Natural Farming for One Health

Edited By

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July 23, 2024

FOREWORD

Indian agriculture has been able to feed the country's population of around 1.4 billion while also contributing to the foreign exchange of the nation through agriculture exports. The Indian agriculture has come long way since independence in increasing food production, reducing import dependence and providing employment opportunities to vast population. Indian agriculture also faces plethora of challenges of carrying climate, various biotic and abiotic climate stresses, land fragmentation and limited resources availability to the farmers.

ICAR research institutes, SAUs and other organizations/centres focuses on developing relevant agricultural technologies for the benefit of farmers, taking these technologies to the doorstep of farmers is very important and challenging task. For addressing issue of sustainable and eco-friendly agriculture, the Ministry of Agriculture and Farmers Welfare, Govt. of India is emphasising on adoption of natural farming for healthy nation.

Natural Farming is a chemical-free farming system rooted in Indian tradition enriched with modern understanding of ecology, resource recycling and on-farm resource optimization. It is considered as agro-ecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity. It is largely based on on-farm biomass recycling with major stress on biomass mulching, use of on-farm cow dung-urine formulations; maintaining soil aeration and exclusion of all synthetic chemical inputs. Natural farming is expected to reduce dependency on purchased inputs. It is considered as a cost-effective farming practice with scope for increasing employment opportunities and agricultural development. Many states have already practicing natural farming and created successful models. A series of awareness and capacity building programs on natural farming are being organised at national level.

In this context, a 3 days collaborative online training on ***'Natural Farming for One Health'*** was organized by the Amity University Uttar Pradesh, Noida with MANAGE, Hyderabad during 30th April to 02 May 2024. More than 200 participants were participated from different states and got enriched their knowledge about concept and practices of natural farming.

I am glad that the organisers have taken initiative to bring out e-publication on ***'Natural Farming for One Health'***. This publication will surely help the extension system, teaching faculties, students and youths. The Program Directors namely Prof. Lakhan Singh, Advisor, Amity University, Noida and Dr. Naresh Kethavath, MANAGE, Hyderabad deserve congratulations for their efforts in publishing this document.

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PREFACE

In an era marked by rapid urbanization, technological advancements, and industrial agriculture, the symbiotic relationship between humans, animals, plants and the environment is being increasingly disrupted. Our mission for higher yields and greater efficiencies has often come at the expense of ecological balance and public health. The concept of 'One Health' has emerged as a holistic approach recognizing that the health of people is closely connected to the health of animals and our environment. Under this situation, natural farming presents a compelling, sustainable solution that addresses the interconnectedness of all life forms on the earth. Natural farming, rooted in traditional agricultural practices and augmented by modern scientific understanding, emphasizes working in harmony with nature. It is characterized by the minimal use of chemical/synthetic inputs depend on natural processes, and conserving biodiversity. The essence of natural farming lies in its principle of minimal disturbance to the natural ecosystem. This approach not only enhances soil fertility and biodiversity but also promotes the health and well-being of all organisms within the ecosystem. Healthy soil teems with microorganisms that play very important role in nutrient cycling and disease suppression, leading to more resilient plant growth. Plants grown in such healthy environment are more vigorous and nutritious, contributing to better human health outcomes. From a One Health perspective, the benefits of natural farming extend beyond the immediate agricultural context. Reduced reliance on synthetic chemicals minimizes the risk of contaminating water bodies and surrounding environments, thereby protecting wildlife and reducing the incidence of chemical-related health issues in humans and animals. Animal welfare is another major component of natural farming that matches with the One Health philosophy. In natural farming systems, livestock are reared in environments that allow for natural behaviors, access to pasture and a more diverse fodder/diet. Healthier animals mean fewer risks of disease transmission to humans, contributing to overall public health safety.

In this book, we explore the multifaceted benefits of natural farming through the lens of One Health. By examining case studies, scientific research, and practical implementations, we aim to provide a comprehensive understanding of how natural farming can contribute to a healthier planet. The chapters delve into various aspects, including soil health, plant nutrition, animal welfare, and community resilience, all underpinned by the principle that the health of humans, animals, and the environment are inextricably linked.

We hope this exploration will inspire farmers, policymakers, researchers and consumers to embrace natural farming as a workable way towards sustainable agriculture and holistic health. As we strive to address the complex challenges of our time, integrating natural farming into our food systems offers a hopeful and practical solution, reinforcing the profound truth that the well-being of one is the well-being of all.

Editors

CONTENTS

Opening Remarks and Outcome

Three days collaborative training on 'Natural Farming for One Health' was jointly organized by Amity University, Noida with MANAGE, Hyderabad during 30 April to 2 May 2024. The training was inaugurated by Dr. Willam Selvamurthy, President, Amity Science, Technology and Innovation, Noida and Chancellor, Amity University, Chhattisgarh on 30.04.2024. In total, 170 participants attended the training in virtual mode.

Dr Willam Selvamurthy, President, Amity Science, Technology and Innovation, Noida and Chancellor, Amity University, Chhattisgarh applauded the efforts of MANAGE and Amity Food & Agriculture Foundation, Amity University for joining hands together for organizing such an important training on natural farming. In his speech, he mentioned that Amity University is doing a lot of research work in the field of agriculture. There is a dedicated institute for natural farming at the Noida Campus which is the Amity Institute of Organic Agriculture (AIOA). Amity University Manesar has 40 indigenous cows whose waste has been generated to serve as fertilizers in farmlands. Amity has established 18 campuses abroad and 12 Amity Universities in India. His major focus was on integrating training, innovation, research and teaching. To ensure nutritional security with healthy life, natural farming may be one of the alternative approaches. Amity University will create a movement for natural farming for one health.

Dr Nutan Kaushik, Director General, AFAF, Amity University, Noida provided her introductory words. She said that the agriculture department in Amity was started in 2005 and the institute is providing extension services to farmers. She also mentioned that Amity University received the Academic Excellence Award in Agriculture 2019. She further discussed about Amity strengths in food technology developing ZECC, various bio-pesticides and bio-fertilizers, Cool Bot, herbal mosquito repellent etc. She presented glimpses of agri-food technology development and transfer in the last five years at Amity. She also mentioned the Agronomic Zinc bio-fortification of food crops.

Dr Veenita Kumari, Deputy Director MANAGE, Hyderabad praised the Amity University Noida for the initiative taken for conducting collaborative training. She focused that the one health concept is dependent on the health of different entities of the ecosystem. She said that natural farming is aimed at revitalizing soil, and we need to work on approaching holistic health for all. She mentioned, MANAGE has trained 60,000 Gram Pradhans to ensure natural farming in Indian villages. Also, MANAGE is building the capacity of women farmers to play the role of para-extension workers improving their skills and knowledge. In natural farming, it is generally a perception that yield will be less but stories are there which has shown successful natural farming with lower investments.

