare (M/o A&FW) wherein financial assistance of up to Rs. 18 lakhs is provided per FPO.
- MGNREGA
- *Mahila Kisan Sashakti karan Pariyojana* (MKSP) under NRLM

References & Additional Readings

- National Centre for Organic and Natural Farming. (n.d.). Home. Retrieved from https://ncof.dacnet.nic.in/
- Regional Centre of Organic Farming. (n.d.). Indigenous Technical Knowledge (ITKs) - Crop-wise with reference to organic progressive farmers practices. Bhubaneswar, Odisha: Regional Director.

CHAPTER 7

Certification & Marketing

7.1 Introduction

Certification is the formal process by which an accredited body provides written assurance that a product, process, or service conforms to specified standards. Certification in natural farming serves as a verifiable guarantee to consumers, stakeholders, and regulatory bodies that farming practices meet stringent, predefined criteria for sustainability and chemical exclusion. This process is important to establish credibility and transparency in the marketplace.

7.2 Importance of Certification

The role of certification extends beyond a label. It is an essential mechanism that establishes the credibility and commercial viability of the entire organic ecosystem. Its primary functions and benefits are as given below:

- **Market Credibility and Consumer Confidence:** A certification mark acts as a trusted signal of quality and authenticity, distinguishing genuine products from unsubstantiated claims and building consumer trust.
- **Enhanced Market Access:** Certification is often a prerequisite for entry into premium domestic and international markets. For exports, a recognised certification like the **National Programme for Organic Production (NPOP)** is mandatory.
- **Process Integrity and Quality Assurance:** The rigorous standards and mandatory record-keeping enforce discipline and traceability throughout the supply chain, ensuring the integrity of the agricultural process from farm to consumer.
- **Price Premium and Economic Viability:** Certified products typically command a higher market price, providing farmers with a better return on their investment and compensating for the transition to sustainable methods.
- **Promotion of Sustainable Agriculture:** Adherence to certification standards inherently promotes practices that improve soil health, conserve biodiversity, and protect the environment.

7.3 Major Certification Systems in India

Certification in India is primarily process-oriented, focusing on the methods of cultivation and handling rather than solely on testing the final product. The principal systems are designed to cater to different scales of operation and market destinations.

7.3.1 National Programme for Organic Production (NPOP)

The National Programme for Organic Production (NPOP) represents India's apex regulatory framework for organic certification, established to ensure that products meet globally recognised standards.

- **Scope:** This is India's official and internationally recognised certification program, primarily geared towards the **export market**. It was established in 2001 under the Agricultural and Processed Food Products Export Development Authority (APEDA).
- **Methodology:** NPOP employs a **third-party verification system**. Independent, accredited agencies conduct inspections and audits to ensure

compliance.

- **Standard:** The program's standards are aligned with international benchmarks, including those of the International Federation of Organic Agriculture Movements (IFOAM), ensuring global acceptance.
- **Designation:** Products certified under this system are authorised to use the **"India Organic"** seal. Due to its rigorous nature and associated costs, it is predominantly used by large-scale producers and commercial enterprises.

7.3.2 Participatory Guarantee System (PGS) - India

As an alternative to the third-party model, the Participatory Guarantee System (PGS) - India was developed as a community-centric quality assurance mechanism tailored for small-scale farmers and domestic markets.

- **Scope:** PGS is an alternative certification framework designed specifically for the **domestic market**, with a focus on small and marginal farmers.
- **Methodology:** It operates on a peer-review model where farmers in a local group assess and verify each other's practices. It is a **first-party certification system** built on a foundation of collective trust.
- **Principles:** The system is founded on transparency, shared ownership, and community participation. It is highly cost-effective, though the certification process can take up to three years.
- **Designation:** PGS has its own distinct logo, recognised within India for products sold domestically.

7.3.3 "In-Conversion to Organic" Certification

Recognizing that the transition from conventional to organic farming is not immediate, the "In-Conversion" category provides a formal status for farms during this interim period.

- **Purpose:** This is a transitional certification applicable to farms moving from conventional to organic practices, a process that typically requires a 2-3 year period.
- **Function:** It allows farmers to market their produce under a specific "in-conversion" label during this transition. This provides early market access and maintains transparency for consumers regarding the product's status, aligning with international standards like the Codex Alimentarius.

7.3.4 Residue-Free or Chemical-Free Certification

Distinct from the process-oriented organic certifications, Residue-Free or Chemical-Free certification is a product-focused validation that concentrates on the final output.

- **Focus:** This certification's primary goal is to validate that the final agricultural produce is free of detectable pesticide residues.

- **Methodology:** Verification is achieved primarily through end-product laboratory testing. While farming practices are considered, the emphasis is on the quantifiable absence of chemicals in the harvested product.
- **Application:** This serves as a direct assurance to consumers concerned about chemical residues and can function as an intermediate step for farmers aspiring to achieve full organic status.

7.4 How to Apply for Certification

The process for obtaining certification depends on the system a farmer or group chooses to adopt. Each system has a structured application and verification path to ensure standards are met. The following outlines the general steps for applying under the primary certification systems available in India.

7.4.1 Applying for Participatory Guarantee System (PGS) - India

The PGS certification process is a peer driven and community managed system. Farmers who wish to get certified must follow a series of collective actions as depicted in Fig. 7.1.[24]

Form a Local Group: The first step is to form a local group or cluster with a minimum of five farmers. An ideal group size is between 50 to 100 members, which allows for effective cooperation and management.

Group Registration: The group must select a leader and register with the designated Regional Council. Each farmer in the group is required to fill out a self-declaration form, making a formal commitment to practice natural farming according to the prescribed standards.

Training and Meetings: All members must attend regular training programs to understand natural farming practices and PGS certification procedures. The group must conduct regular meetings for planning inspections and making decisions, with each member required to attend at least half of the meetings annually.

Peer Inspection: The core of the PGS process is peer appraisal. An inspection team of at least three members from within the group is formed. This team inspects the farm of each member to verify that the practices align with the self-declaration and natural farming standards.

Form a Local Group: The first step is to form a local group or cluster with a minimum of five farmers. An ideal group size is between 50 to 100 members, which allows for effective cooperation and management.

Fig. 7.1: Stepwise Process of Participatory Guarantee System (PGS) Certification under PGS-India

24 *efaidnbmnnnibpcajpcglclefindmkaj/https://pgsindia-ncof.gov.in/Default/assets/front/PDF/Revised_PGS_India_Guidlines.pdf*

7.4.2 Applying for National Programme for Organic Production (NPOP)

The NPOP certification process is a more formal, third party system, which is essential for farmers and businesses aiming for the export market.[25]

(i) **Select an Accredited Agency:** The applicant, either an individual farmer or a producer group, must choose a certification agency that is accredited by the Agricultural and Processed Food Products Export Development Authority (APEDA).

(ii) **Submit an Application:** The applicant must submit a detailed application to the chosen agency. This includes providing comprehensive information about the farm, its operational history, and a complete organic system plan.

(iii) **On-Site Inspection:** The agency appoints a trained inspector to conduct a physical inspection of the farm. The inspector verifies that the farming practices comply with the NPOP standards, examines records, and assesses for any risk of contamination.

(iv) **Review and Certification:** After the inspection, the agency reviews the inspector's report. If all requirements are met, the agency grants the certification. This allows the producer to use the official "India Organic" seal on their products, which is a mark of authenticity in international markets.

7.5 Marketing of Natural Farming Produce

Once natural farming gains traction in the country, it is expected that the produce may fetch at least equal or even higher renumeration owing to its pro-health benefits. Therefore, the potential market for organic farming produce shall also serve as the potential market for natural farming produce. Domestic as well as external trade ecosystems have to be aligned in support of the produce.

Recent studies highlight that certification not only opens access to premium domestic and international markets but also strengthens consumer trust, especially when coupled with transparent labelling and traceability (Shukla et al., 2021; Singh et al., 2022). Marketing connects your farm to buyers and ensures your hard work is rewarded. Farmers can use multiple strategies to reach consumers, institutions, and markets.

7.5.1 Institutional Markets

(i) **Temples and Religious Institutions:** For example, farmers supported by RySS and CSA supply natural produce to the Tirupati Temple. This gives steady demand and fair pricing.

(ii) **Public Distribution System (PDS):** Under Odisha Millet Mission, naturally grown millets are procured for distribution. Farmers get guaranteed markets and consumers get safe, nutritious food.

(iii) **Schools and Anganwadi Centres:** Linking natural produce to mid-day meal schemes and nutrition programs ensures continuous demand

25 *https://apeda.gov.in/national-programme-for-organic-production-npop*

7.5.2 Farmer – Consumer Connect

(i) **Farmers' Markets:** Direct markets in towns and cities let farmers sell their produce without middlemen. Prices are higher and consumers can ask questions about the produce.

(ii) **Community Supported Agriculture (CSA):** Consumers subscribe to receive regular baskets of fresh produce. Farmers get guaranteed income, and consumers get chemical-free food.

(iii) **Food Festivals and Exhibitions:** Events like Amrut Aahar help farmers showcase products, educate consumers about health benefits, and create strong local demand.

7.5.3 Value Addition and Branding

(i) Clean, grade, and pack produce to make it more appealing.

(ii) Convert raw produce into simple products like flour, pickles, or snacks. This increases income and shelf life.

(iii) Farmer groups can create simple brands emphasizing chemical-free and local origin. Examples: "Natural Millets of Odisha" or "Pesticide-Free Mangoes of Andhra Pradesh."

(iv) Using attractive labels, mentioning local origin, and displaying certification logos builds consumer trust.

Some success stories such as Tirupati temple model, Odisha Millet Mission, Amrut Aahar Festival, are a testimony of good marketing strategies.

7.5.4 E-Commerce and Digital Marketing

Farmers can now reach more consumers and get better prices using digital tools and e-commerce platforms. This helps sell produce beyond local markets and increases income opportunities.

(i) **Online Marketplaces:** Platforms like BigBasket, Amazon Fresh, or regional e-commerce portals allow farmers or farmer groups to sell directly to urban consumers.

(ii) **Social Media Promotion:** Sharing photos, short videos, or stories about your farm and produce on WhatsApp, Facebook, Instagram, or YouTube builds trust and attracts buyers.

(iii) **Direct Delivery Models:** Farmers can offer home delivery to nearby towns or cities using subscription models or advance orders. This is similar to Community Supported Agriculture (CSA) but done digitally.

(iv) **Digital Payments:** Using mobile banking or UPI ensures smooth and safe transactions.

Benefits of Digital Marketing:

- Expands customer reach beyond villages and local towns.
- Builds awareness about the benefits of chemical-free and natural foods.
- Reduces dependence on middlemen and increases farmers' share of profits.
- Helps track orders, maintain customer relationships, and plan production according to demand.

7.5.5 Practical Tips for Easy Marketing

(i) Form or join Farmer Producer Organisations (FPOs) or cooperatives to collectively sell produce.

(ii) Explore institutional markets like temples, schools, hospitals, and government procurement programs.

(iii) Use simple post-harvest practices like grading, cleaning, and basic packaging to make produce more attractive.

(iv) Participate in food festivals, fairs, and farmers' markets to build relationships with consumers.

(v) Maintain records and certification through PGS or third-party systems. This shows credibility and helps in getting premium prices.

(vi) Try value addition like milling, drying, or simple processing to increase income.

(vii) Use digital tools to reach urban consumers or health-conscious buyers.

References & Additional Readings

- Meemken, E. M., & Bellemare, M. F. (2020). Smallholder farmers and certification: Impacts on incomes, yields, and welfare. Annual Review of Resource Economics, 12, 439–460. https://doi.org/10.1146/annurev-resource-103019-105856
- Mohanty, B., Kumar, R., & Mishra, A. (2021). Mainstreaming millets for nutrition security: Insights from the Odisha Millet Mission. Current Science, 121(3), 345–352.
- Shukla, R., Patel, N., & Singh, S. (2021). Participatory Guarantee Systems: A sustainable approach to organic certification in India. Journal of Cleaner Production, 320, 128882. https://doi.org/10.1016/j.jclepro.2021.128882
- Singh, S., Bera, S., & Singh, R. (2022). Certification and market development of organic and natural foods in India: Opportunities and challenges. Agricultural Economics Research Review, 35(1), 1–12.

CHAPTER 8

Best Practices for Key Crops

In this chapter, farmers will find a comprehensive package of best practices for key crops specifically grown under natural farming systems. It provides step-by-step guidance for each crop from seed selection and traditional seed treatment to soil preparation, sowing, nutrient management, pest and disease control, and harvesting. The recommendations are tailored to different agro-climatic conditions, helping farmers achieve optimum yields while preserving soil fertility, enhancing biodiversity, and eliminating dependence on synthetic inputs. This chapter serves as a practical, ready-to-use guide for producing nutritious, chemical free food in a sustainable manner.

8.1 Amla[26]

Fig 8.1: Amla Crop

(i) **Climate and soil suitability**

- Amla is grown in hilly areas and tropical forest regions.
- It can also grow in poor, medium, and saline soils.
- Amla is grown under rainfed conditions.
- In autumn (December–January), the tree sheds its leaves.
- In spring (February–March), new leaves and flowers emerge.
- Fruits start forming 10–15 days after flowering.
- After fruit formation, the tree remains dormant for about 100 days.
- Fruit growth occurs in the rainy season, and after the monsoon fruits ripen in October–November.
- The Amla tree can survive even in severe drought conditions - this is its special characteristic.
- It can be planted as an intercrop between desi mango or tamarind trees.

(ii) **Protection from heat and cold**

- The Amla tree can tolerate heat and cold.
- But the small plant needs protection from heat and cold.

26 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

- For this, pigeon pea and pearl millet should be planted two feet away from the periphery of the Amla tree.

(iii) **Varieties**

- Available varieties: Banarasi, Chakaiya, Kanchan (NA-4), Krishna (NA-5), NA-6, NA-7, Anand-1 and Anand-2.

(iv) **Propagation method**

- Amla can be grown from seeds, approach grafting, and softwood grafting.
- In North India, Amla grafting is done through budding, which is planted at the designated place.
- Budding method gives 70–80% success.
- For seeds, collect fruits of desi Amla and dry them in sunlight.
- On average, six seeds come out of one fruit, which come out on their own when dried in sunlight.
- The seeds are sieved and kept in a cloth bag and dried in sunlight every week.

(v) **Planting system**

- Amla is planted at a distance of 24 feet x 24 feet.
- Between every four Amla trees, one plant of custard apple, papaya, or curry leaf is planted.
- Between two Amla or between Amla and intercrop (custard apple, papaya, curry leaf), prepare a pit of 1.5 feet x 1.5 feet x 1.5 feet for drumstick.
- In these pits keep a mixture of 4 parts soil and 3 parts *Ghanjeevamrit*, and along with *Beejamrit* and *Jeevamrit*, put custard apple, papaya, curry leaf, drumstick, and castor seeds.

(vi) **In-situ grafting method**

- Instead of preparing plants in the nursery, sow seeds at the permanent place itself and do grafting there after germination.
- With this method, roots go deep, and production is possible even without irrigation during drought.
- This also protects Amla from strong winds.
- For grafting, choose a rootstock at least one year old.
- Select high-yielding healthy trees and also plant 5–10% desi Amla trees along with them.
- Do not do grafting on desi trees.

(vii) **Budding method**

- Choose a bud for budding from a six-month-old branch.
- Cut a piece of bark 2.5 cm long and 1.0 cm wide with a bud on it, using a sharp knife.

- Remove a piece of bark of the same size from the rootstock one foot above the soil and place the bud piece on it.
- Tie with a polythene strip, do not damage the bud.
- After 20–25 days, if the bud remains green then the graft is successful.
- Cut off the part above the graft so that new sprouting comes out from the bud.

(viii) **Use of *Jeevamrit***

- During monsoon, one month after grafting, apply *Jeevamrit* to each plant once or twice.
- Even after the monsoon, applying *Jeevamrit* makes production possible even in drought.
- Apply 200–400 litres of *Jeevamrit* per acre with irrigation water once or twice a month.
- If cow dung of desi cow or bull is available, *Ghanjeevamrit* will give more benefit.

Foliar spray

- For two months after planting, spray 5 litres of *Jeevamrit* mixed in 100 litres of water per acre.
- For the next two months, spray 10 litres of *Jeevamrit* mixed in 150 litres of water.
- Until fruit formation, spray 20 litres of *Jeevamrit* mixed in 200 litres of water per acre.

(ix) **Mulching and intercropping**

- Amla is a rainfed crop, so mulching is necessary.
- Use drumstick and cowpea as mulching.
- Sow cucumber, bitter gourd, bottle gourd, and watermelon in between.
- Layers of *Jeevamrit* will generate microorganisms and earthworms which will store nutrients near the roots.
- Between every two rows, make a trench 3 feet wide and 1.5 feet deep and mulch with dry grass.
- This will stop evaporation of rainwater and roots will get water from the soil.

(x) **Tree structure**

- In Amla, due to heavy fruiting, branches break.
- Therefore, keep a single stem up to 75 cm and then let four strong branches grow in four directions.