In beginning, Dr Lakhan Singh, Professor & Advisor, Amity University, Noida welcomed all the dignitaries and participants. He highlighted the concept and philosophy of natural farming.

He said that philosophy of natural farming is working with nature to produce healthy food to keep ourselves healthy and to keep land healthy. He mentioned that natural farming emphasizes on use of chemical free practices and easily available farm resources which are manageable for better economy and conservation of nature in long run. A series of sensitizations workshops/conferences/trainings were organized at national level to promote natural farming. KVKs have been enrolled for outscaling of natural farming practices. Dr Singh told that an opportunity will be created to join hands with MANAGE and Amity Noida for collaborative works in future. Dr Naresh Kethavath, Program Director, MANAGE, Hyderabad proposed a formal vote of thanks. He also highlighted significance of natural farming for one health.

During training, 12 lectures were delivered by renowned experts in the field of organic and natural farming. Resource persons were invited from ICAR-Indian Institute of Farming Systems Reserach, Meerut; ICAR-Indian Veterinary Research Institute, Bareilly; Gujarat Natural Farming Science University, Anand; Haryana Agricultural University, Hisar; Dr YS Parmar University of Horticulture & Forestry, Solan; Amity University, Noida; National Centre for Organic & Natural Farming, Ghaziabad; Centre for Sustainable Agriculture, Hyderabad; and Cowberry Industries Pvt Ltd, Surat.

Outcome

- There is a need of mass level awareness among farmers and extension workers about the conceptual clarity on Natural and Organic Farming with proper capacity building programs.
- Conservation and rearing of indigenous cow breeds and using their raw material (Urine, dung etc.) for self-sustaining farming through natural farming practices needed.
- For effective transfer of technologies, the précised knowledge of package of practices for natural farming should be supported by adopting appropriate extension methodologies.
- The new educational courses for natural farming in various agricultural universities have been started and will be the key for driving new young minds towards Natural Farming.
- Scientific basis of natural farming practices should be created to generalise its results and will help in developing package of practices for crop production.
- Farmer Participatory Validation of organic and natural farming in farmers' fields found higher yield.
- Successful Case Studies of Farmers on Natural Farming should be documented and shared on large scale.
- Need to develop the Community Resource Persons/Champion Farmers for strengthening the system of natural farming with proper human resource.
- Focuses should also be diverted on strengthening marketing structure and certification process for channelizing the chemical free food for consumers.
- There is need to establish Bio-input Resource Centre for adopting eco-friendly technologies.
- There is strong need of farm mechanisation in strengthening the concept of regenerative agriculture.

- A targeted and phased approach will maximize feasibility and impact of Natural farming
- Focus on innovation and customization of available local technologies with standardised scientific orientation.
- There is need to enable the support services in the areas of FPOs, Bio-enterprises, PGS/Certification systems, Seed systems etc.
- Institutional arrangement for capacity building of farmers for natural farming is needed.
- Adequate Policy Support in the form of saving fertilizer & irrigation subsidy, the ecosystem services, provision for Carbon credit, etc. are needed
- Donors and major development agencies, particularly the Food and Agriculture Organization of the United Nations (FAO), the United Nations Conference on Trade and Development (UNCTAD) and the International Fund for Agricultural Development (IFAD) to support and help accelerate the uptake of natural farming and other agro-ecological systems as they are crucial to ensuring healthy food for all.
- Research and extension institutions to focus their work on agro-ecology and organic agriculture and to develop long-term solutions and promote and exchange successful techniques amongst farmers and technicians.
- In circular agriculture, all steps of the food system from growing, harvesting, packing, processing, transporting, marketing, consuming and disposing food are designed with a view to promoting sustainable development.
- By understanding and utilizing the diverse functions of microorganisms, farmers can adopt sustainable practices that enhance soil health, increase crop yields, and contribute to a more resilient and eco-friendly farming system.
- State's comprehensive approach, incorporating policy support, technology integration, and community engagement, make the success of the natural farming movement to achieve agricultural sustainability.
- To ensure nutritional security with healthy life, natural farming may be one of the alternative approaches. Amity University will create a movement for natural farming for one health.

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Chapter- 1

Unlocking the Potential of Natural Farming: A Pathway to Sustainable Agriculture in India

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Abstract

Despite cultivating 9.5 lakh hectares and engaging over 20 lakh farmers across 17 states, natural farming in India faces challenges hindering wider adoption. This abstract explores the needs, challenges and potential for scaling up this promising approach. Robust policy frameworks are needed. National and state organic farming policies require better coordination to offer a clear roadmap. Increased investment in research (currently under 1% of agricultural GDP) and extension services is crucial. Additionally, capacity building can equip farmers with the necessary skills. Strengthening market linkages is critical. Organic farmers often lack access to markets and infrastructure. Educating consumers about the benefits and potential premium pricing of natural produce is vital. Natural farming aligns beautifully with several Sustainable Development Goals (SDGs) like Zero Hunger, Good Health and Well-being, Clean Water and Sanitation and Responsible Consumption and Production. By minimizing external inputs and promoting biodiversity, it can significantly contribute to these goals. Scaling up requires a multi-faceted approach. Implementing a phased approach considering regional context is key. Encouraging local innovation and customization of technologies, while maintaining a scientific foundation, fosters wider applicability. Enabling support services like FPOs and certification systems further empowers farmers. Policy incentives like saving fertilizer subsidies and recognizing ecosystem services can incentivize. Natural farming offers a promising path towards a sustainable future for Indian agriculture. By addressing needs, challenges, and opportunities and by fostering collaboration, India can harness this power to create a resilient food system aligned with global sustainability goals.

Introduction

India, a land steeped in rich agricultural traditions, has historically nurtured its fields with natural methods. From the ancient Vedic texts emphasizing the importance of soil health to indigenous knowledge on crop rotation and organic matter management, India's agricultural history is a testament to the power of working with nature, not against it. However, the Green Revolution of the mid-20th century ushered in a paradigm shift. Chemical fertilizers and pesticides, hailed as the key to increased yields, became the dominant agricultural practices. While they undoubtedly boosted production in the short term, the long-term consequences have become increasingly apparent. The reliance on synthetic inputs has led to a decline in soil health. Chemical fertilizers deplete essential nutrients, disrupt the natural microbial balance and render the soil less able to retain water. This, coupled with the overuse of pesticides, has resulted in environmental pollution, affecting water quality and harming beneficial insects. The long-term sustainability of these practices is under question, especially considering the unpredictable monsoon patterns and rising costs of chemical inputs that plague Indian agriculture. The Green Revolution based technological interventions have transformed India from food scarcity to a food surplus country. However, due to heavily reliant on chemical this resulted into increased application of chemical fertilizers and pesticides with declining crop productivity and uncertain market conditions has resulted in un-remunerative agriculture. Consequently, farmers have fallen into the debt trap due to the rising cost of crop production apart from health hazards due to serious exposure to harmful chemical pesticides (Kumar *et al*., 2023). These issues have shown the decreasing share of agriculture in productive economy and employment is taking place at different speeds and different challenges across the regions (Chatterjee, *et al*., 2022). This is where natural farming emerges as a beacon of hope. Rooted in the principles of ecological balance and self-sufficiency, it offers a holistic approach to agriculture. Unlike conventional methods that treat soil as a mere medium, natural farming views it as a living ecosystem teeming with microbial life. By fostering this life, we create a healthy foundation that sustains healthy crops. Natural Farming (NF) is a one-of-a-kind chemical-free farming approach that is regarded as an agro-ecological approach (Rosset *et al*., 2012). In other terms it can be discussed as a type of sustainable agricultural system, is one such alternative to chemical fertilizer based agriculture and high input cost agriculture.In the last couple of years, the government of India has promoted natural farming in big way to promote chemical-free farming. The Prime Minister of India in his address to the nation on the 76th Independence Day of India stated ‘ZBNF is a promising tool to minimize the dependence of farmers on purchased inputs, it reduces the cost of agriculture by relying on traditional field-based technologies which also leads to improved soil health (Duddigan *et al*., 2022).

Natural Farming in India: A Rich Tradition and Modern Movement

India boasts a long and vibrant tradition of natural farming, distinct from its Japanese counterparts. While Masanobu Fukuoka and Mokichi Okada pioneered natural farming methods in Japan, India has its own set of influential figures like Shri Narayana Reddy, Shripad Dabholkar, G Nammalvar, Deepak Suchde, and Bhaskar Save (the "Gandhi of Natural Farming").

Zero-Budget Natural Farming: Developed in the 1980s by Subhash Palekar, Zero-Budget Natural Farming (ZBNF) is a prominent Indian approach. Interestingly, echoes of similar practices can be found in ancient Indian literature and Vedic agriculture (Bharucha et al., 2020; Sharma *et al*., 2022a).

Regional Variations: Natural farming in India is a diverse tapestry. Farmers across the country employ various local methods, traditional practices, and indigenous inputs. These practices are difficult to codify due to regional variations, but they all share the core principles of natural farming (Sharma *et al*., 2022b). These principles inspire a range of farming methods with unique characteristics, making them well-suited for promoting chemical-free, low-cost, and environmentally friendly agriculture in India.

Global Context: Natural farming in India aligns with a global trend of alternative low-input farming practices. These methods promise reduced costs for farmers, chemical-free food for consumers, and improved soil health. Similar to Fukuoka's approach in Japan, natural farming in India emphasizes working with nature, aiming for yields comparable to conventional methods but without the downsides of soil erosion.

Government Initiatives: The National Institution for Transforming India (NITI Aayog) recognizes the potential of natural farming. While there's some overlap in terminology between "organic" and "natural" farming practices among communities and farmers, estimates suggest that around 2.5 million Indian farmers are already embracing regenerative agriculture. The government aims to expand organic farming (including natural farming) to 20 lakh hectares in the next five years, with 12 lakh hectares specifically targeted under the Bharatiya Prakritik Krishi Padhati (BPKP) program.

National Mission on Natural Farming (NMNF): Launched in 2023-24, the NMNF aims to motivate farmers to adopt chemical-free practices and increase the reach of natural farming. This mission builds upon the BPKP scheme. The success of NMNF hinges on a shift in farmer behavior, encouraging them to move away from chemical inputs and embrace locally produced, cow-based alternatives. To achieve this, sustained efforts are needed in creating awareness, providing training, handholding new adopters, and building long-term capacity among farmers (NMNFKP, 2023).

This revised text condenses the information while maintaining key points. It highlights the distinct Indian perspective on natural farming, its historical roots, regional variations, and the government's initiatives to promote its adoption.

Principles and Benefits of Natural Farming

Principles of Natural Farming

Natural farming, also known as zero-budget farming, is a holistic and sustainable approach to agriculture that emphasizes working in harmony with nature rather than against it. Developed by Japanese farmer and philosopher Masanobu Fukuoka, natural farming seeks to restore ecological balance, regenerate soil health, and promote biodiversity while minimizing external inputs and human intervention. This overview delves into the core principles of natural farming, highlighting its key tenets and guiding philosophies.

1. Non-Intervention: At the heart of natural farming lies the principle of non-intervention or "do-nothing" farming, which advocates minimal human interference in the natural processes of the ecosystem. Instead of imposing external inputs or manipulating natural systems, natural farmers observe and emulate the inherent wisdom of nature. By allowing plants, animals, and microorganisms to interact freely within the ecosystem, natural farmers create self-regulating and self-sustaining agricultural systems that require minimal human intervention.

2. No Tillage: Natural farming rejects the practice of conventional tillage, which disrupts soil structure, depletes organic matter, and promotes erosion. Instead, natural farmers employ no-till or minimum tillage techniques to preserve soil health and fertility. By leaving the soil undisturbed, natural farmers promote soil aggregation, microbial activity, and water infiltration, enhancing soil structure and resilience. No-till practices also help reduce carbon loss from the soil, mitigate greenhouse gas emissions, and sequester carbon dioxide, contributing to climate change mitigation efforts.

3. Cover Cropping: Cover cropping is a fundamental practice in natural farming that involves planting cover crops to protect and enrich the soil. Cover crops, such as legumes, grasses, and clovers, help suppress weeds, prevent soil erosion, and improve soil fertility through nitrogen fixation and organic matter addition. By maintaining a living cover on the soil surface throughout the year, natural farmers enhance soil biodiversity, nutrient cycling, and moisture retention. Cover cropping also promotes habitat for beneficial insects, pollinators, and soil organisms, fostering ecological balance within agricultural ecosystems.

4. Mulching: Mulching is another key practice in natural farming that involves covering the soil surface with organic materials such as straw, leaves, or crop residues. Mulching helps conserve soil moisture, suppress weeds, regulate soil temperature, and enhance microbial activity. By creating a protective layer over the soil, mulching reduces evaporation, minimizes erosion, and promotes soil aggregation. Organic mulches also decompose over time, adding organic matter and nutrients to the soil, thereby improving soil fertility and structure.

5. Natural Seed Selection and Propagation: Natural farming emphasizes the use of local, open-pollinated, and heirloom seed varieties adapted to local growing conditions. Natural farmers select seeds based on their resilience, adaptability, and genetic diversity, preferring traditional varieties over hybrid or genetically modified seeds. By saving and exchanging seeds within their communities, natural farmers preserve biodiversity, maintain seed sovereignty, and strengthen local food systems. Natural propagation methods such as seed saving, seed banking, and seed sharing promote resilience and self-reliance among farming communities.