(xi) **Crop protection**

- Amla has less incidence of diseases and pests.

- If disease or pests are seen, spray *Neemastra*, *Brahmastra*, *Agniastra*, *Soonthastra*, or sour buttermilk.

8.1.1 Shri Ram Gopal Singh Chandel, Uttar Pradesh

Shri Ram Gopal Singh Chandel, resident of Barsawan village, Raebareli district, Uttar Pradesh, is a progressive farmer, who has developed a prosperous and inspiring model by moving beyond traditional farming through the integration of natural farming, agroforestry, and medicinal crops. He adopted the cultivation of crops like paddy, wheat, mustard, and gram along with mango, Amla, sweet lime, jackfruit, broccoli, capsicum, tomato, and medicinal crops like brahmi and moringa. His farm has been certified by Uttar Pradesh State Organic Certification Institute, Lucknow.

Shri Chandel adopted methods of nutrient management such as *Beejamrit*, *Jeevamrit*, and *Ghanjeevamrit*, along with pest control methods through *Neemastra* and *Brahmastra*. He made wheat and paddy sowing more effective by using modern techniques like super-seeder, seed drill, and drum seeder. He achieved efficiency in water management through drip and sprinkler irrigation systems.

From natural farming of Amla in 0.4 hectare, Shri Chandel obtained 22 quintals of production at a cost of ₹7,500 and earned a total profit of ₹39,600. Net profit was ₹32,100 and the benefit-cost ratio was 4.28. Whereas in traditional farming the cost was ₹9,600, production was 19 quintals, and net profit was only ₹24,600, in which the benefit-cost ratio was 2.56.

This comparison shows that natural farming not only reduces production cost but also increases production and profit. Along with this, improvement in soil fertility and assurance of sustainable agricultural development was ensured.

8.2 Apple[27]

Fig 8.2: Apple Crop

27 *Package of Practices for Apple based system under Natural farming approved during State level workshop for cultivation in the state by Dr YS Parmar University of Horticulture and Forestry, Himachal Pradesh*

(i) **Whapsa (Moisture Conservation in Soil)**

- Make 4–5 inch deep furrows and cover with dry grass mulch, so that moisture is locked in the soil.
- Apply/irrigate with *Jeevamrit*, which increases the number of microorganisms in the soil, helps in decomposition of organic matter, releases nutrients, and increases soil fertility.

(ii) **Mulching**

- Cover the plant basins with dry grass mulch and cover the space between basins with live mulch.

(iii) **Intercrops**

- Winter crops such as pea (October/November–April/May) and urad (October/November–May) should be planted, which fix atmospheric nitrogen in the soil; and garlic (October–March) should be cultivated, which acts as an insect repellent.
- Long-term crops such as wheat/barley (October/November–May); finger millet (May–November); turmeric and ginger (April–December) should be cultivated, which keep the soil covered for a long time and provide protection.
- Summer crops such as beans (February–July), which fix nitrogen in the soil.
- Rainy season crops such as kidney bean and pea (July–November) should be cultivated, which fix nitrogen in the soil; cabbage (July–November) uses residual moisture; marigold (July–October) acts as a trap crop.
- Multi-season crops such as fenugreek (March–May, August–October, November–February) fix nitrogen and provide continuous soil cover.

(iv) **Bio-applications for Nutrition and Disease/Pest Management**

- Bio-applications in soil
  - » Irrigate with *Jeevamrit* at an interval of 21 days:
  - » In M9 rootstock plants: 2 litres/plant
  - » In M7/MM111/seedling plants: 5 litres/plant
  - » During field preparation, apply *Ghanjeevamrit*:
  - » In rootstock plants: 200 grams/plant
  - » In seedling plants: 400 grams/plant
  - » During intercrop: 1 quintal/bigha
- **Bio-applications for foliar spray**
  - » *Jeevamrit*: 10 litres in 100 litres of water
  - » Sour buttermilk: 5 litres in 100 litres of water
  - » *Ramban*: 7 litres *Jeevamrit* and 3 litres buttermilk mixed with 100 litres water
  - » *Sonthastra*: without dilution

- *Darekastra*: without dilution
- *Agniastra*: 5 litres in 100 litres of water
- *Brahmastra*: 5 litres in 100 litres of water
- *Dashparni Ark*: 5 litres in 100 litres of water

The management schedule for apple orchards under natural farming is as given in Table 8.5.

Table 8.1: Month-wise Management Schedule for Apple Orchards Under Natural Farming

Month	Activities
January	Spraying of *Jeevamrit* at 21-day intervals; pruning; application of plant paste
February	Spraying of *Jeevamrit* at 21-day intervals; pruning; sowing of bean intercrop, harvesting of fenugreek intercrop
March	Application of plant paste, sowing of fenugreek, harvesting of pea and garlic intercrops, spraying of oils such as neem oil, application of *Ghanjeevamrit*, mulching with dry grass and intercrop residues
April	Spraying of Saptdhanya extract at 80% flowering and fruit setting, installation of hail nets, thinning of fruits, weeding
May	Cutting of lateral plants, harvesting of fenugreek intercrops, application of plant paste in the second or third week of May, thinning of fruits; application of insecticidal *astras* (*Darek Astra*, *Brahmastra*, *Agniastra*)
June	Mulching with dry grass, weeding; cutting of lateral branches; spreading and bending of branches; application of insecticidal *astras* (*Darek Astra, Brahmastra*, *Agniastra*)
July	Weeding and application of *Ghanjeevamrit*; cutting of lateral branches; spreading and bending of branches; application of insecticidal *astras* (*Darek Astra*, *Brahmastra*, *Agniastra*)
August	Sowing of kidney bean, harvesting of bean, harvesting of apple fruits, weeding; cutting of lateral branches; spreading and bending of branches; application of insecticidal *astras* (*Darek Astra*, *Brahmastra*, *Agniastra*)
September	Application of plant paste in the last week of the month, weeding-hoeing; spreading and bending of branches
October	Sowing of pea and garlic, harvesting of kidney bean, application of plant paste in the first week

Month	Activities
November	Field preparation for the next fruiting season; sowing of pea
December	Field preparation for the next fruiting season; application of *Ghanjeevamrit*; application of plant paste, spraying of *Jeevamrit* at 21-day intervals

8.3 Banana [28]

Fig 8.3: Banana Crop

(i) **Pre-Monsoon Dry Sowing**

- Before planting banana, sow at least 9 types of crops (pulses, oilseeds, millets, vegetables, and leafy vegetables, etc.) from April/May to the first week of August.
- The objective is to ensure greenery in the field throughout the year and that the soil is never left bare (365-day green cover policy).

(ii) **Intercropping and Multicropping System**

- During the initial 2–3 months after planting, it is essential to promote intercropping and multicropping combinations.
- Intercrops: moong, urad, marigold, leafy vegetables, cluster beans, tomato, etc.
- In later stages, shade-tolerant tuber crops such as turmeric, suran, arvi, ginger, and vine crops can be planted on the boundaries.
- After banana planting, sow *Navadhanya* in the inter-rows and incorporate it into the soil within 30–45 days. This helps in:
  - » Conserving soil moisture
  - » Controlling weeds

28 https://www.manage.gov.in/nf/pptspdfs/apcnf-gujarat.pdf

- » Reducing irrigation needs
- » Improving soil fertility

(iii) **Treatment of Planting Material (Sword Sucker)**

- Remove the roots and basal part of the planting material.
- The sucker should weigh around 450–700 grams with an actively growing cone-shaped bud.
- Keep the sucker in *Beejamrit* for 30 minutes before planting.

(iv) **Planting Distance**

- Normal varieties: Row to row – 6 feet, Plant to plant – 6 feet
- Dwarf varieties: Row to row – 6 feet, Plant to plant – 5 feet

(v) **Organic Nutrient Management**

(vi) ***Ghanjeevamrit***

- At the time of planting, apply 5–10 kg per pit along with Neem cake – 1 kg
- Per pit 1 kg: 500 gms at planting time
- 500 gms after 40–50 days

(vii) ***Jeevamrit* (after planting in days)**

- **Soil application:** 11 times @200 litres per acre – at 15, 30, 60, 90, 120, 150, 180, 210, 240, 255, and 270 days after planting
- **Foliar spray:** 7 times @30-day interval:
  - » 45 days after planting – 15 litres *Jeevamrit* mixed with 200 litres water
  - » 75 days after planting – 20 litres *Jeevamrit* mixed with 200 litres water
  - » 105 days after planting – 25 litres *Jeevamrit* mixed with 200 litres water
  - » 135 days after planting – 30 litres *Jeevamrit* mixed with 200 litres water
  - » 165 days after planting – 40 litres *Jeevamrit* mixed with 200 litres water
  - » 195 days after planting – 50 litres *Jeevamrit* mixed with 200 litres water
  - » 225 days after planting – 50 litres *Jeevamrit* mixed with 200 litres water

(viii) **Growth Promoters**

- ***Panchagavya***:
  - » Quantity: 4 litres/acre mixed with 100 litres water
  - » Spray 3 times:
    - 5–6 months after planting with *Jeevamrit* (before flowering)
    - 7–8 months after planting with *Jeevamrit* (at flowering stage)
    - Before fruit ripening: fill 250 ml in each polythene cover and tie to the bunch

(ix) **Agricultural Operations**

- Weeding: at 30, 60, 90, and 120 days
- De-suckering: up to 7–8 months
- Cleaning of dry leaves: do not remove green leaves
- Mulching: use paddy husk and dried banana leaves @12–13 kg per plant
- Earthing up: 3–4 months after planting
- Propping: 7–8 months after planting, provide support using bamboo or eucalyptus poles
- Cleaning of undeveloped bananas: remove incomplete bananas to improve quality and weight
- **Bunch covering:** cover with dry leaves to protect from sun and improve quality
- Do not do this during rainy season

(x) **S2S Kit and Pest Management (Table 8.4)**

Table 8.2: S2S Kit and Pest Management for Banana

Component	Details
Intercrops	Leafy vegetables, cluster beans, tomato, turmeric, suran, arvi, ginger, bottle gourd, marigold
Border crop	Subabul
Yellow sticky traps	20–25/acre
Light trap	1 per acre
Monitoring	Regular monitoring with *Jeevamrit* is essential

8.3.1 Mr. Dixit Patel, Gujarat

Mr. Dixit B. Patel, a resident of Sangrampura village in Khedbrahma taluka of Sabarkantha district, Gujarat, is a progressive farmer with a B.E. degree in Electronics. He has developed a model that integrates scientific thinking with natural farming, balancing low cost, high quality, and environmental sustainability. Since 2016, he has been cultivating G-9 variety bananas, pulses (as intercrops), and more than 25 types of vegetables using natural methods. He practices mulching with grasses and crop residues available on the farm and adopts the "Parivar Kisan Concept" to train farmers at the village level.

Mr. Patel's natural farming has produced remarkable results both economically and ecologically. From one hectare of banana cultivation, he obtained 100 quintals of yield, with an expenditure of only ₹40,000 and a net profit of ₹3,60,000. In contrast, conventional farming yielded 70 quintals, with an expenditure of ₹1,75,000 and a net profit of ₹2,05,000. The benefit-cost ratio in natural farming was 9.0, compared to only 1.17 in conventional farming. His fruits and vegetables had better taste and quality, which also improved consumers' immunity. Enhanced soil health and reduced greenhouse gas emissions contributed to mitigating the effects of global warming. Mr. Patel's journey demonstrates that with technical expertise,

environmental commitment, and farmer-driven initiatives, agriculture can be made sustainable and a means of community development.

8.4 Castor[29]

Fig 8.4: Castor Crop

(i) **Land Preparation**

- During field preparation, apply 800 kg of *Ghanjeevamrit* per acre by mixing it with soil in first year, 500 kg in second year and 200 kg in subsequent years.

(ii) **Varieties**

- Recommended varieties for Gujarat: GCH-1, 2, 3, 4, 5, and 7.

(iii) **Spacing**

- In less fertile soil under rainfed conditions: 90 cm x 60 cm
- In irrigated conditions: 90 cm x 20 cm
- In fertile soil: 120 cm x 60 cm

(iv) **Seed Rate**

- 8–10 kg per hectare

(v) **Seed Treatment**

- Treat seeds with *Beejamrit* to protect against seed-borne and soil-borne diseases.

(vi) **Sowing Time**

- The best sowing time is around 15th August

(vii) **Irrigation Management**

- Castor is a deep-rooted crop and can extract water from deeper soil layers.

29 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

Therefore, irrigation should be heavy but less frequent.

- For higher yield, provide 2–3 heavy irrigations wherever possible.
- Under irrigated conditions, after the monsoon ends, irrigate every 15–20 days, 3–4 times.

(viii) **Application of *Jeevamrit***

- Mix 5 litres of *Jeevamrit* in 100 litres of water and spray it on foliage after one month of the sowing.
- Mix 7.5 litres of *Jeevamrit* in 120 litres of water and spray it on foliage 21 days after the first spray.
- Mix 10 litres of *Jeevamrit* in 150 litres of water and spray it on foliage 21 days after the second spray.
- Mix 15 litres of *Jeevamrit* in 150 litres of water and spray it on foliage 21 days after the third spray.
- Mix 3 litres of sour buttermilk in 100 litres of water and spray it on foliage 21 days after the fourth spray.
- Mix15 litters of *Jeevamrit* in 150 litres of water and spray it on foliage after 21 days of fifth spray.

(ix) **Mixed / Intercropping**

- Castor + Sunflower (1:2)
- Castor + Soybean (1:1)
- Castor + Cluster bean (2:1)
- Castor + Groundnut (1:3)

(x) **Mulching**

- Mulching with crop residues is recommended in castor fields.

(xi) **Crop Protection Measures**

- For sucking pests (like thrips and whitefly) in the early stage: Spray *Neemastra* @ 200 litres per acre.
- For caterpillars and other insects: Spray *Dashparni Ark* or *Agniastra* @ 7.5 litres + 250 litres water.
- For fungal diseases in castor: Use sour buttermilk or Sonthastra @ 7.5 litres + 250 litres water for best results.

8.4.1 Success Story: Shri Ashok Kumar, Haryana

Shri Ashok Kumar of Lokra village, Gurugram district, has demonstrated that revolutionary changes in agriculture are possible through natural farming. His

deep commitment to environmental sustainability inspired him to adopt *Jeevamrit* and neem-based bio-pesticides, which provided effective control over pests and diseases. Through intercropping vegetables between rows of castor, he enhanced land productivity and diversified income sources.

In castor cultivation alone, he earned a net profit of ₹1,45,000, ompared to ₹1,25,524 under conventional farming. The benefit-cost ratio also stood at 2.02, higher than the conventional method's 1.9. Similar trends were observed in other crops such as bottle gourd, black wheat, and broccoli. His practices reduced farming costs, increased production, and saved both time and labor.

8.5 Cotton[30]

Fig 8.5: Cotton Crop

(i) **Land Preparation**

- Apply 800 kg of *Ghanjeevamrit* per acre to the soil before sowing seeds, during first year, 500 kgs in second year, and 200 kgs in subsequent years.

(ii) **Varieties / Spacing**

- Both desi (local) and improved varieties can be used.
- Spacing between two rows: 90 cm – 120 cm x 30 cm – 45 cm.
- Seed rate for desi varieties: 8–10 kg per hectare.

(iii) **Seed Treatment**

- Seeds should be treated with *Beejamrit* to protect against soil-borne and seed-borne diseases such as anthracnose, black arm of cotton, root rot, and seedling rot.

(iv) **Sowing Time**

- During the monsoon season - June to July.

30 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

(v) **Application of *Jeevamrit***

- After sowing, apply 200 litres of *Jeevamrit* per acre along with irrigation.
- Thereafter, apply 200 litres of *Jeevamrit* per acre at 15-day intervals every month with irrigation water.

(vi) ***Jeevamrit* / Spraying of Saptdhanyankur**

- First spray: One month after planting, mix 5 litres of *Jeevamrit* in 100 litres of water.
- Second spray: 21 days after the first spray, mix 7.5 litres of *Jeevamrit* in 120 litres of water.
- Third spray: 21 days after the second spray, mix 10 litres of *Jeevamrit* in 150 litres of water.
- Fourth spray: 21 days after the third spray, mix 15 litres of *Jeevamrit* in 150 litres of water.
- Fifth spray: 21 days after the fourth spray, mix 3 litres of sour buttermilk in 100 litres of water.
- Sixth spray: 21 days after the fifth spray, mix 15 litres of *Jeevamrit* in 150 litres of water.

(vii) **Intercropping**

- Castor, maize, marigold, sesame, green gram, soybean, moth bean, etc., are sown as intercrops.

(viii) **Mulching**

- After sowing of seeds, crop residues are used for **mulching**.

(ix) **Crop Protection Measures**

- If insect eggs or larvae appear on leaves: Spray 3 litres of *Brahmastra* + 3 litres of *Agniastra* in 200 litres of water.
- Control of sucking pests: Spray 200 litres of *Neemastra* per acre.
- Nematode control: Soil drenching with 8% *Brahmastra* solution (8 litres per 100 litres of water).
- Fungus/Virus control: Spray 3–4 days old buttermilk mixed with 100 litres of water.
- Control of pink bollworm and jassids: Spray 5–7 litres of *Brahmastra* in 200 litres of water.
- Caterpillar control: Spray 7.5 litres of *Agniastra* in 250 litres of water.

(x) **Harvesting Stages**

- Cotton picking should be done in the morning, as due to moisture, dry leaves and other debris do not stick to cotton.

- Hand-picking is the best and most suitable method, which should be done at regular intervals.
- To achieve higher yield, 3–4 pickings should be carried out at regular intervals.

8.6 Cumin[31]

Fig 8.6: Cumin Crop

(i) **Land Preparation**

- Field preparation for cumin sowing is done after the harvest of Kharif groundnut.
- Cumin is a medium-duration crop; therefore, apply 250–300 kg *Ghanjeevamrit* per acre along with neem cake, before sowing.

(ii) **Variety Selection**

- Crop duration: 90–100 days

(iii) **Spacing**

- The common method of sowing is broadcasting, but it is recommended to use seed drill for line sowing.

(iv) **Seed Rate**

- 15–16 kg per hectare

(v) **Seed Treatment**

- Treat seeds with *Beejamrit* and dry them in shade for 3–4 hours before sowing.
- Sowing is done with the help of a seed drill.

(vi) **Time of Sowing**

- Optimum sowing period: 1st to 15th November.

(vii) **Nutrient Management**

- **First spray:** On the next day after sowing

31 https://naturalfarming.niti.gov.in/wp-content/uploads/2022/11/Package-of-Practices-Gujarat-.pdf

- **Second spray:** On the 7th day after sowing
- **Third application:** One month after sowing, apply 200 litres *Jeevamrit* with irrigation
- **Fourth spray:** At flowering stage (around 45 days), spray *Saptadhanyankur extract* to improve seed quality and size
- **Fifth application:** 65 days after sowing, apply 200 litres *Jeevamrit*

(viii) ***Jeevamrit* Spray**

- At the time of the third irrigation, spray 1 litre *Jeevamrit* mixed with 15 litres water.
- After that, spray *Jeevamrit* at 15-day intervals, 3–4 times during the crop cycle.

(ix) **Crop Protection Measures**

- **Termite control:** Apply a mixture of 1 kg *Dhatura* leaves + 1 kg *Aakda* leaves + 30 litres cow dung slurry + 1 kg gram flour + 2–3 kg *Mrida* with irrigation.
- **Alternaria blight management:** On appearance of symptoms, spray 7–10 days old buttermilk.
- **Sucking pests and caterpillar control:** Spray cow urine, neem oil, *Neemastra*, or *Dashparni Ark*.
- **Fungal disease control:** Use old buttermilk or *Sonthastra* (ginger extract).

8.7 Custard Apple[32]

Fig 8.7: Custard Apple Crop

(i) **Medicinal properties**

- The leaves of custard apple have insect-resistant properties, and from these, decoctions like *Brahmastra*, Dashparni extract, *Neemastra* are prepared.
- Its seeds contain about 30% oil, which can be used for making insecticides.
- The cake made from the seeds contains 40% nitrogen and is suitable for applying to the soil.

32 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

(ii) **Propagation method**

- Select an elite tree for seed collection.
- If selection is not possible, then buy good quality fruits from the market at a higher price. By doing this, good yield can be obtained in the future.
- Without grafting this is not possible, but in natural farming the size, taste, and sweetness of all fruits are obtained from seeds themselves.

(iii) **Intercropping system**

- Plant custard apple as an intercrop between mango, tamarind, or Amla.
- Keep a distance of 36 feet between two tamarind or desi mango trees.
- Plant one Amla tree between every four tamarind or mango trees.
- Plant one custard apple plant between every tamarind/mango and Amla.
- Also plant a drumstick tree between these two fruits.
- Sow mango, tamarind, Amla, custard apple, and drumstick seeds at the designated place.

(iv) **Method of sowing seeds**

- After eating the pulp of custard apple, dry the seeds in shade and sow after three months, because the seeds have dormancy.
- Seeds extracted in October–November can be sown in June.
- Soak the seeds in *Jeevamrit* for 48–72 hours before sowing.

(v) **Pit preparation**

- Dig pits of size 1.5 feet x 1.5 feet x 1.5 feet at the designated places in the orchard.
- In the pit, mix 4 parts soil, 2 parts sieved cow dung manure, and 1 part *Ghanjeevamrit*, and fill this mixture in each pit.
- Spray *Jeevamrit* on it and cover with dry grass.
- With rainwater or light irrigation, germination will occur in a few days.
- After germination, remove the dry grass.

(vi) **Use of *Jeevamrit***

- Mix 5 litres of filtered *Jeevamrit* in 100 litres of water and spray on plants.
- Apply *Jeevamrit* into the soil around the plants twice a month.
- From the day of sowing custard apple seeds, also sow cowpea seeds at a distance of 2 feet.
- Remove weeds for the first three months and use them for mulching. Vegetables can be planted wherever space is available.

(vii) **Flowering and fruiting**

- It takes 35 days for the flower bud to develop fully.
- Excessive flowering occurs in June–July.
- Fruits mature in 4.5 to 5 months - from September to November.
- Mix 20 litres of cloth-filtered *Jeevamrit* in 200 litres of water per acre and spray at least once a month on custard apple trees.
- There should be partial shade over custard apple, which can be obtained from drumstick trees.

(viii) **Harvesting**

- Harvesting of fruits takes place between September and November.

(ix) **Crop protection**

- Pests that damage custard apple: Mealybug, fruit borer, caterpillar, fruit fly, scale insect, lac insect, whitefly, nematode, root-knot nematode.
- Control them by spraying *Brahmastra*, *Neemastra*, and *Agniastra*.
- For nematode control, planting flower crops like marigold is necessary, its roots contain a substance called alphaterthoneil which controls nematodes.
- Diseases of fruits and leaves can be prevented and controlled by spraying *Jeevamrit*, sour buttermilk, and Sonthastra.

8.8 Gram[33]

Fig 8.8: Gram Crop

(i) **Land Preparation**

- Under normal monsoon conditions, plough the field crosswise 1–2 times. This helps retain soil moisture.
- If the monsoon arrives late, prepare the field with a single ploughing.
- During winter months, apply 200–500 litres of *Jeevamrit* per acre.
- If the field has not been given presowing irrigation, 200–400 kg of *Ghanjeevamrit* per acre is applied.

33 https://naturalfarming.niti.gov.in/wp-content/uploads/2022/11/Package-of-Practices-Gujarat-.pdf

(ii) **Variety Selection, Spacing, and Seed Rate**

- Gujarat Desi Gram-3 and Gujarat Desi Gram-5 are high-yielding varieties. They show moderate tolerance to pests and diseases and are popular among farmers. Hence, these are prioritised in natural farming as per Table 8.1.

Table 8.3: Variety Selection, Spacing, and Seed Rate for Gram

Variety	Spacing (cm)	Seed Rate (kg/ha)
Gujarat Chana-1	45	70–90
Gujarat Chana-2	30–45	80–100
Gujarat Chana-3	10–15	100
Gujarat Chana-5	45	60

(iii) **Seed Treatment**

- Treat seeds with *Beejamrit* to prevent soil-borne diseases such as root rot and seedling rot.
- Treatment should be done one night before sowing. Dry the seeds overnight and sow them the next morning.

(iv) **Time of Sowing**

- Optimal sowing period: 15 October to 15 November

(v) **Irrigation Management**

- If the field has remained waterlogged throughout the monsoon, no irrigation is required.

(vi) **Application of *Jeevamrit* in Soil**

- After sowing, apply 200 litres of *Jeevamrit* per acre with irrigation water.
- Thereafter, apply 200 litres of *Jeevamrit* twice a month with irrigation water.

(vii) ***Jeevamrit* Spraying Schedule**

- 30 days after sowing: 12.5 litres *Jeevamrit* mixed with 250 litres water
- 51 days after sowing: 19 litres *Jeevamrit* mixed with 300 litres water
- 72 days after sowing: 25 litres *Jeevamrit* mixed with 375 litres water
- 83 days after sowing: 37.5 litres *Jeevamrit* mixed with 375 litres water
- 104 days after sowing: 7.5 litres sour buttermilk mixed with 250 litres water

(viii) **Crop Protection Measures**

- Spray 5 litres *Agniastra* per acre to protect the crop from caterpillars, 21 days after sowing.
- Aphids and other sucking pests can be effectively controlled with *Dashparni Ark*, *Brahmastra*, *Agniastra*, *Neemastra*, etc.

- Diseases like bacterial blight, fusarium wilt, and root rot can be controlled using *Sonthastra* (ginger extract) and castor cake.

8.8.1 Shri Shailendra Kumar, Haryana

Shri Shailendra Kumar, a graduate (B.Sc.) and a progressive farmer from Uplana village, Assandh block, Karnal district, Haryana, has achieved remarkable success in natural cultivation of Kabuli chickpea (HC-5).

He adopted the HC-5 variety and used a multi-crop seed drill for mechanised sowing. Paddy residues were managed through farm mechanisation, while fertility was enhanced using green manures such as *Dhaincha* and moong. Shri Kumar eliminated the need for chemical fertilizers and pesticides by relying on natural inputs such as cow dung, cow urine, *Beejamrit*, *Jeevamrit*, *Agniastra*, and neem oil.

A comparison of natural and conventional farming on one hectare revealed significant differences. In natural farming, he harvested 15.5 quintals, earning a net profit of ₹68,718 with a benefit-cost ratio (BCR) of 6.65. In conventional farming, yield was 13 quintals with a net profit of ₹43,760 and a BCR of 1.94. His methods reduced cultivation costs, saved time and labor, improved soil quality, and increased market demand for his produce.

8.9 Groundnut[34]

Fig 8.9: Groundnut Crop

(i) **Land Preparation**

- During field preparation, apply 800 kg of *Ghanjeevamrit* per acre by mixing it into the soil in first year, 500 kg in second year and 200 kg in subsequent years at the time of sowing.

(ii) **Varieties and Seed Rate**

- Bunch type: GG-2, GG-5, GG-7, TG-26, TG-37-A, GJG-9
  - » Seed rate: 100 kg per hectare– Spacing 45 cm x (7.5 to 10) cm
- Semi-spreading type: GG-20, GJG-22
  - » Seed rate: 120 kg per hectare– 60 cm x 10 cm

34 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

- Spreading type: GAUG-10, GG-11, GG-12, GG-13, JGJ-HPS-1, GJG-17
  - » Seed rate: 100 to 110 kg per hectare– 75 cm x (10 to 15) cm

(iii) **Spacing and Planting Pattern**

- A soil depth of 15–20 cm is considered suitable for groundnut sowing.
- Sow groundnut on 1.2-meter-wide broad beds, keeping four rows per bed at 30 cm spacing. Maintain 30 cm furrows on both sides of each bed for drainage and easy intercultural operations.

(iv) **Seed Treatment**

- Treat seeds with *Beejamrit* to prevent soil-borne diseases such as root rot, seedling rot, and collar rot.
- Carry out seed treatment before sowing so that the seeds can dry overnight and be ready for sowing the next morning.
- Before sowing, soak the seeds in 25% cow urine solution to improve germination and enhance drought tolerance.

(v) **Sowing Time**

- Early sowing: Last week of May to first week of June.
- Timely sowing: 15 June to 30 June (depending on water availability).
- Summer crop: 15 January to 15 February.

(vi) **Sowing Method**

- Before sowing, apply 100 kg *Ghanjeevamrit* per hectare by mixing into the soil.
- After sowing, apply mulching with crop residues.

(vii) **Irrigation Management**

Apply irrigation at the following critical growth stages:

- First irrigation: 4–5 days after sowing.
- Second irrigation: 20 days after sowing.
- Two irrigations at flowering stage.
- One or two irrigations at pegging stage.
- 2–3 irrigations during pod development, depending on soil type.
- During each irrigations apply 500 litres of *Jeevamrit* mixed with irrigation water.

(viii) ***Jeevamrit* Spraying Schedule**

- 30 days after sowing: 5 litres *Jeevamrit* mixed with 100 litres water
- 51 days after sowing: 7.5 litres *Jeevamrit* mixed with 120 litres water
- 72 days after sowing: 10 litres *Jeevamrit* mixed with 150 litres water
- 83 days after sowing: 15 litres *Jeevamrit* mixed with 150 litres water
- 104 days after sowing: 3 litres sour buttermilk mixed with 100 litres water

(ix) **Mixed/Intercropping**

- Groundnut + Cotton

- Groundnut + Castor
- Groundnut + Sesame

(x) **Crop Protection Measures**

- If insect eggs or larvae appear on leaves: Mix 3 litres *Brahmastra* and 3 litres *Agniastra* in 200 litres of water and spray.
- For sucking pest control: Spray 200 litres of *Neemastra* per acre.
- For nematode control: Apply 8% *Brahmastra* solution (8 litres per 100 litres water) by soil drenching.
- For fungal/viral control: Spray 3–4 days old buttermilk mixed with 100 litres of water.

(xi) **Harvesting Stage**

- Harvest the crop 90 to 120 days after sowing.

8.9.1 Success Story: Shri Machhibhai Ratadiya, Gujarat

Shri Machhibhai Ratadiya, a resident of Nainivadi village in Kalavad taluka of Jamnagar district, Gujarat, has set an inspiring example in sustainable agriculture. He adopted natural farming practices for wheat, groundnut, and other crops, while also integrating modern irrigation and mechanisation techniques such as drip and sprinkler systems, seed drills, harvesters, and reapers. These measures helped him increase production and reduce costs.

He has trained many farmers, developed a seed bank of indigenous varieties, and promoted direct marketing techniques for value addition. The results of his natural farming efforts are remarkable, from one hectare of groundnut (GG-20 variety), he harvested 43 quintals, earning a net profit of ₹91,330-significantly higher than ₹70,000 from conventional farming. The benefit-cost ratio reached 2.57, compared to just 1.4 under conventional methods.

8.10 Guava[35]

Fig 8.10: Guava Crop

35 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

(i) **Raising Seedlings**

- Guava seedlings can be prepared from seeds, but this has both positive and negative effects.
- Therefore, instead of seeds, air layering method is considered the best method of propagation.

(ii) **Layering Method**

The guava plants selected for layering should have the following characteristics:

- Large umbrella-shaped canopy, healthy branches, and low height
- Higher yield and excellent quality fruits
- More pulp and fewer seeds
- White pulp and delicious in taste
- Greater resistance to pests and diseases

To mark the trees with these characteristics, tie a strip of red or other colored cloth.

(iii) **Process of Layering**

- Choose such branches that are neither too old nor too new, and which spread on the ground surface.
- The branch should be about 1.5 feet in length. Remove the leaves from the terminal portion.
- Take wide-mouthed earthen pots and fill them with a mixture of 4 parts good soil, 2 parts dry cow dung, and 1 part *Ghanjeevamrit*. Add water and fill.
- Within two days, microbial activity will begin in the pot.
- Cut the terminal portion of the branch with a knife. Place a piece of wood on the cut portion, cover with soil, and place a stone on top.
- Water to maintain moisture in the pot.
- After one month, roots will start developing, and after three months, the seedling will be ready for planting.

(iv) **Best Time for Layering**

- It is most suitable to prepare layering from 21st December to March.

(v) **Planting Distance**

- Keep a distance of 15 feet x 15 feet or12 feet x 12 feet between two guava plants.

(vi) **Use of *Jeevamrit***

- After 15 days of planting, mix 5 litres of *Jeevamrit* in 100 litres of water and spray.
- After this, apply *Jeevamrit* with irrigation once or twice a month.

(vii) **Intercrops**

- Crops like drumstick (moringa) and castor can be taken with guava.
- Along with this, crops like pigeon pea, chili, ginger, turmeric, and marigold can also be taken.

- Before taking any intercrop, do not forget to apply 100 kg desi cow dung manure and 50 kg *Ghanjeevamrit* per acre.

(viii) **Mulching**

- In spring season, dry guava leaves fall on the soil and perform the function of mulching.
- Mulching with green parts of other plants is more beneficial.
- Planting drumstick between two guava plants provides necessary nitrogen.
- Intercrops like chili, pigeon pea, ginger, and turmeric at maturity perform the function of mulching.

(ix) **Crop Protection**

- Guava may be attacked by pests, diseases, and harmful insects.
- In low-cost natural farming of fruit crops, guava leaves are resistant to diseases, which prevents pest and disease attacks.
- If any pest or disease attack is observed, spray the entire plant with *Neemastra*, *Brahmastra*, *Agniastra*, *Soontrastra, Vyavhingastra,* sour buttermilk, and coconut water.

8.11 Maize[36]

Fig 8.11: Maize Crop

(i) **Land Preparation**

- During field preparation, mix and apply 500 kg of *Ghanjeevamrit* per hectare into the soil.

(ii) **Varieties**

- Gujarat Maize – 2, Gujarat Maize – 4, Narmadmoti, Ganga Safed – 2, etc.