6. Minimal External Inputs: Natural farming minimizes reliance on external inputs such as chemical fertilizers, pesticides, and synthetic additives. Instead, natural farmers focus on enhancing soil fertility, pest management, and plant nutrition through natural means. Composting, green manuring and bio-fertilizers are used to replenish soil nutrients and promote microbial activity. Natural pest control methods such as crop diversification, companion planting, and habitat enhancement encourage ecological balance and reduce pest pressures. By reducing dependence on external inputs, natural farming reduces production costs, environmental pollution, and health risks associated with chemical agriculture.

7. Observational Learning and Adaptation: Natural farming emphasizes the importance of observational learning, experimentation, and adaptation to local ecological conditions. Natural farmers closely observe their surroundings, learn from the behavior of plants and animals, and adapt their farming practices accordingly. By integrating traditional wisdom with modern scientific knowledge, natural farmers develop context-specific solutions that are resilient, sustainable, and regenerative. Continuous learning, innovation, and adaptation are integral to the success of natural farming systems in diverse agro-ecological contexts.

8. Respect for Nature and Life: Central to natural farming is a deep reverence for nature and all living beings. Natural farmers recognize the interconnectedness of all life forms and strive to cultivate a harmonious relationship with the natural world. By fostering biodiversity, nurturing ecosystems, and promoting ecological harmony, natural farming honors the intrinsic value of all living organisms and recognizes the interdependence of humans and nature. Through mindful stewardship of the land, natural farmers seek to create abundance, beauty, and resilience in agricultural landscapes.

As the global demand for sustainable food production grows, natural farming offers a compelling model for resilient and harmonious agriculture in the 21st century. Subhash Palekar, an Indian agriculturist and proponent of Zero Budget Natural Farming (ZBNF), has outlined a set of principles for natural farming that align with his philosophy and approach. Zero Budget Natural Farming emphasizes chemical-free, low-cost, and environmentally sustainable farming methods. Below are the key principles of natural farming according to Subhash Palekar:

1. Zero Budget: The cornerstone of Subhash Palekar's approach is the concept of "Zero Budget," which implies that farmers can practice agriculture without incurring any external input costs. In ZBNF, farmers are encouraged to use locally available resources and natural farming techniques, eliminating the need for expensive agrochemicals, fertilizers, and pesticides.

2. Jiwamrita: Jiwamrita is a microbial culture prepared using locally available ingredients such as cow dung, cow urine, jaggery, gram flour, and soil. It contains beneficial microorganisms that enhance soil fertility, improve nutrient availability, and promote plant growth. Applying Jiwamrita to the soil fosters a healthy microbial ecosystem, reducing the dependence on synthetic inputs.

3. Beejamrita: Beejamrita is a seed treatment solution that involves soaking seeds in a mixture of cow dung, cow urine, jaggery, gram flour, and water. This treatment is believed to protect seeds from pests and diseases while providing essential nutrients for germination. Beejamrita is a natural alternative to chemical seed treatments.

4. Mulching: Mulching is the practice of covering the soil with organic materials like straw, crop residues, or leaves. This helps conserve soil moisture, suppress weed growth, regulate soil temperature, and improve soil structure. Mulching is a key component of natural farming to enhance water retention and reduce evaporation.

5. Waaphasa (Soil Aeration): Palekar emphasizes the importance of maintaining well-aerated soils. Continuous tillage can lead to soil compaction and reduced aeration. Natural farming encourages minimal or zero tillage to preserve soil structure, prevent erosion, and promote the natural flow of air within the soil.

6. Agroecological Principles: Natural farming under Palekar's guidance adheres to agroecological principles that promote the integration of ecological processes into agricultural systems. This includes understanding and working with the local ecosystem, emphasizing biodiversity, and considering the ecological interactions between plants, animals, and microorganisms.

7. Seed Treatment with Cow Urine: SubhashPalekar recommends treating seeds with cow urine to protect them from pests and diseases. Cow urine is believed to have natural antifungal and antibacterial properties, providing a protective coating to seeds without the use of synthetic chemicals.

8. Crop Rotation and Diversification: Crop rotation and diversification are encouraged to break pest and disease cycles and maintain soil fertility. Growing a variety of crops helps prevent the buildup of specific pests or diseases associated with monoculture and promotes a balanced ecosystem.

9. Non-Use of Chemicals: A fundamental principle of natural farming according to SubhashPalekar is the complete avoidance of synthetic chemicals, including chemical fertilizers, pesticides, and herbicides. The aim is to create a self-sustaining agricultural system that relies on natural processes and inputs.

10. Promotion of Indigenous Breeds: Natural farming emphasizes the use of indigenous and native breeds of animals, particularly cattle. Indigenous breeds are well-adapted to local conditions and play a crucial role in providing manure, enhancing soil fertility, and supporting sustainable farming practices.

11. Minimal Water Usage: Efficient water management is promoted in natural farming. Techniques such as mulching, cover cropping, and water-saving irrigation methods are encouraged to reduce water consumption and enhance water use efficiency.

12. Integration of Livestock: Natural farming advocates the integration of livestock, particularly cows, into farming systems. Cattle contribute to the farm through the provision of manure, which is a vital input for soil fertility, and their presence supports the overall ecological balance of the farm. Subhash Palekar's principles of natural farming emphasize a holistic and sustainable approach that aligns with traditional farming wisdom while incorporating contemporary ecological insights.

Current Scenario of Natural Farming in India

Many states have taken up initiatives for natural farming promotion Andhra Pradesh, Gujarat, Himachal Pradesh, Odisha, Madhya Pradesh, Rajasthan, Uttar Pradesh and Tamil Nadu are among the leading states. As of now more than 10 lakh ha. area is covered under natural farming in India.

Table1. State-wise area and farmers under natural farming (2022-23)

State	Area (in ha)	No. of practicing farmers
Uttar Pradesh	97460	105000
Telangana	2403	2002
Tamil Nadu	2000	2360
Rajasthan	9000	171000
Punjab	2217	1853
Odisha	24000	27009
Maharashtra	74000	82000
Madhya Pradesh	111000	59071
Kerala	82000	326000
Karnataka	2000	4400
Jharkhand	50	40
Jammu and Kashmir	12120	3850
Himachal Pradesh	50000	159000
Haryana	7931	2992
Gujarat	186000	432000
Bihar	132	137
Andhra Pradesh	290000	630000
Total	952313	2008714

Source:https://naturalfarming.dac.gov.in/NaturalFarming/ImplementationProcess

Natural Farming: A Champion for Sustainable Development Goals

Natural farming, a broad term encompassing various low-input agricultural practices, aligns beautifully with the United Nations' Sustainable Development Goals (SDGs). These 17 goals aim to achieve a future that is sustainable, prosperous, and equitable for all. Let's explore how natural farming contributes to several key SDGs:

1. Zero Hunger (SDG 2): Natural farming practices, by promoting healthy soil and fostering biodiversity, can potentially lead to increased crop yields and improved soil fertility. This can contribute to greater food security and address hunger, particularly in vulnerable communities.

2. Good Health and Well-being (SDG 3): Natural farming minimizes the use of synthetic fertilizers and pesticides, potentially reducing residues in food products. This can contribute to healthier food for consumers and minimize exposure to potentially harmful chemicals.

3. Clean Water and Sanitation (SDG 6): Natural farming practices, by promoting soil health and organic matter content, can improve water infiltration and reduce agricultural runoff. This can help to protect water sources from contamination by chemical fertilizers and pesticides.

4. Decent Work and Economic Growth (SDG 8): Natural farming often requires less external inputs compared to conventional farming. This can lead to reduced production costs for farmers, potentially increasing their profit margins and improving their livelihoods.

5. Responsible Consumption and Production (SDG 12): Natural farming promotes sustainable resource management by minimizing waste and relying on renewable resources. This aligns with the goal of responsible consumption and production patterns.

6. Climate Action (SDG 13): Natural farming practices, such as composting and minimal tillage, can help to sequester carbon in the soil. This can contribute to mitigating climate change by reducing greenhouse gas emissions in the agricultural sector.

7. Life on Land (SDG 15): Natural farming promotes biodiversity by encouraging beneficial insects and soil organisms. This creates a healthier and more resilient ecosystem, supporting a variety of plant and animal life.

Obstacles Faced by Indian Natural Farmers

While natural farming offers a promising path towards a sustainable future for Indian agriculture, the transition for farmers isn't without its hurdles. Here's a closer look at the key challenges faced by those embracing this ecological approach:

Yield Fluctuations: One of the initial concerns for farmers switching to natural methods is a potential dip in yields. This is because the soil microbiome takes time to adjust to the absence of chemical fertilizers and rebuild its natural fertility. This transition period can be discouraging for farmers accustomed to the immediate boost provided by chemical inputs.

Knowledge and Skill Gap: Natural farming requires a deeper understanding of ecological processes and on-farm resource management. Farmers need to learn new techniques for composting, bio-fertilizer preparation, and natural pest control methods. This knowledge gap can be a significant barrier, especially for small-scale farmers with limited access to training and extension services.

Availability of Organic Inputs: Sourcing reliable and affordable organic inputs like cow dung and bio-fertilizers can be challenging, especially in regions with limited livestock or established organic production networks. This can lead to dependence on middlemen and potentially inflate input costs.

Marketing and Market Access: Establishing a market for organically produced food requires building trust with consumers and creating reliable distribution channels. Farmers often lack access to dedicated organic markets or may struggle to negotiate fair prices for their produce. Additionally, the certification process for organic produce can be expensive and time-consuming, further discouraging some farmers.

Financial Sustainability: The initial investment in organic seeds or setting up composting infrastructure can be a burden for small and marginal farmers. Additionally, the potential yield dip during the transition period can create financial strain. Government subsidies for conventional inputs often overshadow support for organic farming, making the initial shift even more challenging.

Climate Variability and Pest Management: Unpredictable weather patterns, particularly erratic monsoon seasons, can pose a significant risk for natural farmers. Additionally, managing pests and diseases using organic methods requires a proactive and knowledge-intensive approach. Farmers need to be adept at identifying and managing pest populations through natural methods like companion planting and attracting beneficial insects.

Limited Infrastructure and Extension Services: The infrastructure for storage, processing, and transportation of organic produce is often less developed compared to conventional agriculture. Additionally, access to extension services trained in natural farming practices can be limited, hindering knowledge dissemination and on-farm support for farmers.

Social Pressures and Skepticism: Transitioning to natural farming can involve a shift in mindset. Farmers may face social pressures from neighbors or local communities who are accustomed to conventional practices. Overcoming skepticism and demonstrating the long-term benefits of natural farming can be an additional hurdle.

Addressing these challenges will be crucial for the large-scale adoption of natural farming practices in India. Collaborative efforts from the government, research institutions, NGOs, and farmer cooperatives are needed to provide training, support infrastructure development, and establish robust marketing channels for organic produce.

Successful Examples of Natural Farming Practicing Farmers in India

Across India, a wave of farmers proving that natural farming can be a successful and rewarding path. Here are a few inspiring examples:

Krishnappa Dasappa Gowda (Karnataka): This farmer from Karnataka cultivates a diverse mix of crops – teak, mango, coffee, turmeric, ginger, paddy, and sugarcane – on his five-acre farm using SubhashPalekar's Zero Budget Natural Farming (ZBNF) method. He relies on Jivamrit, a microbial inoculant, to enhance soil health and utilizes mulching for moisture retention. The result? Increased yields, reduced input costs, and a thriving farm ecosystem.

Ghanshyambhai Viththalbhai Patel (Gujarat): This award-winning farmer from Gujarat has successfully adopted natural farming techniques for cultivating paddy and wheat. He utilizes cow dung and urine for crop protection, creating his own bio-pesticides. Patel's story demonstrates the effectiveness of natural methods in achieving high yields while minimizing reliance on expensive chemicals.

Vijay Kumar (Himachal Pradesh): In the hilly terrains of Himachal Pradesh, Vijay Kumar practices natural farming on his 25-bigha land. He utilizes Beejamrit for seed treatment, Jivamrit for soil fertility, and various natural pest control methods like neem-based solutions. His success with a variety of crops like cauliflower, peas, potatoes, rajma, and apples showcases the adaptability of natural farming practices across diverse agro-climatic conditions.

Suman Devi (Madhya Pradesh): A small-scale farmer from Madhya Pradesh, Suman Devi is a testament to the economic viability of natural farming for marginal farmers. On her small plot, she practices natural farming for vegetables, earning a daily income sufficient to support her family. Her story highlights the potential of natural farming to improve household income security while promoting sustainable practices.

- **Focus on Vegetables**: Devi concentrates on cultivating high-value vegetables like tomatoes, spinach, and chilies. This strategy allows her to maximize returns on her limited land area.
- **Composting Magic**: To create nutrient-rich fertilizer, Devi utilizes readily available kitchen scraps and farm waste for composting. This on-farm resource management reduces reliance on external inputs.
- **Intercropping**: Devi practices intercropping, strategically planting complementary crops together. This maximizes space utilization, promotes biodiversity, and can even enhance pest control through natural predator-prey interactions.

Chetanrao Patil (Maharashtra): This progressive farmer from Maharashtra manages a 12-acre farm entirely through natural methods. He utilizes vermicomposting, crop rotation, and intercropping to maintain soil fertility and manage pests organically. Patil's success story showcases the scalability of natural farming practices for large-scale production.

- **Vermicomposting Powerhouse**: Patil utilizes vermicomposting, a process that involves composting with earthworms. This method creates nutrient-rich vermicompost, a valuable fertilizer for his crops.
- **Crop Rotation**: To maintain soil fertility and disrupt pest cycles, Patil practices crop rotation. This strategy prevents soil nutrient depletion and promotes a healthy agricultural ecosystem.
- **Intercropping Masterclass**: Similar to Devi, Patil employs intercropping techniques, maximizing land use efficiency and creating a biodiverse farm environment.