36 https://naturalfarming.niti.gov.in/wp-content/uploads/2022/11/Package-of-Practices-Gujarat-.pdf

(iii) **Spacing**

- Plant spacing: 60 cm x 20 cm

(iv) **Seed Rate**

- Seed rate: 15–20 kg per hectare

(v) **Seed Treatment**

- Treat seeds with *Beejamrit* to protect against soil-borne diseases and ensure healthy plant growth.
- Treatment should be done one day before sowing; soak the seeds overnight and sow them the next morning.

(vi) **Time of Sowing**

- Kharif crop: June–July
- Rabi crop: October–November

(vii) **Irrigation**

- In Kharif season, irrigate only if there is a prolonged dry spell.
- In Rabi season, provide irrigation at intervals of 15–20 days.

(viii) **Application of *Jeevamrit* in Soil**

- After planting, apply 250 litres of *Jeevamrit* per acre through irrigation water.
- Thereafter, apply 250 litres of *Jeevamrit* twice a month with irrigation water.

(ix) ***Jeevamrit* Spraying Schedule**

- One month after planting – 5 litres *Jeevamrit* mixed with 100 litres water
- 21 days after the first – 7.5 litres *Jeevamrit* mixed with 120 litres water
- 21 days after the second – 10 litres *Jeevamrit* mixed with 150 litres water
- 21 days after the third – 15 litres *Jeevamrit* mixed with 150 litres water
- 21 days after the fourth – 3 litres sour buttermilk mixed with 100 litres water

(x) **Mixed / Intercropping**

According to the agro-climatic zone, intercrop with:

- Maize + Pigeon pea
- Maize + Castor
- Maize + Groundnut

(xi) **Crop Protection Measures**

- Sucking pest control: Spray *Neemastra* @ 200 litres per acre
- Control of worms: Spray *Brahmastra* @ 3 litres / 100 litres water
- Borer, Fall Armyworm, and Fruit Fly control: Spray *Agniastra* @ 3 litres / 100 litres water

- Fungal / viral disease control: Spray buttermilk (3–4 days old) mixed in 100 litres water

8.11.1 Shri Chandu Sattibabu, Andhra Pradesh

Shri Chandu Sattibabu, a resident of Ammapalem village, Pedavegi Mandal, West Godavari district of Andhra Pradesh, has proven that maize production can be significantly improved through natural farming.

Educated up to Class 10 and actively practicing natural farming for the past four years, he has adopted innovative techniques such as Pre-Monsoon Dry Sowing (PMDS) and developed a diverse cropping system with 18 types of *Navadhanya* (traditional grains). Intercropping *Navadhanya* between maize rows replaced the monocropping system, improving soil health, biodiversity, and pest resistance.

From 0.4 hectares under natural farming, Shri Sattibabu harvested 48 quintals of maize, earning a net profit of ₹68,150, compared to only ₹39,000 under conventional farming. The benefit-cost ratio was 3.7, much higher than the 2.3 of conventional farming. Intercropping *Navadhanya* provided an additional ₹3,000 income.

Shri Sattibabu's journey demonstrates that with ecological understanding, community engagement, and innovation, Indian farmers can achieve sustainable prosperity.

8.12 Mango[37]

Fig 8.12: Mango Crop

(i) **Graft/Cutting Treatment**

- Treat grafts/cuttings with *Beejamrit*.

Pre-Monsoon Dry Sowing in Mango Orchards

- Farmers establishing new orchards should first carry out pre-monsoon dry sowing and then plant grafts of high-yielding mango varieties to ensure good establishment and growth.

37 *https://www.manage.gov.in/nf/pptspdfs/apcnf-gujarat.pdf*

- In orchards aged 0–5 years, along with pre-monsoon dry sowing, grow intercrops such as coarse cereals, pulses, vegetables, leafy vegetables, and vine crops like pumpkin and bottle gourd.
- Filler fruit crops such as papaya, drumstick (moringa), and fig can also be planted between two rows of mango trees.
- **In orchards older than 5 years:**
  - » In shaded areas, grow rhizome crops and root vegetables such as turmeric, ginger, carrot, beetroot, onion, and radish, along with leafy vegetables.
  - » In sunny areas, adopt a multi-cropping system.
- Document the income obtained from the main crop and intercrops.

(ii) **Canopy Management in Mango Plants**

Canopy management in young plants:

- Training during the juvenile stage is necessary to give the plant a strong framework.
- Allow the graft to grow as a single stem up to a height of 1 meter above ground level.
- In October–November, cut the top at a height of 60 cm – 70 cm to encourage primary branches.
- In March–April, 3–7 primary branches will emerge, of which 3–4 should be retained in different directions.
- In October–November, cut the primary branches at 60 cm – 70 cm to encourage secondary branching.
- From secondary branches, retain 2–3 branches per primary branch.
- Tertiary branches are obtained by cutting secondary branches at 60 cm – 70 cm.

(iii) **Canopy management in fruit-bearing trees:**

- Mango is a *terminal bearer*, meaning flowers appear at the tips of branches.
- **First pruning (after harvest):** complete by June/July.
  - » Skirting: remove lower hanging branches.
  - » Opening up: remove entangled inner branches to allow sunlight penetration.
  - » Hygiene: remove diseased or dead branches.
  - » Biomass removal: do not remove more than 25% of the biomass at a time, otherwise flowering may be reduced.
- **Second pruning (before flowering):** carry out in mid-December and complete within 1–2 weeks.
  - » Skirting: remove lower hanging branches.

» Opening up: remove disorganised inner branches.

» Tip pruning: cut new shoots back to mature wood to encourage flowering.

» Hygiene: remove diseased or dead branches.

(iv) **Organic Nutrient Management**

Ghanjeevamrit: Apply 10–20 kg per tree in June/July and October/November depending on tree age.

Jeevamrit: The Spraying schedule for mango is as given in Table 8.2.

Table 8.4: *Jeevamrit* Spraying Schedule for Mango

Age Group	Soil Application	Foliar Spray
Orchard 1–5 years old	3–5 litres Jeevamrit every 15 days	1st spray: 15 litres *Jeevamrit* mixed with 200 litres water (Dec/Jan) 2nd spray: 30 litres *Jeevamrit* mixed with 200 litres water (Feb/Mar)
Orchard 5+ years old	5–10 litres Jeevamrit every 30 days	Same as above

Growth Promoter: *Saptadhanyakur*

(v) **S2S Kit and Pest Management (Table 8.3)**

Table 8.5: S2S Kit and Pest Management for Mango

Component	Details
Intercrops	Coarse cereals, pulses, leafy vegetables, root crops, vine vegetables
Filler fruit crops	Papaya, drumstick (moringa), fig
Windbreak	Subabul / Gliricidia – 3 rows
Sticky traps	Yellow/blue: 20–25 per acre
Pheromone traps (fruit fly)	8 per acre
Light trap	1 per acre

8.12.1 Mr. Hareshbhai Thakkar, Gujarat

Mr. Thakkar Hareshbhai Morarjibhai from Vavdi village, Bhuj taluka, Kutch district of Gujarat, has transformed his farm into a vibrant and inspiring model by combining natural farming with agricultural innovations. He has adopted natural methods in cultivating fruit crops such as strawberry, mango, dragon fruit, banana, papaya, pomegranate, date palm, guava, muskmelon, watermelon, sweet lime, malta, and fig, along with vegetable crops like chili, capsicum, cabbage, brinjal, cucumber, sponge gourd, bottle gourd, bitter gourd, beetroot, broccoli, beans, zucchini, tomato, cherry, lettuce, spinach, onion, and drumstick. He also practices animal husbandry with 32 indigenous Kankrej cows and one bull, which provide inputs for preparing natural formulations such as *Jeevamrit*, Panchagavya, Chhasamrut, Saptadhanyakura

extract, organic potash, organic phosphorus, and organic nitrogen. He promoted innovation by preparing calcium from banana flowers, fungicide from cactus, and folic acid from lime. Through the drip irrigation system on his farm, 80,000 litres of *Jeevamrit* are applied at one time. He mechanizes irrigation and harvesting using seed drills, harvesters, and spraying machines. He carries out value addition of his produce at home itself and markets them directly through social media platforms like WhatsApp, YouTube, and Facebook. His farm has been visited by delegations from countries such as Israel, Uzbekistan, and the United Arab Emirates, reflecting international recognition of his work.

The natural farming practices of Mr. Thakkar have delivered remarkable economic results across different crops. From one hectare of land under strawberry cultivation through natural farming, he obtained 350 quintals of production, a net profit of ₹37,50,000, and a benefit-cost ratio of 2.66, whereas under conventional farming the yield was 125 quintals with a profit of ₹11,00,000 and a ratio of only 1.41. In the case of mango (Kesar variety), natural farming gave 175 quintals of production and a profit of ₹5,25,000, with a benefit-cost ratio of 6.25, compared to conventional farming which gave 150 quintals, a profit of ₹3,37,500, and a ratio of 3.07. For dragon fruit (red variety), natural farming resulted in 125 quintals of production and a net profit of ₹19,38,750, with a benefit-cost ratio of 7.23, while conventional farming produced 100 quintals with a profit of ₹13,50,000 and a ratio of 4.64.

8.13 Moringa/Drumstick[38]

Fig 8.13: Moringa/Drumstick Crop

(i) **Flowering and Fruiting**

- In drumstick (Moringa), flowering occurs in February and March.
- Fruiting (pod formation) takes place in April and May.

(ii) **Medicinal Properties**

- The chemical extracted from its roots is antimicrobial, which works as a nematicide/vermicide.
- Its leaves, branches, bark, and seeds are also endowed with antimicrobial properties.

38 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

- The extract of drumstick leaves possesses antimicrobial and fungicidal properties.

(iii) **Propagation Method**

- Propagation of drumstick is done by seeds or cuttings.
- The length of the cutting should be 3 feet and the thickness should be 5 to 6 cm.
- Seeds are treated with *Beejamrit* before sowing.
- Before sowing, soak the seeds in *Beejamrit* for 24 hours.
- Maintain a spacing of 6 to 12 feet between rows - this depends on which fruit crop is taken as an intercrop.

(iv) **Pruning**

- The branches of drumstick continue to grow continuously.
- Therefore, keep pruning until the branches of drumstick reach a height of 2 feet from the main fruit crop.
- When the tree reaches an appropriate height, then let it grow upwards.
- In this way, the tree provides shade to the main fruit crop, and the pruned branches are used for mulching.

8.14 Paddy (Kharif)[39]

Fig 8.14: Paddy (Kharif) Crop

Before kharif, Pre-Monsoon Dry Sowing (PMDS) with 18 varieties of crops is done in May and continued up to July 2nd week (approximately 75 days) to get a good crop stand and biomass. By practising PMDS, the farmers harvest some portion of the different groups of crops/ vegetables / leafy vegetables, which can be used for self-consumption; some biomass may be used as fodder or may be used as Mulch / incorporated into the soil before kharif plantation.

39 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

(i) **Seed and Seedling Treatment with *Beejamrit***

- 5 litres *Beejamrit* for 25- 30 kg seed respectively, it stimulates and catalyses soil biology and protects from seed/soil-born pests and diseases.
- Promote Line sowing, Drum Seeder planting, System of Rice Intensification (SRI) in irrigated paddy and Direct seeding (Line) in rainfed paddy, which allows minimal disturbance to the soil.

(ii) *Ghanjeevamrit*

- Apply 800 kg *Ghanjeevamrit* per acre at the time of sowing in first year, 500 kg in second year and 200 kg in subsequent years.

(iii) *Jeevamrit*

- Soil application: 200 litres per acre after sowing, after that apply 200 litres per acre twice a month with irrigation water.
- Foliar application:
  - » 5 litres *Jeevamrit* in 100 litres of water after sowing
  - » 7.5 litres *Jeevamrit* in 120 litres of water after 21 days of first spray.
  - » 10 litres of *Jeevamrit* in 150 litres of water after 21 days of second spray.
  - » 3 litres of sour buttermilk in 100 litres of water after 21 days of third spray.
  - » 3 litres of sour buttermilk in 100 litres of water after 21 days of fourth spray.
  - » 15 litres of *Jeevamrit* in 150 litres of water after 21 days of fifth spray.

(iv) **Application of Azolla**

- 10-15 Kgs/Acre after 7 Days After Transplanting (DAT), which fixes nitrogen, reduces weed development, acts as living organic mulch (reduces irrigation frequency by reducing evaporation loss of water), and some biomass can be incorporated.

(v) **All the non-negotiables**

- Clipping of leaf tips, Alleys, Border/Bund/Peripheral plantation- Marigold/ Red gram/Maize/Vegetables and Gliricidia /Sesbania, Yellow sticky traps, Pheromone traps- for Yellow Stem Borer, Bird perches and Light traps must be practised.

(vi) **Growth Promoters**

- Sapthadhanyakura tonic- 250ml in 100lits of water, 1 time-at Milking and grain filling stage to boost both quality and quantity of yields.

(vii) **Suggested 365 Days Green Cover (DGC)** in paddy under different situations

- Canal situation:
  - » Pre-Monsoon Dry Sowing (PMDS)-Kharif Paddy-RDS (Rabi Dry Sowing)-Rabi Paddy

- Bore wells and Uplands:
  - » PMDS-Kharif Paddy-RDS-Rabi Paddy.
  - » PMDS-Kharif Paddy-RDS-Rabi Pulses/other crops
  - » Under borewells, adjust the Kharif sowings so that the harvests may be complete by October end or by the 1st fortnight of Nov and then take up Rabi dry sowings, raise RDS up to 25- 50 days so that there may be good growth for incorporation.
- Promote High-End Models in Paddy Fields
  - » Multi-layer horticultural Model, raising of Horticulture plants (like Fruit trees, Vegetables and Flower crops) after widening of Paddy bunds and initiate, 5 Layer model (50'X50' model) (in 5-6 cents area) in one corner of paddy field to 5 feet height and SRT (Saguna Rice Technology) wherever possible.

8.15 Paddy (Rabi) [40]

Fig 8.15: Paddy (Rabi) Crop

After kharif, the raising of Rabi Dry Sowing (RDS) with a minimum of 9 varieties of crops (comprising of Pulses, Oil seeds, Millets, Vegetables and Leafy vegetables), sown as relay crop on November 2nd week and continued up to December 2nd week (appx.30 days) to get a good crop stand and biomass. The essential principle is to have 365 days of green cover and to see that the soil is not kept barren.

(i) **Seed and Seedling Treatment with *Beejamrit***

- To avoid weedicide application, promote Line sowing, Drum Seeder planting, SRI in irrigated paddy and Direct seeding (Line) in rainfed paddy, which allows minimal disturbance to the soil.
- Facilitating the placement of paddy weeders, both manual and power-driven, at Custom Hiring Centre (CHC) / NPM shops is crucial.

40 https://www.manage.gov.in/nf/pptspdfs/apcnf-gujarat.pdf

(ii) ***Ghanjeevamrit***

- Apply 1000-1500kg/acre, during last ploughing/Puddling and
- 400kg/acre in two equal splits at 20 Days After Sowing (DAS) and 40 DAS at 20-day intervals.

(iii) ***Jeevamrit***

- Soil application: 2000 litres /acre, 10 times @ 200 litres each time, starting from 10 DAS with 10 days intervals.
- Foliar application: 4 times, at 25DAS (15 litres of *Jeevamrit* in 100 litres of water)
  - » 45DAS (20 litres of *Jeevamrit* in 150 litres of water)
  - » 55DAS (30 litres of *Jeevamrit* in 150 litres of water)
  - » 70DAS (50 litres of *Jeevamrit* in 150 litres of water)

(iv) **Application of Azolla**

- 4 Kgs/Acre after 7 DAS, which fixes nitrogen, reduces weed growth, acts as living organic mulch (reduces irrigation frequency by reducing evaporation loss of water), and some biomass can be incorporated.

(v) **Seed to Seed Kit- All the Non-Negotiables**

- Clipping of leaf tips
- Seedling treatment with *Beejamrit*
- Alleys- Provide 30 cms alley for every 2 metres
- Azolla mother pit
- Border/Bund/Peripheral-plantation-Marigold/Redgram/Maize/Vegetables and Glyricidia / Sesbania.
- Yellow sticky traps-20-25/Acre
- Pheromone traps for Yellow Stem Borer and Leaf folder-8/acre at 20-30 DAT
- Bird perches-10-15/Acre
- Light trap: 1/acre

(vi) **Growth Promoters**

- Sapthadhanyakura tonic- 700 grams of paste in 100 litres of water,1 time-at Milking and grain filling stage to boost both quality and quantity of yields.

8.15.1 Success Story: Shri Pundalik Vishnu Jori, Maharashtra

Shri Pundalik Vishnu Jori, a progressive farmer from Kashal village in Pune district, Maharashtra, has set a remarkable example of innovation and sustainability in paddy cultivation. Despite having formal education only up to the seventh standard, he revolutionised his farming practices by adopting natural farming techniques and mechanisation. By using tools such as the paddy transplanter, cono weeder, and

reaper, he was able to save both labor and time. Through the application of natural inputs like *Jeevamrit* and *Dashparni Ark*, he reduced costs while improving soil fertility and the quality of his produce. Along with actively participating in trainings and demonstrations organised by Agricultural Technology Management Agency (ATMA), he also disseminated agricultural knowledge through social media.