The time is ripe for the Extension Education team to comprehensively examine organic and natural farming. This examination should encompass consumer trends and market potential for organic products, along with the entire value chain - processing, storage, and export capabilities. We must acknowledge the challenge of feeding a growing population with these methods. Building trust in the authenticity of organic food for distant consumers is crucial, and achieving this may require exploring certification processes, labeling initiatives, and transparency measures. Finally, developing policies that incentivize organic farming, promote research, and address infrastructure needs is essential to bolster the organic economy.

Scaling Up Natural Farming in India: A Comprehensive Approach

It emphasizes collaboration among various stakeholders and highlights key areas for action:

Policy and Support Systems:

- **Strengthen Policy Frameworks:** Enhance coordination and implementation of national, state, and local organic farming policies for a consistent approach.
- **Invest in Research and Extension:** Allocate resources to research, extension services, and capacity building programs focused on natural farming techniques, technologies, and best practices.
- **Empower Farmers:** Support farmer education, training, and empowerment initiatives to equip them with the knowledge and skills to adopt and scale natural farming effectively.
- **Foster Innovation:** Create an environment that encourages innovation, entrepreneurship, and collaboration among farmers, researchers, policymakers, and industry players.

Market Access and Consumer Awareness:

- **Promote Market Linkages:** Facilitate access to markets, value chains, and marketing infrastructure for organic farmers through public-private partnerships, market aggregators, and e-commerce platforms.
- **Raise Consumer Awareness:** Educate farmers and consumers about the benefits of natural farming to build trust and demand for naturally produced food.

Sustainable Practices and Long-Term Vision:

- **Strengthen Monitoring and Evaluation:** Establish robust mechanisms to track progress, assess impacts, and learn from scaling initiatives, incorporating feedback from stakeholders and beneficiaries.
- **Indigenous Breeds and Resources:** Encourage the conservation and rearing of indigenous cow breeds and the utilization of their raw materials (urine, dung) for self-sustaining natural farming practices.
- **Technology Transfer and Education:** Develop and disseminate precise knowledge packages on natural farming practices through appropriate extension methodologies.

- **Scientific Validation:** Conduct research to establish the scientific basis of natural farming practices, facilitating the development of standardized practices for crop production.
- **Marketing and Certification:** Strengthen the marketing structure and certification process to ensure consumers have access to chemical-free food.

Integration with Sustainability Goals:

- **SDGs and Agroecology:** Address the Sustainable Development Goals (SDGs) collectively, with a special focus on an agroecological approach to farming.
- **Bio-Bank and Mechanization:** Establish a Bio Bank of viable regenerative technologies and explore farm mechanization solutions to support regenerative agriculture.

Additional Considerations:

Phased Approach: Implement a targeted and phased approach to maximize the feasibility and impact of natural farming initiatives.

Local Innovation: Focus on innovation and customization of existing local technologies, ensuring a standardized scientific basis.

Support Services: Enable support services in areas like Farmer Producer Organizations (FPOs), bio-enterprises, Participatory Guarantee System (PGS) certification, seed systems, and institutional capacity building for farmers.

Policy Incentives: Provide adequate policy support such as savings on fertilizer and irrigation subsidies, recognition of ecosystem services, and carbon credit provisions.

Promoting Bio-inputs: Popularize the use of refined products like compost, biochar, beneficial microorganisms, and plant materials for their effectiveness as biofertilizers and biopesticides.

Conclusion

Natural farming presents a compelling vision for Indian agriculture. It offers a pathway towards reduced environmental impact, improved soil health, and potentially more nutritious food production. However, to achieve widespread adoption, several key needs must be addressed. Firstly, there is a critical need for robust policy frameworks and support systems. Strengthening coordination between national, state, and local organic farming policies will ensure consistency and provide a clear roadmap for farmers. Additionally, allocating resources for research, extension services, and capacity building programs is essential. Equipping farmers with the knowledge and skills to adopt natural farming practices effectively is paramount for success. Secondly, fostering market linkages and consumer awareness is crucial. Facilitating access to markets, value chains, and marketing infrastructure for organic farmers will connect them with potential customers. Educating consumers about the benefits of natural farming is equally important. Building trust and demand for naturally produced food will incentivize farmers to adopt these practices. Thirdly, a long-term vision that integrates with the SDGs is necessary. Natural farming inherently aligns with several SDGs, including goals for zero hunger, good health and well-being, clean water and sanitation, and responsible consumption and production. By prioritizing an agroecological approach that promotes biodiversity and minimizes external inputs, natural farming can contribute significantly to achieving these sustainability goals. Scaling natural farming requires a strategic and multi-faceted approach. Implementing a phased approach that considers regional specificities will ensure feasibility and maximize impact. Encouraging innovation and customization of existing local technologies, while maintaining a standardized scientific foundation, is crucial for adaptation and wider applicability. Enabling essential support services like FPOs, bio-enterprises, and certification systems will empower farmers and strengthen the overall ecosystem. Additionally, providing adequate policy support through incentives like saving fertilizer subsidies and recognizing ecosystem services can make natural farming a more attractive option for farmers. At last, natural farming holds immense potential for transforming Indian agriculture. By addressing the key needs, challenges, and opportunities, and by fostering collaboration among policymakers, researchers, farmers, and consumers, India can harness the power of natural farming to create a more sustainable and resilient food system for the future. This approach, aligned with the SDGs, can ensure a future where environmental protection, economic prosperity, and food security go hand in hand.

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Chapter- 2

Cultivating Vitality: Harnessing Microbes and Earthworms for Sustainable Farming Success

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Abstract

In an era marked by environmental challenges and increasing global food demand, sustainable farming practices have become imperative. This chapter explores the pivotal role of microbes and earthworms in enhancing soil health and promoting sustainable agriculture. Microbes, ranging from bacteria to fungi, form intricate communities that influence nutrient cycling, disease suppression and plant growth promotion. Concurrently, earthworms aerate the soil, facilitate nutrient availability and enhance soil structure through their burrowing activities. Together, these soil organisms create a dynamic ecosystem that supports resilient and productive farming systems. This chapter delves into the mechanisms through which microbes and earthworms contribute to sustainable agriculture, drawing on recent research and case studies. It discusses practical applications, including the integration of microbial and earthworm management strategies into agricultural practices. By harnessing the biological potential of these organisms, farmers can mitigate environmental impacts, improve crop yields and foster long-term sustainability in agriculture.

Keywords: *Microbes, earthworms, soil health, nutrient cycling, biological diversity, soil ecosystem, climate resilience*

Introduction

In the heart of every thriving farm lies a hidden universe - a bustling community of microbes and earthworms silently toiling beneath our feet. As modern agriculture grapples with escalating challenges of climate change, soil degradation, and diminishing resources, the symbiotic relationship between these tiny organisms and the earthworms emerges as a beacon of hope. Their collaborative efforts not only rejuvenate soil health but also promise sustainable solutions crucial for feeding a burgeoning global population while preserving our planet's delicate ecosystems. Microbes, the unseen champions of agriculture, encompass a diverse array of microscopic organisms - from beneficial bacteria and fungi to protozoa and viruses - that inhabit the soil in staggering numbers. These tiny yet mighty organisms play a pivotal role in shaping the health and productivity of agricultural ecosystems. Through their complex interactions with plants and the soil matrix, microbes contribute to essential functions such as nutrient cycling, disease suppression and the enhancement of soil structure. Harnessing their biological potential holds promise for sustainable farming practices, offering solutions to challenges ranging from soil degradation to climate change resilience. Earthworms, often referred to as nature's soil engineers are integral to the vitality of agricultural ecosystems. These humble creatures, through their incessant burrowing and feeding activities, aerate and till the soil, improving its structure and water-holding capacity. As they digest organic matter, earthworms enrich the soil with nutrients essential for plant growth, while their castings enhance soil fertility. Beyond their role in soil health, earthworms contribute to sustainable agriculture by facilitating nutrient cycling and enhancing the resilience of crops to environmental stresses. Understanding and harnessing the beneficial impacts of earthworms can significantly bolster sustainable farming practices worldwide.

Natural farming represents a paradigm shift towards sustainable agricultural practices rooted in harmony with nature and ecological principles. Unlike conventional methods reliant on synthetic inputs, natural farming emphasizes minimal intervention and holistic management of ecosystems. By nurturing soil health through bioformulations, cover cropping, and incorporation of agro-residues, natural farming promotes biodiversity, enhances soil fertility, and mitigates environmental impacts such as water pollution and greenhouse gas emissions. This approach not only strives for higher yields and improved crop quality but also fosters resilience against climate change and contributes to long-term sustainability in agriculture. Incorporating agro-residues into agricultural practices plays a crucial role in sustainable farming systems. Agro-residues, which include crop residues, are valuable resources that can be recycled back into the soil. Agro-residues enrich soil organic matter, improve soil structure, and enhance nutrient availability for crops. This sustainable practice not only reduces waste and environmental pollution but also promotes soil health and fertility over time. Integrating agro-residues into farming operations supports the principles of natural farming, contributing to resilient and sustainable agricultural systems. Mulching, a fundamental practice in sustainable agriculture, involves covering the soil surface with materials. This protective layer serves multiple purposes, including conserving soil moisture, suppressing weed growth, moderating soil temperature fluctuations and promoting soil health. Mulches, such as straw, leaves, or compost, gradually decompose, enriching the soil with organic matter and nutrients. In addition to its agronomic benefits, mulching reduces erosion, improves water infiltration and enhances the overall resilience of crops to environmental stresses. Embracing mulching as part of agricultural management strategies underscores its integral role in fostering sustainable farming practices worldwide. Crop rotation is a time-honored agricultural practice that involves alternating the types of crops grown in a specific area over different seasons or years. This systematic rotation is designed to optimize soil health, enhance crop productivity, and manage pests and diseases effectively. By diversifying crop species, farmers can break pest cycles, suppress weed growth, and improve soil fertility through nitrogen fixation and organic matter accumulation. Additionally, crop rotation promotes sustainable agriculture by reducing the reliance on chemical inputs and supporting natural ecosystem functions. Embracing crop rotation as a cornerstone of farming practices contributes to resilient agricultural systems that balance productivity with environmental stewardship.

Biodiversity refers to the variety and variability of life forms on Earth, encompassing all levels of biological organization from genes to ecosystems. In agriculture, biodiversity plays a crucial role in maintaining resilient and sustainable farming systems. Diverse plant and animal species contribute to ecosystem services such as pollination, nutrient cycling, pest regulation and soil health maintenance. Agricultural practices that enhance biodiversity, such as agroforestry, cover cropping, and integrated pest management, not only support ecosystem resilience but also improve farm productivity and mitigate risks associated with climate change and pest outbreaks. Protecting and promoting biodiversity in agricultural landscapes is essential for ensuring food security, fostering environmental sustainability and preserving natural habitats for future generations. Mixed cropping is a traditional agricultural practice where two or more different crops are grown together in the same field during the same growing season.

This method contrasts with monoculture, where a single crop is cultivated over a large area. Mixed cropping offers several advantages including maximizing land use efficiency, enhancing biodiversity, reducing risks associated with pests, diseases and adverse weather conditions. Different crop combinations in mixed cropping systems can complement each other by utilizing resources such as sunlight, water and nutrients more efficiently. This practice also promotes soil health through improved nutrient cycling and weed suppression. By fostering ecological resilience and increasing overall farm productivity, mixed cropping aligns with sustainable farming principles and contributes to resilient agricultural systems worldwide.

Cultivating Vitality explores the pivotal roles of microbes and earthworms in sustainable agriculture, emphasizing their contributions to soil health, nutrient cycling and crop productivity. By harnessing microbial communities and earthworm activities, farmers can enhance soil fertility, reduce dependency on chemical inputs and promote environmental sustainability. This holistic approach fosters resilient farming systems capable of mitigating climate impacts and ensuring long-term agricultural viability. Through practical applications and case studies, the chapter demonstrates how integrating these biological allies can achieve sustainable farming success while preserving ecosystem integrity.

Microbes in Agriculture

Nutrient cycling facilitated by microbial communities is essential for maintaining soil fertility, enhancing crop productivity and promoting sustainable agricultural practices. Understanding and optimizing these microbial processes are crucial for achieving resilient agricultural systems that support food security, environmental sustainability and ecosystem health.

Nutrient Cycling

Nutrient cycling is a fundamental process in agriculture facilitated by diverse microbial communities present in the soil. Microbes including bacteria, fungi and protozoa, play pivotal roles in breaking down organic matter and releasing essential nutrients that are vital for plant growth and ecosystem health.

Decomposition of Organic Matter

Microbes are key decomposers in the soil, breaking down complex organic compounds found in plant residues, crop stubble and animal manure. Through enzymatic processes, microbes degrade these materials into simpler forms, releasing nutrients such as nitrogen (N), phosphorus (P) and potassium (K) into the soil solution.

Nitrogen Cycling

Nitrogen is crucial for plant growth and is often a limiting nutrient in agricultural systems. Nitrogen-fixing bacteria, such as *Rhizobium* in legume nodules and free-living *Azotobacter*, convert atmospheric nitrogen (N_2) into ammonium (NH_4^+) or nitrates (NO_3^-), which plants can absorb and utilize for protein synthesis and growth.

Phosphorus Cycling

Phosphorus is released from organic matter and soil minerals by phosphorus-solubilizing microbes. These microbes produce organic acids and enzymes that break down organic phosphorus compounds, making phosphate (PO_4^{3-}) available for plant uptake. This process is essential as phosphorus availability often limits crop productivity.