The comparative results of natural farming versus conventional farming are highly inspiring. On 0.4 hectares of land, natural farming yielded him 29 quintals of Indrayani paddy and a net profit of ₹69,000, whereas conventional farming produced only 21 quintals and a profit of ₹41,000. Recognizing his guidance in organic farming and mechanisation of paddy, ATMA honoured him with the "Outstanding Farmer Award."

8.16 Papaya[41]

Fig 8.16: Papaya Crop

(i) **Field Preparation**

- After plowing the soil, prepare furrows/ridges at a distance of two feet from the planting spot.
- In a planting distance of 8 feet, four furrows/ridges are formed.
- Sow seeds/plant seedlings at 8 feet or desired spacing in the first furrow.
- At the time of planting, give a mixture of four parts soil and three parts *Ghanjeevamrit* in equal proportion.

(ii) **Varieties**

- Old varieties: Madhubindu, Selection-7, Ceylon, Washington.
- New varieties: CO-1, CO-2, CO-7, Coorg Honeydew, Red Flesh, Pusa Delicious, Pusa Majesty, Pusa Giant, Pusa Nanha, Pusa Dwarf.

(iii) **Propagation**

- Commercially papaya is grown by seed. Seeds can be extracted from quality fruits from the market and sown directly in the field. Raising seedlings in the nursery is not necessary.

41 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

- If seedlings are to be raised in nursery, prepare beds 4.5 feet wide (3 feet bed and 1.5 feet furrow). Sow *Beejamrit*-treated seeds in lines at 3 inch x 3 inch spacing.
- Cover seeds with soil, spray *Jeevamrit*, then apply a layer of dry leaves.
- After this, do light irrigation to maintain moisture for germination.
- Spray *Jeevamrit* and irrigate daily. Seeds will germinate in 15–20 days.
- After germination, remove the mulch and irrigate through furrows with *Jeevamrit* mixed water.
- For spraying, mix 300–500 ml *Jeevamrit* in 10 litres of water.
- For one acre area, 200–250 grams of seed is required.
- The viability of papaya seeds remains up to 45 days, hence early sowing is advisable.

(iv) **Planting Time**

- June–July
- September–October
- January–February
- Sow 2–4 seeds/seedlings per pit at 10 cm spacing.

(v) **Flowering and Fruiting**

- In papaya, flowers appear after 4–6 months. Remove male plants.
- For good pollination, keep 5.7% male plants in the field.
- Male plants have long flower stalks and white-yellow flowers.
- Fruiting starts after 10–11 months, and fruits become ready for harvesting in 14 months. If a plant bears more fruits, remove weak and small fruits; otherwise, the fruits will be small and of poor quality.

(vi) **Intercrops**

- Papaya is an intercrop of mango, guava, orange, sweet lime, chikoo, and litchi.
- Along with these, drumstick, pigeon pea, colocasia/taro, chili, ginger, turmeric, cowpea, onion, marigold, tomato, brinjal, black gram, cluster beans, and cucurbitaceous vegetables can be taken.
- Plant drumstick between two rows and sow pigeon pea in furrows at 8 feet distance.
- Sow drumstick in one line and pigeon pea in another line alternately.
- In the second and fourth rows, plant cowpea, chili, and marigold.
- In the third row, sow cucurbitaceous vegetables.
- In this way intercrops can be planted throughout the field.

(vii) **Mulching**

- Do mulching on both sides of furrows between two rows of papaya.
- Intercrops help in weed control. If weeds appear, uproot and leave them there itself.
- After the intercrop duration is over, dry leaves and plants will act as dry mulching.
- According to the season, sow new intercrops to obtain live mulching.

(viii) ***Jeevamrit* Spraying Schedule**

After the rainy season ends, apply *Jeevamrit* twice a month in the soil near the plants. After this, spray *Jeevamrit* on papaya and intercrops as per the following schedule:

- One month after germination: Mix 5 litres of *Jeevamrit* in 100 litres of water.
- Two months after germination: Mix 7 litres of *Jeevamrit* in 100 litres of water.
- Three months after germination: Mix 10 litres of *Jeevamrit* in 100 litres of water.
- Before fruit setting: Mix 10 litres of *Jeevamrit* in 100 litres of water.
- After fruit setting: Mix 3 litres of sour buttermilk in 100 litres of water.
- Fifteen days after fruit setting: Mix 1 litre of coconut water in 100 litres of water.
- Final spray (15 days later): Mix 1 litre of coconut water in 100 litres of water.

(ix) **Crop Protection**

- After monsoon or irrigation, waterlogging may cause pest and disease problems.
- To prevent this, spray *Neemastra*, *Brahmastra*, *Agniastra*, sour buttermilk, and *Soonthastra*.

8.16.1 Shri Sethia Ratilal Vitthaldas, Gujarat

Shri Sethia Ratilal Vitthaldas from Gunatitpur village, Bhachau taluka of Kutch district in Gujarat has achieved remarkable success in horticulture, vegetables, and other crops by adopting natural farming since the year 2008. He has developed a self-reliant and sustainable agricultural model by adopting innovations like a five-layer crop system, animal husbandry with Gir cows and bullocks, and mechanisation of *Jeevamrit*. His farm has five automatic *Jeevamrit* tanks (each of 5000 litres capacity), which ensure nutrition along with irrigation. He uses only natural inputs-such as *Jeevamrit*, *Ghanjeevamrit*, *Brahmastra*, *Saptadhanyankur* extract, *Neemastra*, and Dashparni extract. He has established a desi seed bank and organizes workshops on the second Sunday of every month, from which hundreds of farmers are benefiting.

Shri Ratilal obtained 825.5 quintals of production from natural farming of Taiwan variety papaya, with a cultivation cost of ₹3,75,000 and total profit reaching ₹8,69,000.

The net profit was ₹4,94,000, while the benefit-cost ratio was 2.32. On the other hand, in conventional farming the production was 816 quintals, but the cost was ₹5,00,000 and the net profit was only ₹3,10,000. This comparison shows that natural farming not only reduces cost, but also increases profit.

On his farm, seed treatment with *Beejamrit* ensures 100 percent germination and protection from soil-borne diseases. Mixed cropping system, bio-fuel mulching, drip and sprinkler irrigation, seed drill and harvester technologies save labor and time. He has developed a market of 500 regular customers for more than 200 natural products, making direct marketing and value addition possible. This story shows that by combining innovation, dedication, and traditional knowledge with modern technology, farmers can not only become economically prosperous, but also a source of environmental balance and community inspiration.

8.17 Pomegranate[42]

Fig 8.17: Pomegranate Crop

(i) **Varieties**

- The major varieties of pomegranate are: Kandhari, Dholka, Jalore Seedless, Muscat, Ganesh, Mridula, Jyoti, Bhagwa, Super Bhagwa, etc.
- Different varieties are cultivated in different regions:
  - » Kandhari - Himachal Pradesh
  - » Dholka and Bhagwa - Gujarat
  - » Jalore Seedless - Rajasthan
  - » Muscat, Ganesh, and Mridula - Maharashtra

(ii) **Planting Distance**

- Planting distance is determined according to the type of soil:
- In light soil: 12 feet x 12 feet
- In sandy loam soil: 12 feet x 15 feet
- In heavy soil: 15 feet x 15 feet

42 *Acharya, D. (2023). Natural Farming. Gujarat Natural Farming and Organic Agricultural University, Anand.*

(iii) **Propagation Methods**

- Pomegranate is propagated by seeds, cuttings, and layering.
- Cutting and layering are equally effective.

Propagation by Cutting

- Select a well-managed pomegranate orchard.
- Tag disease-free and quality plants with old colored cloth.
- Use the new shoots growing near the stem of the plant for cutting.
- The length of the cutting should be 22 to 26 cm, with at least 4 to 6 buds.
- Remove the leaves but do not damage the buds.
- Dip the cuttings in *Beejamrit* and plant them.
- At the time of planting, bury at least 2 buds and three-fourths of the part in soil.
- The best time for planting cuttings is 2 hours before sunset.

Propagation by Air Layering

- Air layering is the best propagation method.
- All branches of the plant are suitable for layering.
- Select a branch from the tree with thickness similar to a pencil.
- Remove the leaves from the middle 15 to 20 cm portion of the branch.
- Then remove a circular bark of 2 to 3 cm thickness.
- Cover this part with moist sphagnum moss and tie with a polythene strip and thin jute rope (sutli).
- Sphagnum moss has high water-holding capacity, hence watering is not required.
- Air layering gives best results during the monsoon months.

(iv) **Planting Method**

- Plant seedlings at a distance of 12 feet x 12 feet, 12 feet x 15 feet, or 15 feet x 15 feet in the field.
- Make furrows at a distance of 3 feet in the field so that four furrows are formed in 12 feet.
- Dig a pit in the first furrow for planting the layered seedling, and after planting, support it with a wooden stick and tie with sutli.
- After this, plant other seedlings and sow intercrops.
- Before planting, prepare a mixture of 100 kg cow dung manure, 50 kg Ghana *Jeevamrit* and 300 kg soil per acre, and use it for layering and intercrops.

(v) **Use of *Jeevamrit***

- During monsoon, 2–4 days after rainfall stops, irrigate around the main crop (pomegranate) and intercrops with *Jeevamrit*.

- Apply *Jeevamrit* once or twice a month.
- After the monsoon, apply 200–400 litres of *Jeevamrit* per acre with irrigation once or twice a month.

(vi) **Spray Schedule:**

Time	**Quantity of *Jeevamrit* (in 100 litres of water)**
Initial Spray	5 litres
Next Spray	7 litres
Final Spray	10 litres

(vii) **Mulching**

- *Jeevamrit* and mulching are interconnected.
- When the intercrop matures, it becomes live mulch.
- After harvesting the intercrop, its residue acts as dry mulching.
- After harvesting drumstick pods, prune them and use the waste for mulching.
- Pruning leads to quick emergence of new shoots, resulting in greater quantity of mulch.
- Plant intercrops in open spaces so that from the lower layer and the upper live mulch, microorganisms and earthworms are generated, which will nourish the roots of plants for years.
- Due to this, additional manure will not be required.

(viii) **Crop Protection**

- Pomegranate requires a dense shady environment.
- In open environment, pomegranate does not give good yield.
- Therefore, provide shade with castor and drumstick plants.

(ix) **Pest and Disease Control:**

- If all the practices of natural farming are adopted, there is no threat of pests and diseases.
- If all requirements are not fulfilled, the disease resistance capacity of plants weakens and pest attacks occur.
- On the day of pruning of pomegranate or the next evening, light torches and walk between two rows - this destroys 80% of the pests by burning them.
- Harmful Pests: Thrips, jassids, pomegranate caterpillar, mite, stem borer, etc.
- Spray for Control: If any pest or disease attack is observed, spray the entire plant with *Neemastra*, *Brahmastra*, *Agniastra*, *Jeevamrit*, Whapasa , and sour buttermilk.

8.17.1 Shri Ratilal Vitthaldas, Gujarat

Shri Sethia Ratilal Vitthaldas of Gunatitpur village, Bhachau Taluka, Kutch district, Gujarat, has achieved remarkable success in horticulture, vegetables, and mixed crops by adopting natural farming since the year 2008. He has developed a sustainable and profitable agricultural model by adopting innovations such as the five-tier crop system,

animal husbandry with Gir cows and bullocks, and mechanisation of *Jeevamrit*. On his farm, there are five automatic *Jeevamrit* tanks, and he uses only natural inputs such as *Jeevamrit*, *Brahmastra*, Saptadhanyakur extract, *Neemastra*, etc. He runs an indigenous seed bank and organizes workshops every month to train farmers.

Shri Ratilal obtained a production of 145 quintals from the natural farming of Sinduri variety of pomegranate, with a cultivation cost of ₹1,25,000 and a total profit reaching ₹4,22,000. The net profit was ₹2,97,000, and the benefit-cost ratio was 3.38. In contrast, in conventional farming, the production was 108.8 quintals, the cost was ₹2,50,000, and the net profit was only ₹74,000, with the benefit-cost ratio being only 1.30.

This difference shows that natural farming not only reduces production cost but also increases production and profit. With seed treatment by *Beejamrit*, hundred percent germination and protection from soil-borne diseases are ensured. The mixed cropping system, biofuel mulch, drip irrigation, and use of modern equipment save labor and time.

Shri Ratilal has developed a market of 500 regular customers for more than 200 natural products. He disseminated information through social media and obtained technical support by connecting with the ATMA project.

8.18 Potato[43]

Fig 8.18: Potato Crop

(i) **Land Preparation**

- Before planting potatoes, mix 100 kg of well-decomposed farmyard manure with 100 kg of *Ghanjeevamrit* per acre into the soil.

(ii) **Variety Selection, Seed Rate, and Spacing**

- **Varieties:** Kufri Pukhraj, Kufri Badshah, Kufri Jyoti
- **Seed rate:** 1.5–2.5 tons per hectare

43 https://naturalfarming.niti.gov.in/wp-content/uploads/2022/11/Package-of-Practices-Gujarat-.pdf

- **Spacing:** Row-to-row distance 45–60 cm and plant-to-plant distance 15–20 cm.

(iii) **Seed Treatment**

- Potato cultivation is done using tubers, either whole or cut into pieces.
- Many diseases spread through seed potatoes, which can cause severe losses. Hence, treating seed with *Beejamrit* is essential.

(iv) **Sowing Time**

- For higher yields, timely planting of potatoes is crucial.
- The best time is when maximum temperature is 30–32°C and minimum temperature is 18–20°C.
- **Early crop:** 25 September – 10 October
- **Main crop:** 15 October – 25 October
- **Timely sowing:** 15 October – 15 November

(v) **Irrigation Schedule**

- Potato crops require proper water management, and drainage of excess water is necessary.
- In natural farming, due to moisture conservation in the soil, irrigation should be done in moderate amounts.

(vi) **Application of *Jeevamrit***

- Apply 200 litres of *Jeevamrit* in soil with irrigation water at intervals of 15 days.

(vii) ***Jeevamrit* Sprays**

- One month after planting: 5 litres *Jeevamrit* mixed with 100 litres water
- 35 days after planting: 10 litres neem oil mixed with 150 litres water
- 40 days after planting: 10 litres *Jeevamrit* mixed with 150 litres water
- 43 days after planting: 10 litres sour buttermilk mixed with100 litres water
- 50 days after planting: 10 litres *Bramhastra* mixed with 10 litres *Agniastra* mixed with 200 litres water
- 65 days after planting: 20 litres *Jeevamrit* mixed with 200 litres water

(viii) **Mulching**

- After planting, apply mulching using crop residues.

(ix) **Crop Protection Measures**

- **Sucking pest control:** Spray 7.5 litres *Neemastra* with 250 litres water
- **Nematode control:** Soil drenching with *Brahmastra* @ 8 litres mixed with 100 litres water (8% solution)
- **Caterpillar control:** Spray 7.5 litres *Agniastra* mixed with 250 litres water
- **Fungal and viral disease control:** Spray 7.5 litres sour buttermilk mixed with 250 litres water

(x) **Harvesting** Time

- Harvesting is done **110 days after planting**.

8.18.1 Mrs. Bindu Devi, Bihar

Mrs. Bindu Devi from Patalghat village, Manpur block, Gaya district, Bihar, has given new dimensions to the possibilities of natural farming without any formal education.

She adopted the SRI (System of Rice Intensification) method for paddy, wheat, mustard, vegetables, and moong cultivation. She used:

- *Beejamrit* for seed treatment
- *Jeevamrit* and *Ghanjeevamrit* for crop nutrition
- *Neemastra*, *Agniastra*, and *Brahmastra* as natural pesticides for crop protection
- *Mathastra* and *Sothastra* as natural fungicides
- *Shri Amrit* and *Moongamrit* as plant growth regulators

For pest control, she also used pheromone traps, sticky plates, bird perches, and bonfires, along with mixed cropping and border cropping techniques. For water conservation, she adopted drip irrigation and mulching using live and dead grasses.

The most remarkable result was seen in potato cultivation on 0.04 hectare, where she obtained 12 quintals of production and a net profit of ₹14,800, while in traditional farming, the production was 7 quintals and the profit ₹5,000. Her benefit-cost ratio in potato was 4.6, which is five times higher than the traditional 0.9. These results clearly show that natural farming ensured reduction in production costs, improvement in soil health (increase in the number of earthworms), better quality and shelf life, and availability of chemical-free food grains.

8.19 Sugarcane[44]

Fig 8.19: Sugarcane Crop

44 https://naturalfarming.niti.gov.in/wp-content/uploads/2022/11/Package-of-Practices-Gujarat-.pdf

(i) **Bed Preparation**

- A total of 4 beds are prepared:
  - » Bed 1: Seasonal vegetables
  - » Bed 2: Seasonal pulses
  - » Bed 3: Seasonal vegetables
  - » Bed 4: Sugarcane (at points C and D), with onion or garlic planted on top
- For the first 3 months, all the beds are irrigated.
- After 3 months, when the sugarcane reaches a height of 4 feet, irrigation in beds 0 and 4 is stopped.
- After 3 months, the intercrops are harvested, which results in good sugarcane production.

(ii) ***Jeevamrit* Spray Schedule**

- One month after transplanting: Apply a mixture of 100 litres of water with 5 litres of *Jeevamrit*.
- Twenty-one days after the first spray: Apply 150 litres of water mixed with 20 litres of *Jeevamrit*.
- Twenty-one days after the second spray: Apply 200 litres of water mixed with 20 litres of *Jeevamrit*.
- Twenty-one days after the third spray: Apply 200 litres of water mixed with 5 litres of sour buttermilk.
- Twenty-one days after the fourth spray: Apply 200 litres of water mixed with 20 litres of *Jeevamrit*.
- Twenty-one days after the fifth spray: Apply 200 litres of water mixed with 20 litres of *Jeevamrit*.

(iii) **Intercropping**

- The life cycle of sugarcane can be divided into three stages:
  - » **First 4 months (Infant stage):** Roots grow rapidly.
  - » **Next 4 months (Juvenile stage):** Cane grows vigorously.
- Intercrops taken during the infant stage act as a nutritional reserve for sugarcane.
- After 4 months, sunlight falls directly on the cane, which enhances yield.
- Sugarcane should be planted facing south, as sunlight comes from the south and falls directly on the leaves.
- If the land has a steep slope, plant sugarcane opposite to the slope so that rainwater seeps into the soil.

(iv) **Irrigation Management**

- After sowing sugarcane, irrigate all channels for the first 3 months.
- After 3 months, when sugarcane reaches a height of 4 feet, stop irrigating channel 1.
- For the next 3 months, irrigate only channel 3.
- Stop irrigation in the remaining channels so that roots spread in search of water and become stronger.
- This helps to increase both the height and yield of sugarcane.
- Using this method, about 40,000 healthy canes per acre can be obtained.

(v) **Ratoon Crop**

- After harvesting sugarcane, allow the fallen leaves to dry.
- Then, move the dry leaves from channel 2 into channel 4, and from channel 1 into channel 3.
- Ensure that sugarcane sets are not covered - they should remain free for sprouting.
- After this, sow legume seeds in channel 2 and channel 4 to improve crop yield.

(vi) **Pest Management**

- When needed, mix 3 litres *Brahmastra* and 3 litres *Agniastra* with 200 litres of water and spray.
- This mixture helps in controlling pests.

(vii) **Disease Management**

- When sugarcane turns yellow or shows fungal infection, mix 3 litres sour buttermilk with 150 litres of water and spray.

(viii) **Weed Management**

- In sugarcane cultivation, do not allow any type of weed to grow during the first 3 months. Keep removing weeds from time to time.
- If weeds still remain after 3 months, cut them from the base of the crop and use them as mulch.
- By doing so, weeds actually help in improving sugarcane yield.

8.19.1 Mr. Sukhdev Singh, Punjab

Mr. Sukhdev Singh, a B.Sc. Agriculture graduate from Chamari village, Ajnala block, Amritsar district, Punjab, has set an inspiring example by adopting natural farming. He applied natural methods in food and vegetable crops and established a turmeric processing unit, vermicompost unit, and biogas plant, thereby making integrated use of resources. He prepared organic inputs like *Jeevamrit* on his own and applied them in fields. By using power tillers, transplanting machines, cono weeders, and rear-mounted implements, he reduced labor and energy costs. He is also active in

organic jaggery (gur) production and markets his products through Siddhagiri Natural Farmer Producer Company (FPC), ensuring fair prices and consumer trust. Every year, he benefits nearly 2,500 farmers through training programs and workshops. By adopting the SRI (System of Rice Intensification) technique in paddy cultivation, he successfully doubled his income - a testament to his innovation and leadership.

The economic benefits from sugarcane through natural farming are noteworthy. From one hectare of land, by doing natural farming, he obtained 113.75 quintals of jaggery, with a cultivation cost of ₹62,500, yielding a net profit of ₹7,33,750. His Benefit-Cost Ratio (BCR) was 11.74. In comparison, conventional farming produced 120.5 quintals, with a cost of ₹70,000 and a net profit of ₹5,92,650, giving a BCR of 8.46. Despite a slight difference in yield, natural farming proved more profitable because of lower input costs and better product quality. His efforts also led to increased grain and fodder production, labor and time savings, and the ensured availability of chemical-free produce. In 2015, he was honored with the "Best Farmer Award" by the Department of Agriculture, Amritsar, at a farmer's fair.

Mr. Sukhdev Singh's journey shows that with a scientific approach, ecological commitment, and farmer-to-farmer collaboration, farming can be transformed into a sustainable and highly profitable enterprise.

8.20 Turmeric[45]

Fig 8.20: Turmeric Crop

(i) **Pre-Monsoon Dry Sowing Preparation**

- Before turmeric planting, in April, line sowing of at least 9 types of crops (pulses, oilseeds, millets, vegetables, and leafy vegetables) should be done.
- The greater the seed diversity, the better the crop quality and biomass.
- Farmers can harvest a part of these crops for household consumption. The remaining biomass can be used as fodder, mulch, or incorporated into the main crop.

45 https://www.manage.gov.in/nf/pptspdfs/apcnf-gujarat.pdf

(ii) **Intercropping and Mixed Cropping of Turmeric**

- Turmeric can tolerate shade, so it can be grown as an intercrop in fruit orchards, coconut, or oil palm plantations.
- A 1:2 ratio of turmeric and maize is a preferred intercropping system.
- Vegetables like chili, onion, and brinjal can be grown as mixed crops in turmeric rows.
- Boundary crops can include yam, colocasia, and red gram.
- If nematodes are a problem, grow turmeric with marigold.

(iii) **Seed Treatment and Organic Nutrient Management**

- Treat with *Beejamrit*; then soak in *Trichoderma viride* @ 7 g/litre of water for 20 minutes and dry in shade.

(iv) **Inputs at Final Ploughing (per acre)**

- *Ghanjeevamrit*: 20 –25 quintal
- Neem cake: 300 kg

(v) ***Ghanjeevamrit* Application**

- 8 quintal per acre total
  - » 2 times @ 400 kg at the time of planting
  - » 400 kg @ 60 days after sowing using placement method

(vi) ***Jeevamrit* Application**

- Every 20 days interval, with irrigation, 11 times in crop season @ 200 litres/acre
- From 75 days onwards, after sowing until 275 days, at 20-day intervals

Foliar Spray:

- 13 times at 20 days interval in the entire crop period
- Schedule:
  - » 45 days after sowing: 5 litres *Jeevamrit* mixed with 125 litres water
  - » 65 days after sowing: 10 litres *Jeevamrit* mixed with 125 litres water
  - » 85 days after sowing: 15 litres *Jeevamrit* mixed with 150 litres water
  - » From 105 to 285 days after sowing: every 20 days, 30 litres *Jeevamrit* mixed with 150 litres water

(vii) **Growth Promoters and Pest Control**

- Saptadhanyakur

(viii) Important Practices in Turmeric Cultivation

- **Planting method**:
  - » Clay soils: raised beds/ridges and furrows
  - » Loamy soils: broad beds and furrows

- **Drainage:** ensure proper drainage to avoid waterlogging
- **Organic nutrition:** higher doses of *Jeevamrit* improve both yield and quality
- **Irrigation:** frequent irrigation needed during rhizome maturity
- **Crop rotation:** every 2 years, adopt multi-cropping with gingelly, sunflower, and millet
- **S2S Kit:**
- Follow all mandatory practices
- Make the kit available at NPM shops/FPOs/VOs before sowing

(ix) **Organic Pest Control Measures**

- Blue sticky traps: 20–25 per acre
- Bird perches: 10–15 per acre
- Light traps: 1 per acre
- Border crops: Castor, pigeon pea
- Trap crops: Chili, onion, marigold

(x) **365-Days Green Cover (DGC)**

- Immediately after turmeric harvest in March, do pre-monsoon dry sowing.
- Line-sow any 9 types of seeds, including sesame, sunflower, millet in multi-cropping systems.
- Repeat pre-monsoon dry sowing afterward.

8.20.1 Shri Tulsiram Chatur, Maharashtra

Shri Tulsiram Sitaram Chatur, a resident of Kutanga village, Dharni taluka, Amravati district, Maharashtra, is a dedicated farmer educated up to class 12.

He used *Jeevamrit* and *Beejamrit* for soil and seed treatment in crops like sorghum, indigenous wheat (*Bansi*), onion, and vegetables. He successfully practiced mulching and moisture management techniques. For pest and disease control, he used organic solutions such as neem extract and *Dashparni Ark*.

Shri Tulsiram Chatur's natural farming method has delivered remarkable economic outcomes, particularly in turmeric cultivation. On 0.4 hectares, he cultivated turmeric using both natural and conventional methods, producing 25 quintals in each. The cost of cultivation was ₹65,000 under natural farming compared to ₹1,00,000 under conventional farming. As a result, the net profit was ₹3,10,000 from natural farming, while conventional farming yielded a net profit of ₹2,75,000. The benefit–cost ratio was significantly higher under natural farming at 5.8, as against 3.8 under the conventional method.

8.21 Vegetables[46]

Fig 8.21: Vegetables Crop

(i) **Crop Combinations**

Kharif Season:

(a) Tomato + French beans + Brinjal

(b) Cucumber + French beans + Okra

Rabi Season:

(a) Pea + Spinach + Fenugreek

(b) Cabbage + Fenugreek + Coriander

(ii) **Planting Geometry**

Kharif Season:

- Main crops: Tomato / Cucumber
- Intercrops: French beans, Okra, and Brinjal
- Spacing of main crops:
  - » Tomato: 90 cm × 30 cm
  - » Cucumber: 90 cm × 90 cm
- Sowing/planting period: April–May
- Intercrops: Sown alternately between main crops at 30 cm spacing
- Major varieties:
  - » Tomato (Var. Solan Lalima)
  - » Cucumber (Var. Cucumber-90)

46 *Package of Practices for Vegetable Crops based system under Natural farming approved during State level workshop for cultivation in the state jointly held at CSK HPKV, Palampur and Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh.*

  - French beans (Var. Contender)
  - Brinjal (Var. Pusa Purple Long / Pusa Purple Cluster)
  - Okra (Var. P-8)

Rabi Season:

- Main crops: Pea / Cabbage
- Intercrops: Fenugreek, Coriander, and Spinach
- Spacing of main crops:
  - Pea: 60 cm × 10 cm
  - Cabbage: 60 cm × 45 cm
- Sowing/planting period: October–November
- Intercrops: Sown alternately between main crops at 30 cm spacing
- Major varieties:
  - Pea (Var. PB-89, Azad P-1)
  - Cabbage (Var. Golden Acre)
  - Fenugreek (Var. IC-74)
  - Spinach (Var. Pusa Harit)
  - Coriander (Var. Solan Selection)

(iii) **Field Preparation:**

- Irrigate the field and plough 2–3 times with a power tiller.
- Level the soil and maintain adequate moisture.
- Prepare raised beds of 1.2 meters width with drainage channels in between, ensuring **Whapasa rows** (moisture balance).
- Apply *Ghanjeevamrit* @10 quintals per hectare in prepared beds.

(iv) **Cultural Practices to be followed**

- **Seed/Seedling treatment using *Beejamrit*:**
  - Soak large seeds in *Beejamrit* for 3–4 hours.
  - Soak small seeds for 1–2 minutes.
  - Dip seedling roots in *Beejamrit* for half an hour.
- **Application of *Ghanjeevamrit*:**
  - Apply twice: Half dose at the time of final field preparation
  - Remaining half dose one month after sowing/planting

- **Application of *Jeevamrit*:**
  - » **Soil application:**
  - » Apply 500 litres per hectareof *Jeevamrit* mixed with water at sowing/ planting.
  - » Repeat every 10–15 days during crop growth.
  - » **Foliar spray:**
  - » One month after sowing/planting @10% (10 litres *Jeevamrit* + 100 litres water)
  - » 15–20 days later @10% (10 litres *Jeevamrit* mixed with 100 litres water)
  - » 15–20 days later @15% (15litres *Jeevamrit* mixed with 100 litres water)
  - » 15–20 days later @20% (20 litres *Jeevamrit* mixed with 100 litres water)
- **Acchadana/Mulching:**
  - » Use organic residues or live mulch.
  - » Reduces tillage, suppresses weeds, increases humus formation, and improves soil water retention.
  - » Enhances microbial activity and nutrient recycling.
- **Whapasa**:
  - » Provide water in Whapasa rows and cover with mulch.
  - » *Whapasa* means 50% air and 50% moisture between two soil particles.
  - » This micro-environment supports microbes and roots, improving water availability, water-use efficiency, and drought tolerance.
- **Disease Management:**
  - » Spray 3–5 days old sour buttermilk @3% (3 litres mixed with 100 litres water), 2–3 times during crop period.
  - » Apply *Sothastra* spray when required.
- **Application of *Saptadhanyankur*:**
  - » Spray freshly prepared *Saptadhanyankur*, 1–2 times to improve crop quality.
  - » First spray: 45 days after sowing/planting
  - » Second spray: One month after the first spray
- **Pest Management:**
  - » Spray *Agniastra*, *Brahmastra*, *Neemastra/Darakastra*, and *Dashparni Ark* @3%.
  - » If crop loss due to pests is less than 5%, it is considered to be ‘return to nature’ and no plant protection measures should be taken.

8.22 Wheat[47]

Fig 8.22: Wheat Crop

(i) **Land Preparation**

- Along with the available farmyard manure, mix and apply 250 kg *Ghanjeevamrit* per hectare into the soil during field preparation.

(ii) **Varieties**

- **For** timely sowing: Lok-1, GW-366, GW-322, GW-496, GW-451, GW-503, GW-190, GW-273
- For limited irrigation: GW-1139, GW-1255, HI-8489

(iii) **Seed Rate and Seed Treatment**

- For regular sowing, 125 kg seed per hectare is required, while for late sowing, 125–150 kg seed per hectare is needed.
- Treat the seeds with *Beejamrit* to prevent soil-borne diseases such as root rot and seedling rot.
- The treatment should be done one night before sowing, dry the seeds overnight and sow them the next morning.

(iv) **Time of Sowing**

- Early sowing: First week of November
- Timely sowing: 10–15 November
- Late sowing: 25 November – 15 December

(v) **Spacing**

- Row-to-row spacing – 25 cm
- Plant-to-plant spacing – 7.5 cm to 10 cm

47 https://naturalfarming.niti.gov.in/wp-content/uploads/2022/11/Package-of-Practices-Gujarat-.pdf

(vi) **Irrigation Schedule**

- First irrigation: 20–25 days after sowing (crown root initiation stage)
- Second irrigation: 40–45 days after sowing (tillering stage)
- Third irrigation: 70–75 days after sowing (late jointing stage)
- Fourth irrigation: 90–95 days after sowing (flowering stage)
- Fifth irrigation: 110–115 days after sowing (dough stage)

(vii) **Application of *Jeevamrit* with Irrigation Water**

- Apply 200 litres of *Jeevamrit* per acre with irrigation water.
- Thereafter, apply 200 litres of *Jeevamrit* twice a month with irrigation water.

(viii) ***Jeevamrit* Spraying Schedule**

- After 30 days of sowing: 12.5 litres *Jeevamrit* mixed with 250 litres water
- After 51 days of sowing: 19 litres *Jeevamrit* mixed with 300 litres water
- After 72 days of sowing: 25 litres *Jeevamrit* mixed with 375 litres water
- After 83 days of sowing: 37.5 litres *Jeevamrit* mixed with 375 litres water
- After 104 days of sowing: 7.5 litres sour buttermilk mixed with 250 litres water

(ix) **Mixed / Intercropping**

- Pigeon pea, maize, marigold, sesame, etc. can be grown as intercrops.

(x) **Crop Protection Measures**

- Sucking pest control: Spray *Neemastra* 7.5 litres mixed with 250 litres water
- Nematode control: Soil drenching with *Brahmastra* 8% solution (8 litres / 100 litres water)
- Caterpillar control: Spray *Agniastra* 7.5 litres mixed with 250 litres water
- Fungus and virus control: Spray sour buttermilk 7.5 litres mixed with 250 litres water

8.22.1 Shri Narendra Singh Mehra, Uttarakhand

Shri Narendra Singh Mehra, a resident of Devla Malla village in Haldwani block, Nainital district, has emerged as a leading farmer in the field of natural farming.

A Postgraduate Diploma holder in Geography and Tourism, Shri Mehra has transformed his academic knowledge into practical innovations. Since 2017, he has been practising natural farming with inputs such as *Beejamrit*, *Jeevamrit*, and botanical extracts for plant protection. He introduced wheat–garlic intercropping and adopted direct seeding of paddy.

A comparison of natural and conventional wheat cultivation on 1 hectare showed a clear difference. Under natural farming with the “Narendra-09” variety, he harvested 24 quintals of wheat and earned a net profit of ₹53,400, while conventional farming

with the "PBW-154" variety yielded 22 quintals with a profit of only ₹26,800. The benefit-cost ratio was 5.6 in natural farming-more than double that of conventional farming (2.53).

References & Additional Readings

- Acharya, D. (2023). *Natural Farming*. Gujarat Natural Farming and Organic Agricultural University, Anand.
- Agarwal, M., Agarwal, S., Ahmad, S., Singh, R., & Jayahari, K. M. (2021). FOOD LOSS AND WASTE IN INDIA: THE KNOWNS AND THE UNKNOWNS (Working Paper). Mumbai, India: World Resources Institute India. Retrieved from http://www.wri.org/publication/food-loss-and-waste-in-india
- Directorate of Agriculture, ATMA & SAMETI. (n.d.). Lecture Outline Framework: Natural Farming- Curriculum. Gandhinagar, Gujarat.
- Lecture Outline Framework: Natural Farming -Curriculum, ATMA & SAMETI Directorate, Gujarat
- Tamil Nadu Agricultural University. (2014, November). Organic farming practices for groundnut: Seed. Retrieved from
- Tamil Nadu Agricultural University. (n.d.). Organic farming practices for paddy: Seed. Retrieved from https://agritech.tnau.ac.in/org_farm/orgfarm_prac_agri_paddy_seed.html
- Training manual for Organic Agriculture by the Food and Agriculture Organisation of the United Nations (FAO). 2015 (https:/ /www.fao.org > fileadmin > templates > docs)

CHAPTER 9

Carbon Credits in Natural Farming

9.1 Introduction

Natural Farming is an agricultural system that eliminates the use of all synthetic chemical inputs and promotes on-farm biomass recycling to enhance soil biology. Beyond its well-documented benefits for farmers and ecosystems, natural farming holds immense potential in combating climate change. By reducing greenhouse gas (GHG) emissions and increasing carbon sequestration in soils and vegetation, natural farming systems can generate carbon credits**,** tradable units that represent one metric ton of carbon dioxide (CO_2) or its equivalent reduced or removed from the atmosphere.

These credits can be sold in carbon markets, opening up an additional income source for farmers while helping industries and governments meet their emission reduction targets. As India strives toward its Nationally Determined Contributions (NDCs) under the Paris Agreement, integrating natural farming with carbon credit mechanisms offers a strategic opportunity for rural development and climate action.

9.2 What are Carbon Credits?

A carbon credit is a verified certificate representing 1 tonne of CO_2 equivalent (tCO_2e) emissions avoided, reduced, or sequestered. They can be generated by various climate-friendly projects, including forestry, renewable energy, and now, increasingly, climate-smart agriculture. Credits can be sold in two main markets:

9.2.1 Voluntary Carbon Markets (VCM) – Companies or individuals buy credits to offset their emissions voluntarily.

9.2.1 Compliance Markets – Regulated by governments under emission trading schemes.

For natural farming, credits usually fall under “soil carbon sequestration” and “methane/nitrous oxide reduction” categories.

9.3 Carbon Credits Generation in Natural Farming

In natural farming, the accumulation of stable carbon in the soil is driven by the constant addition of biomass through mulching and the enhanced activity of microorganisms. This system converts agricultural lands into carbon sinks, which mitigates climate change and improves the water-holding capacity of the soil. This enhancement increases resilience to drought and rainfall variability. While precise large-scale quantification is an ongoing area of research, the foundational principles align directly with the objectives of carbon farming. Natural farming employs multiple regenerative practices that either remove carbon from the atmosphere or prevent its release:

9.3.1 Increased Organic Matter Addition

(i) Regular application of farmyard manure (FYM), compost, crop residues, and green manures builds soil organic carbon.

9.3.2 Agroforestry and Tree Integration

(i) Incorporating trees, hedges, and perennials enhances aboveground and belowground biomass carbon.

9.3.3 Mulching and Cover Cropping

(i) Maintains continuous soil cover, prevents erosion, and adds biomass.

9.3.4 Reduced Tillage and Soil Disturbance

(i) Helps preserve existing carbon stocks by minimizing oxidation.

9.3.5 Elimination of Synthetic Inputs

(i) Avoids nitrous oxide emissions from chemical fertilizers and reduces energy footprint.

9.4 Steps to Generate Carbon Credits in Natural Farming

The stepwise flow for carbon credits estimation and trading in natural farming can be learnt from Fig. 9.1.

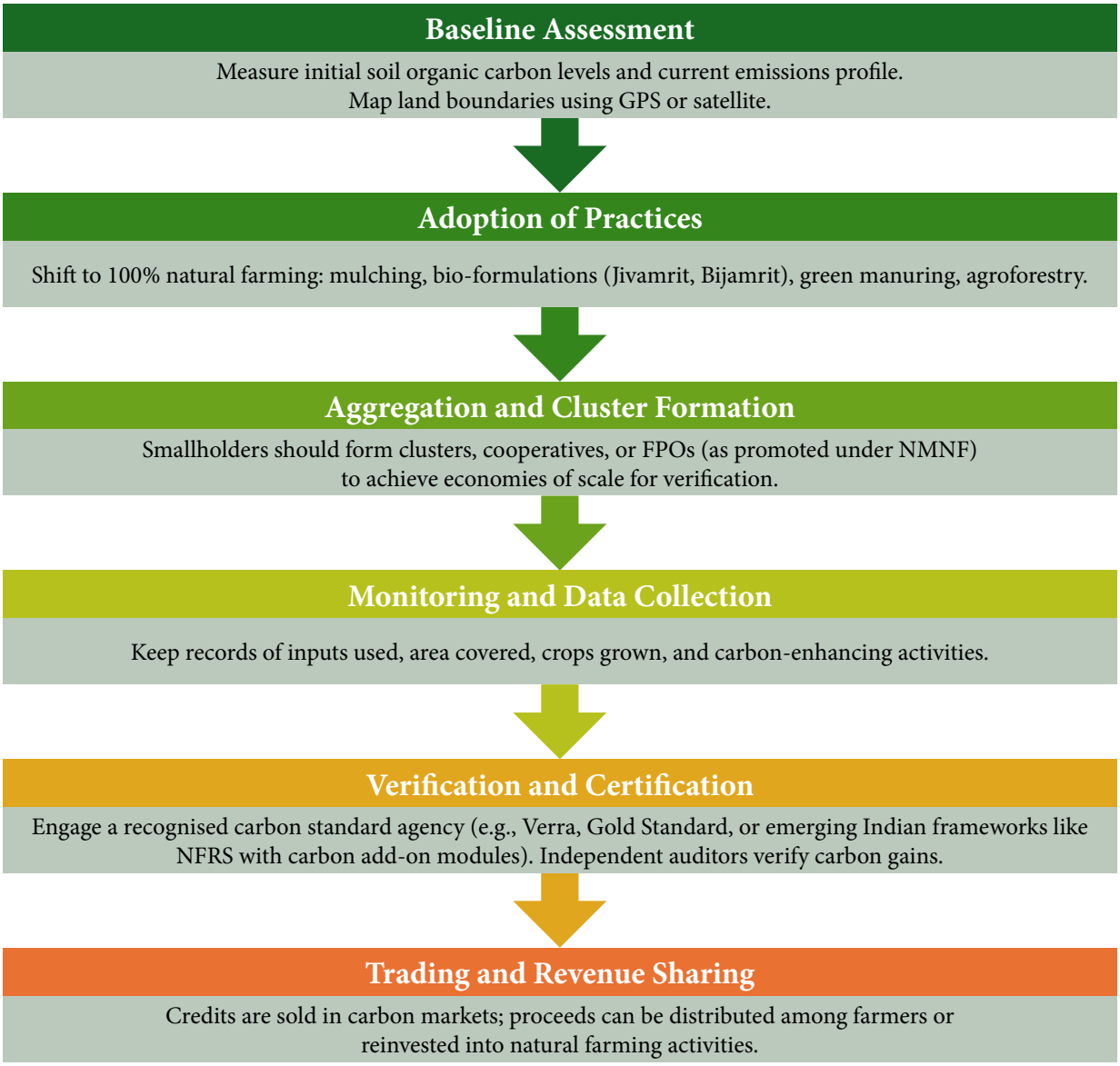

Fig. 9.1: Process Flow for Carbon Credit Generation under Natural Farming

Conclusion

Carbon credits in natural farming represent a win–win solution: they reward farmers for climate-positive practices, reduce national GHG emissions, and attract new forms of green finance into rural areas. While challenges remain, especially related to certification costs and awareness, India's large-scale initiatives like NMNF provide the ideal framework for rolling out carbon credit programs. With proper support, a farmer practicing natural farming can not only restore soil and ecosystem health but also earn while healing the planet.

CHAPTER 10

Integrated Framework and Toolkit for Natural Farming

This report presents a comprehensive and integrated vision for the implementation of Natural Farming across India, framing it not merely as an alternative set of agricultural techniques, but as a foundational paradigm shift toward ecological resilience, farmer profitability, and food sovereignty. It offers a science-based, systematic approach that moves away from the high-cost, high-risk model of chemical-dependent agriculture to a self-reliant system rooted in agroecological principles. Its central argument is that by revitalising the living soil and working in harmony with natural processes, farmers can break the cycle of debt, restore their land, and produce nutritious, chemical-free food, thereby addressing some of the most pressing economic and environmental challenges facing Indian agriculture today.

At the heart of this framework is the principle of shifting the focus from "feeding the plant" with synthetic inputs to "nurturing the soil ecosystem." A healthy, vibrant soil, teeming with microbial life, is the true engine of farm productivity. This living soil can unlock and make available all essential plant nutrients in a balanced form. Achieving such soil vitality requires the regular preparation and application of on-farm microbial inoculants. The journey begins with *Beejamrit*, a seed treatment made from cow dung, cow urine, and other local ingredients, which coats the seed with protective beneficial microbes, ensuring robust germination and safeguarding young seedlings from soil-borne pathogens. This is followed by routine applications of *Jeevamrit*, a potent liquid microbial culture that multiplies soil microbial populations, and *Ghanjeevamrit*, its solid, storable counterpart, applied as a basal dose to build long-term fertility.

Building on this microbial foundation, the practice of Acchadana or mulching is emphasised to keep the soil covered 365 days a year. Bare soil is considered vulnerable and unproductive. Applying straw, crop residues, or other biomass not only conserves moisture and suppresses weeds, but also feeds soil organisms continuously, promoting the ideal Whapasa condition - the optimal balance of air and water in soil pores. Complementing mulching is the practice of 365-Day Green Cover (DGC), often initiated through Pre-Monsoon Dry Sowing (PMDS) of diverse cover crops, which prevents erosion, enhances water infiltration, and maintains a living root network to feed the soil food web year-round.

The framework also recognises biodiversity as a cornerstone of resilience and natural pest regulation. Instead of fragile monocultures, it advocates polyculture through intercropping and mixed cropping, integrating legumes, cereals, oilseeds, and vegetables to disrupt pest cycles, improve nutrient cycling, and diversify income sources. Border crops, trap crops such as marigold, and bird perches are integrated as functional design elements to create a balanced on-farm ecosystem where beneficial species thrive and pests are naturally controlled.

Empowerment through Atma Nirbharta (self-reliance) is central. Farmers are provided with clear, step-by-step guidance to prepare all necessary inputs on-farm, from microbial inoculants to botanical pest repellents such as *Neemastra*, *Agniastra*, and *Brahmastra*, using low-cost, locally available resources. This drastically reduces input costs, alleviating indebtedness, while preserving traditional, chemical-free post-harvest handling methods for cleaning, curing, and storage to maintain quality and reduce losses.

Economic viability is strengthened by integrating production with formal recognition and market access. Farmers are guided to obtain certification, particularly through the Participatory Guarantee

System (PGS-India), a cost-effective, peer-verified mechanism endorsed by the Government of India, enabling even smallholders to access premium markets for naturally grown produce.

In this manual, the principles above have been explored in detail in their respective chapters: the science of Natural Farming (Chapter 1), seed and soil management (Chapters 2–3), water conservation (Chapter 4), pest and disease control (Chapter 5), bio-input preparation (Chapter 6), and certification and marketing (Chapter 7).

This chapter distils that body of knowledge into a practical, end-to-end operational framework for farmers and extension officers. For farmers, it outlines what to do, what to know, and what to have across the crop cycle. For extension officers, it presents a four-pillar strategy for persuasion, training, input support, and marketing - ensuring that Natural Farming adoption is systematic, supported, and sustainable at scale.

10.1 Farmer's Toolkit: End-to-End

The farmer's toolkit is structured to address the complete agricultural cycle. It should be used as both a checklist and a planning tool. The three sections that follow describe the activities to be undertaken, the knowledge to be acquired, and the resources to be secured.

10.1.1 What a Farmer Should Do

The key actions in Natural Farming follow the seasonal cropping sequence. Each stage has specific tasks that must be completed within a defined time window to ensure success. They are summarised in Table 10.1.

Table 10.1: Timeline of Farmer's Key Natural Farming Actions

Crop Stage	Key Actions	Chapter Reference
Pre-Season (4–8 weeks before sowing)	Registration with the State NF Cell or the National Mission on Natural Farming portal; enrolment in crop insurance schemes; baseline soil and water testing; selection and procurement of indigenous seeds; Scheduling preparation of bio-inputs such as *Jeevamrit* and *Ghanjeevamrit*; Initiating baseline data collection for carbon credit registration	1, 2, 6, 8, 9, 11

Crop Stage	Key Actions	Chapter Reference
Pre-Sowing (1–2 weeks before sowing)	Land preparation using minimum tillage, contour bunding, and mulching; Seed treatment with *Beejamrit*; Preparation of *Jeevamrit*, *Ghanjeevamrit*, and botanical pest-repellent extracts.	2, 3, 4, 6, 8
Establishment Stage	Sowing or transplanting as per crop requirement; installation and inspection of irrigation systems; first application of *Jeevamrit* to promote root establishment	2, 6, 8
Vegetative Stage	Application of *Jeevamrit* at intervals of 7–15 days; use of botanical sprays to prevent pest outbreaks; maintenance of organic mulch for weed suppression and moisture conservation	3, 4, 5, 6, 8
Reproductive Stage	Targeted botanical pest and disease management; adjustment of irrigation to flowering and grain-filling needs; maintaining detailed records for certification and carbon credits	4, 5, 7, 8, 9
Harvest and Post-Harvest Stage	Marketing and certification	7

10.1.2 What a Farmer Should Know

Successful Natural Farming requires not just action but understanding. Farmers should be familiar with the following know-hows before initiating natural farming (Fig. 10.1).

The scientific principles of soil ecology and the role of beneficial microorganisms in nutrient cycling.

The composition, preparation methods, dosage, and application schedules for bio-inputs such as *Jeevamrit*, Ghan *Jeevamrit*, and botanical extracts, as described in Chapter 6.

Water conservation and irrigation scheduling practices outlined in Chapter 4, including micro-irrigation methods and in-field water harvesting.

Ecological methods for pest, disease, and weed management explained in Chapter 5, including trap cropping, botanical sprays, and mulching strategies.

Certification systems for Natural Farming, including Participatory Guarantee Systems (PGS) and third-party certification processes, as described in Chapter 8.

The concept of carbon credits, eligibility criteria, registration procedures, and potential revenue streams.

Post-harvest handling, grading, and NF-compliant storage practices from Chapter 7.

Record-keeping requirements for both certification and carbon credit verification.

Fig. 10.1: The Know-Hows of Natural Farming

10.1.3 What a Farmer Should Have

Natural Farming requires certain resources to be available and maintained in good condition throughout the year. The Essential Resources for Natural Farming are summarised in Table 10.2.

Table 10.2: Essential Resources for Natural Farming

Resource Category	Details
Livestock	At least one indigenous cow for bio-input preparation; poultry or ducks for integrated pest management
Bio-Input Infrastructure	Covered shed for fermentation; drums or tanks for liquid bio-inputs; sieves and stirring implements

Resource Category	Details
Seed Resources	Indigenous seed stock and access to community seed banks
Mulching Material	Crop residues, green biomass, or tree leaves for soil cover
Irrigation Facilities	Drip or sprinkler systems; farm pond or other rainwater harvesting structures
Post-Harvest Facilities	NF-compliant storage bins; grading tables; packaging materials for market-ready produce

10.2 Extension Officers' Framework for Natural Farming Promotion

Extension officers are the primary link between policy initiatives and farm-level implementation. Their work spans farmer registration, persuasion, training, provision of input support, and market linkage facilitation. This framework organises their responsibilities into four coordinated pillars as given in Table 10.3.

Table 10.3: Extension Officer's Four-Pillar Action Matrix

Pillar	Key Actions	Expected Outcome
Persuasion	Organise exposure visits to established NF farms; conduct sensitisation workshops; facilitate dissemination of NF information through local meetings; form NF farmer clusters; establish Bio-Resource Centres (BRCs); connect farmers with carbon credit agencies	Increased adoption of NF practices
Training	Deliver structured training on NF science; demonstrate preparation and use of bio-inputs; link farmers to nearby BRCs; train community resource persons	Enhanced farmer competence and self-reliance
Input Support	Coordinate timely supply of seeds and bio-inputs through BRCs; facilitate on-farm bio-input production; support infrastructure development for irrigation and storage	Improved readiness for each crop stage
Marketing	Assist farmers in certification processes; support branding and packaging; connect farmers to premium NF markets	Better price realisation for NF produce

10.3 Conclusion

This integrated framework consolidates the key technical, operational, and institutional elements necessary for the adoption and scaling of Natural Farming. By following the actions outlined in **What to Do**, acquiring the skills in **What to Know**, and maintaining the assets in **What to Have**, farmers can transition to Natural Farming with confidence.

Extension officers, by applying the four-pillar framework, can ensure that farmers are supported from registration to market access, resulting in both environmental and economic benefits. Natural Farming is therefore not only a set of techniques but a pathway towards ecological balance, rural livelihood security, and long-term sustainability.

CHAPTER 11

Farmer Support Arrangements for Natural Farming

11.1 Introduction

Transitioning to natural farming requires more than knowledge of ecological practices. Farmers need institutional, financial, and infrastructural support to successfully shift from chemical-intensive farming. The Government of India has introduced several schemes to support this transition by offering financial incentives, technical training, infrastructure development, and marketing assistance. This chapter provides a detailed, step-by-step guide to four major schemes:

- National Mission on Natural Farming (NMNF)
- PM PRANAM (Programme for Restoration, Awareness Generation, Nourishment and Amelioration of Mother Earth)
- SATAT (Sustainable Alternative Towards Affordable Transportation)
- GOBARDHAN (Galvanizing Organic Bio Agro Resources Dhan)

11.2 National Mission on Natural Farming (NMNF)

11.2.1 Objectives

(i) To promote nature-based sustainable systems of farming, enhancing the usage of on-farm prepared bio-inputs to reduce dependency on externally purchased inputs and lower the input costs.

(ii) To improve soil health and promote sustainable agriculture practices.

(iii) To popularise livestock (preferably local breed of cow) integrated agriculture-animal husbandry models.

(iv) To strengthen on-farm agroecological research and knowledge-based extension capacities of ICAR institutions, KVKs, Agricultural Universities, etc.

(v) To build upon the on-field experience of practicing NF farmers and scientific expertise to thereby evolve & improvise location specific NF package of practices for increased spread of NF.

(vi) To establish scientifically supported common standards and easy farmer friendly certification procedures for naturally grown chemical-free produce.

(vii) To create and promote a single national brand for naturally grown chemical-free produce.

11.2.2 Eligibility

(i) All farmers, including tenant farmers and sharecroppers.

(ii) Farmer Producer Organisations (FPOs), cooperatives, and Self-Help Groups (SHGs).

(iii) Clusters organised at village or block level (minimum cluster size is 50 hectare and 125 farmers, which can include individual or pooled holdings).

11.2.3 Execution of the Mission

(i) **Cluster Identification and Registration:** Clusters of minimum 50 ha are identified by state agriculture departments or farmer collectives.

(ii) **Submission of Cluster Plan:** Details of farmers, crops, proposed natural inputs, and resource mapping must be submitted.

(iii) **Capacity Building and Training:** Farmers undergo training programs organised by state or central agencies.

(iv) **Approval and Fund Release:** Cluster plans are reviewed and approved by state-level committees. Funds are released in a phased manner under the NMNF.

11.2.4 Key Support Arrangements of the Mission

(i) **NF Demonstration Farms:** Approximately 2060 NF model demonstration farms will be established for hands-on training on natural farming. The NF model demonstration farms will be established by each of the 665 training institutes:

- Three at farmers' fields and one at on-station developed by each of the 425 Krishi Vigyan Kendra (KVKs) and 40 Agricultural Universities (AUs).
- One NF model demonstration farm will be established by each of the 200 LNFI. Further, FMT, Krishi Sakhis (Community Resource Persons - CRP) will also have their farms as NF model demonstration farms.
- The NF demonstration farms shall receive the following benefits[48]:
  - ₹50,000/- per NF model demonstration farm, as per actuals, for 2 years
  - One time Costs: ₹10,000
  - Tools, equipment for input preparation: ₹5000
  - Other Infrastructure - boards, posters, etc.: ₹5000
  - Support per season for 2 years (4 seasons): ₹10,000
  - Raw materials for input preparation: ₹4000
  - Biomass mulching material: ₹4000
  - Seed and planting materials: ₹2000

(ii) **Support for BRCs:**

- A support of ₹100,000/- (per BRC) is provided for setting up of Bioinput Resource Centres.
- Further, training and capacity building for BRC entrepreneurs is also

48 https://agriwelfare.gov.in/Documents/HomeWhatsNew/GuidelineofNMNF_FinalApproved_27122024.pdf

provided under the mission.

(iii) **Certification:** A support of ₹2100/- per hectare is provided for NF Certification for the trained willing farmers.

(iv) **Training and Capacity Building:**

- Farmer Training shall be organised at KVK/ AU/ LNFI.
- Local Natural Farming Institutions (LNFI) are fully functional NF farms existing for more than 3 years in at least 2 acres of land, which are already used as training sites. LNFI will be identified by State/ UTs and onboarded on the NMNF IT portal.
- The on-field training and extension system will be supported by Farmer Master Trainers (FMT) - farmers who are practicing NF for a minimum of 3 years and their farms would also serve as NF model demonstration farms.
- The Krishi Sakhis (CRP) will undergo on-field hands-on training by FMTs and Scientists/ Experts associated with KVK/ AU/ LNFI. A team of 2 Krishi Sakhis (CRP) will mobilise approximately 125 willing farmers and form a cluster (cumulative area of 50 ha).

Support for exposure visits, marketing linkages, and certification processes is provided.

11.3 SATAT

11.3.1 Objectives

(i) Promote the production of Compressed Bio-Gas (CBG) from agricultural residues, animal dung, and other organic wastes.

(ii) Create a market for crop residues which otherwise may be burnt or wasted.

(iii) Provide nutrient-rich organic slurry and compost as by-products for use in natural farming.

11.3.2 Eligibility

(i) All the existing and upcoming CBG projects using at least 50% biomass (Agri residue) as feedstock as per Detailed Project Report (DPR).

(ii) CBG projects must have an installed or proposed CBG production capacity of at least 2 tonnes per day (TPD) and be registered on the GOBARdhan portal.

(iii) Under construction projects with at least 50% of physical progress as per DPR shall be considered eligible.

(iv) CBG project has not availed any benefits/ subsidy/ assistance on the machinery/ equipment to be procured under this scheme from any other Central Government/State Government schemes.

11.3.3 Procedure for Application

(i) Locate nearby SATAT-affiliated CBG plants through oil marketing company (OMC) websites or state energy departments.

(ii) Sign an agreement with the plant operator for supply of crop residues, dung, or organic waste.

(iii) The application for financial assistance may be submitted on the designated portal (https://satat.co.in/satat/#/) on quarterly basis between 1st to 30th day of every quarter. For example, for the quarter April- June 2024, the applications can be submitted between 1st April to 30th April 2024.

(iv) Application will be examined by Project Management Agency (PMA). PMA will shortlist selected beneficiary within the approved budget and submit the same to PAC on monthly basis. Project Appraisal Committee (PAC) will recommend to Project Approval Board (PAB). After PAB approval, PMA will send the approval to beneficiary and Central Nodal Agency (CNA).

(v) After approval, CBG producer shall deposit: (i) CBG producer shall deposit the total cost of the Biomass Aggregation Machinery (BAM) in OEM /its authorised dealer/distributor account from their own fund, (ii) Margin money in OEM /its authorised dealer/distributor account and avail credit facility availed from banks and financial institutions for remaining cost of the BAM.

(vi) The CBG producer will receive the equipment as elucidated in scheme guidelines.

(vii) The CBG producer will upload the application for release of financial assistance along with relevant documents on the designated portal for release of funds. After receiving documents, PMA will conduct physical verification of the equipment and upload verification report.

(viii) PMA will submit the proposal along with recommendation for release of FA to the Ministry. Ministry shall process the proposal and, after due approval, release the funds to the CNA for releasing the financial assistance in Bank/ financial institution/Beneficiary' account as the case may be. CNA will release the financial assistance.

(ix) Deliver biomass periodically based on plant requirements. Beneficiary will upload a report of quantity of biomass collected from these BAM sets in last calendar year by 31st January of next year.

(x) Collect the by-product slurry or compost, which can be used directly or after further curing.

(xi) Beneficiary shall get the eligible equipment/ machinery of value above Rs. 5 lakhs suitably insured against loss by damage, theft, fire, act of God, etc.

11.3.4 Key Support Arrangements of the Scheme

- Maximum financial assistance of 50% of the procurement cost of biomass aggregation machinery or Rs. 90 lakh per set (whichever is less) will be admissible as grant to a CBG producer.
- The financial assistance of Rs. 1.8 crore for 4 TPD CBG capacity project would be provided with a capping of Rs. 9 crore per project on pro rata basis.

11.3.5 Benefits

- Additional income from sale of agricultural residues or animal waste.
- Access to high-quality organic manure or slurry at low or no cost.
- Contribution to waste management and reduction of stubble burning.
- Opportunity for FPOs to set up value-added services like slurry enrichment.

11.4 GOBARDHAN

11.4.1 Objectives

To support the setting up of Waste to Energy projects for generation of Biogas/ BioCNG/ Power/ producer or syngas from urban, industrial and agricultural wastes/residues.

11.4.2 Eligibility

- The company or a partner of the Consortium, JV/ SPV interested in availing the benefits of the programme can be Local Bodies / Municipal Corporations, Govt. or Private Sector Companies/ firms, Central Public Sector Undertaking (CPSU), Joint Sector Companies, Trusts, NGO, Societies, Cooperatives, Entrepreneurs, Partnership firms, Limited Liability Partnerships, Energy Service Companies (ESCOs).
- Gaushalas seeking benefits of the scheme should be registered with the state government.

11.4.3 Application Procedure

(i) **Submission of proposal:** The proposal for grant of "In-Principle" approval of Central Financial Assistance (CFA) will be accepted through BioURJA Portal (https://biourja.mnre.gov.in) before commissioning of the proposed plant.

(ii) **In-principle approval:**

- In case loan drawn by the developer of Waste to Energy plant is equal or more than from eligible CFA, the Implementation Agency shall receive the applications through BioURJA portal, examine the applications and shall forward the consolidated proposal to Ministry on bimonthly basis. The Ministry shall issue an "In-Principle" approval with the concurrence of IFD and approval of Secretary, MNRE.

- For projects without debt/loan or projects wherein loan drawn by the developer of Waste to Energy plant is less than the eligible CFA, the Implementation Agency shall receive the applications through BioURJA portal, examine the applications and thereafter the applications will be put up to Project Appraisal Committee (PAC). Only PAC recommended applications will be forwarded to Ministry in a consolidated manner on bimonthly basis. The Ministry shall issue an "In-Principle" approval with the concurrence of IFD and approval of Secretary, MNRE.

(iii) **Commissioning of the plant:**

- The time period for commissioning is 24 months for WTE plants and 12 months for Biomass Gasifiers from the date of "In-Principle" approval.
- After submission of application in the BioURJA portal, if developers intend to commission the plant before "In-Principle" approval of CFA is accorded, prior intimation of commissioning the plant to IA is mandatory.

(iv) **Plant performance:** Inspection team will visit the plant for performance inspection based on request from the developer. The performance inspection of the plant will have to be carried out within 18 months from the date of commissioning beyond which "In-Principle" approval will be cancelled except in those cases where reason(s) of delay in inspection is (are) beyond the control of developer.

11.4.4 Key Support Arrangements in the Scheme

Standard pattern of CFA for grant of 'In-principal Approval' to Waste to Energy projects under the programme is as given in Table 11.1.

Table 11.1: GOBARDHAN Scheme: Standard Pattern of CFA for Waste To Energy Projects

S.No.	Type of project	Standard CFA rate @ installed capacity of the plant
1	Biogas	Rs 0.25 Cr per 12000 cubic metres (maximum CFA of Rs. 5.0 Cr/project)
2	BioCNG / Enriched Biogas/ Compressed Bio Gas	-Rs 4.0 Cr per 4800 kg/day *(for BioCNG generation from new biogas plant)* -Rs 3.0 Cr per 4800 kg/day *(for BioCNG generation from existing Biogas plant#)* -Maximum CFA of Rs. 10.0 Cr/project for both cases.

S.No.	Type of project	Standard CFA rate @ installed capacity of the plant
3	Power *(based on Biogas)*	-Rs 0.75 Cr/MW *(for power generation from new biogas plant)* -Rs 0.5 Cr /MW *(for power generation from existing Biogas plant#)* -Maximum CFA of Rs. 5.0 Cr/project for both cases.
4	Power based on bio & agro-industrial waste (other than MSW through incineration process).	Rs 0.4 Cr/MW (maximum CFA of Rs. 5.0 Cr/project)
5	Biomass Gasifier for electricity/thermal applications	Rs. 2,500 per kWe with dual fuel engines for electrical application Rs. 15,000 per kWe with 100% gas engines for electrical application Rs. 2 lakh per 300 kWth for thermal applications.

In case Developer is setting up a new BioCNG/ Power plant based on Biogas already available or generated from already commissioned/operational/existing biogas plant or have already availed financial assistance from Government of India for Biogas plant, then CFA will be provided only for conversion of biogas to BioCNG (@Rs 3.0 Cr per 4800 kg/day) or biogas to power (Rs 0.5 Cr /MW), as mentioned in the table above.

11.4.5 Benefits

- Biogas for cooking or electricity generation.
- Packaged organic manure for sale or self-use.
- Additional income from by-product sales.
- Reduction of methane emissions from unmanaged dung.

11.5 E-Resources for Natural Farming

Digital platforms and online resources play an important role in supporting the transition to Natural Farming by providing access to training materials, advisories, implementation guidelines, and market linkages. These e-resources assist farmers, field functionaries, and trainers in accessing reliable, updated, and standardised information related to Natural Farming practices and schemes.

11.5.1 National-Level Natural Farming Resources

- **NITI Aayog Natural Farming Portal:** This portal aggregates Natural Farming knowledge, evidence, impact metrics, state progress dashboards, case studies, policy briefs, research insights, and implementation frameworks curated by NITI Aayog. It serves as a knowledge hub for planners, trainers, and researchers involved in Natural Farming at national and state levels.

Website: https://naturalfarming.niti.gov.in

- **Natural Farming Portal of the Department of Agriculture & Farmers Welfare (DAC&FW):** The DAC&FW Natural Farming Portal provides scheme guidelines under the National Mission on Natural Farming (NMNF), technical protocols (e.g., *Jeevamrit*, *Beejamrit*), training material, approved bio-input practices, and state-wise implementation status.

  Website: https://naturalfarming.dac.gov.in

- **Ministry of Agriculture & Farmers Welfare, NMNF Section:** The Ministry's official portal hosts scheme documents, operational guidelines, implementation frameworks, and programme updates associated with the National Mission on Natural Farming.

  Website: https://agricoop.nic.in

11.5.2 Some Key State-Level Natural Farming Digital Platforms

- **Andhra Pradesh Community Managed Natural Farming (APCNF):** The APCNF portal contains structured training curriculums, farmer manuals, bio-input preparation guides, field advisories, video tutorials, and implementation dashboards for one of India's largest Natural Farming initiatives.

  Website: https://apcnf.in

- **Himachal Pradesh Prakritik Kheti Portal:** This state portal provides resources on Prakritik Kheti, including technical advisories, input preparation videos, farmer outreach tools, and extension support materials that align with Natural Farming practices.

  Website: https://hpagriculture.com (Prakritik Kheti section)

- **Gujarat Natural Farming Science University (GNFSU):** GNFSU offers academic and training resources, research publications, syllabi, and digital modules specifically focused on Natural Farming science and practice.

  Website: https://gnfsu.edu.in

11.5.3 Digital Training and Knowledge Repositories

- **NMNF Training Modules (DAC&FW):** Standardised training modules, field guides, SOPs, and audio-visual materials created under the National Mission on Natural Farming are accessible for trainers and extension personnel.

  Website: https://naturalfarming.dac.gov.in/training

- **APCNF Knowledge Repository:** A curated repository of manuals, field protocols, training videos, and practice notes covering Natural Farming inputs, crop systems, and implementation experiences.

  Website: https://apcnf.in/resources

11.5.4 Advisory and Market Support Tools

- **mKisan Portal:** Provides personalised SMS and voice advisories to farmers on crop management, weather, pest alerts, and Natural Farming best practices.

  Website: https://mkisan.gov.in

- **National Agriculture Market (e-NAM):** Digital platform facilitating market access, price discovery, and transparent trading, supporting farmers practicing Natural Farming in selling produce at competitive prices.

  Website: https://www.enam.gov.in

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