Potassium and Micronutrient Cycling

Microbes also play critical roles in releasing potassium (K) and micronutrients from organic matter and minerals in the soil. These nutrients are essential for various physiological processes in plants, including enzyme activation, osmotic regulation, and disease resistance.

Soil Health and Ecosystem Resilience

Beyond nutrient cycling, microbial activities contribute to soil health by improving soil structure, enhancing water retention and promoting beneficial interactions among soil organisms. Healthy soils foster robust plant growth, reduce nutrient leaching and mitigate environmental stresses such as drought and disease outbreaks.

Sustainable Agriculture Practices

Harnessing microbial contributions to nutrient cycling is integral to sustainable agriculture practices. By promoting soil microbial diversity through practices like cover cropping, crop rotation and bioformulations, farmers can enhance nutrient availability, reduce reliance on synthetic fertilizers and improve overall farm productivity while preserving environmental quality.

Crop diversification

Crop diversification is a cornerstone of sustainable agriculture, offering myriad benefits for soil health, pest management, resource efficiency, economic stability and environmental conservation. Embracing diverse cropping systems not only safeguards agricultural productivity but also fosters resilience and sustainability in the face of global challenges. Integrating crop diversification strategies into agricultural policies and practices is essential for building resilient food systems that can meet future food security needs while preserving natural resources and biodiversity. Crop diversification is a strategic agricultural practice that involves cultivating a variety of crops within a farming system over time or simultaneously on the same field. This part explores the multifaceted benefits of crop diversification in promoting agricultural resilience, enhancing soil health and sustaining productivity in diverse farming environments.

Enhancing Soil Health and Fertility

Crop diversification improves soil health by reducing monoculture-associated issues such as nutrient depletion and pest build-up. Different crop species have varying root structures and nutrient requirements, which helps break pest and disease cycles and enhances nutrient cycling. Leguminous crops in rotations fix nitrogen and enriching soil fertility naturally.

Mitigating Pest and Disease Pressure

Diverse crop rotations disrupt pest and disease cycles, reducing the need for chemical pesticides and fostering natural pest control mechanisms. This practice minimizes crop-specific pest outbreaks and spreads risks associated with adverse weather conditions, thereby enhancing farm resilience.

Nutrient Management and Sustainability

Rotating crops with different nutrient demands optimizes nutrient use efficiency and reduces the risk of nutrient imbalances in soils. This approach mitigates environmental impacts, such as nutrient leaching and promotes sustainable nutrient cycling within the agroecosystem.

Improving Water and Resource Use Efficiency

Crop diversification contributes to improved water and resource use efficiency by matching crop water needs with seasonal rainfall patterns and soil types. Deep-rooted crops enhance soil structure and water infiltration, reducing erosion and enhancing overall water retention capacity.

Economic and Market Diversification

Diversifying crops reduce market risks associated with price fluctuations and demand changes for specific commodities. Farmers can capitalize on diverse market opportunities and enhance income stability by cultivating a mix of crops suited to local agro-climatic conditions and consumer preferences.

Supporting Biodiversity and Ecosystem Services

A diverse crop portfolio supports biodiversity by providing habitat and food sources for beneficial insects, pollinators and wildlife. It enhances ecosystem resilience and services such as pollination, soil conservation and carbon sequestration, contributing to long-term environmental sustainability.

Resilience to Climate Change

Crop diversification enhances agricultural resilience to climate change impacts, such as extreme weather events and temperature fluctuations. Farmers can adapt cropping patterns and species selection to mitigate risks and maintain productivity under changing climatic conditions.

Natural Farming Practices: The Need of the Hour

The adoption of natural farming practices is essential for addressing current agricultural challenges and building resilient food systems capable of meeting future global food demands. Embracing natural farming not only safeguards natural resources and biodiversity but also enhances the resilience of farming communities to economic, environmental and climatic uncertainties. By prioritizing sustainability, soil health and ecosystem integrity, natural farming represents a forward-thinking approach to sustainable agriculture that benefits farmers, consumers and the planet alike.

Preserving Soil Health and Fertility

Natural farming practices, such as minimal tillage, cover cropping, and mulching, prioritize soil health by preserving soil structure, enhancing organic matter content, and promoting beneficial soil microorganisms and earthworms. Healthy soils support nutrient cycling, water retention, and overall crop productivity without depleting natural resources.

Mitigating Environmental Impacts

Natural farming reduces environmental impacts associated with conventional agriculture, such as soil erosion, water pollution from agrochemical runoff and greenhouse gas emissions. By minimizing synthetic inputs and promoting biological diversity, natural farming conserves ecosystems and maintains biodiversity crucial for ecosystem services.

Enhancing Resilience to Climate Change

Natural farming methods enhance agricultural resilience to climate change by improving soil water-holding capacity, reducing vulnerability to droughts and floods, and promoting carbon sequestration in soils. Diverse crop rotations and agroforestry practices buffer against extreme weather events and temperature fluctuations.

Promoting Biodiversity and Ecosystem Services

Natural farming supports biodiversity by integrating diverse crop species, preserving native habitats, providing food and shelter for beneficial insects, pollinators and wildlife. Healthy ecosystems enhance natural pest control, pollination and soil fertility, essential for sustainable food production.

Improving Human Health and Food Safety

By avoiding synthetic pesticides and fertilizers, natural farming reduces chemical residues in food and minimizes health risks associated with agricultural chemicals for farmers, consumers and surrounding communities. Organic farming practices promote nutritious and safe food choices while supporting local food systems.

Empowering Farmers and Building Local Economies

Natural farming empowers farmers by reducing input costs, enhancing crop diversity and improving market access for natural and sustainably grown products. It fosters economic resilience by diversifying income sources and creating opportunities for value-added products and eco-tourism.

Promoting Sustainable Development Goals (SDGs)

Natural farming aligns with global sustainability goals, such as achieving zero hunger, promoting responsible consumption and production and combating climate change.

The Role of Indigenous Cows in Agriculture

The use of indigenous cows in agriculture offers a holistic approach to sustainable farming, promoting soil health, biodiversity conservation and community resilience. Embracing their role in integrated farming systems enhances ecological sustainability, cultural heritage and economic prosperity for farmers. By recognizing and utilizing the potential of indigenous cow breeds, agriculture can move towards a more resilient and sustainable future. This section explores the multifaceted advantages of integrating indigenous cow breeds into agricultural systems and their potential to enhance ecological resilience and community well-being.

Nutrient-Rich bioformulations and Soil Fertility

Indigenous cows are renowned for producing nutrient-rich manure that enhances soil fertility and improves soil structure. Cow dung contains valuable organic matter, beneficial microorganisms, and essential nutrients such as nitrogen, phosphorus, and potassium, which promote healthy crop growth and reduce the need for synthetic fertilizers. Cow dung is used to prepare *Jeevamrit* and *Ghanjeevamrit*.

Sustainable Soil Management

Utilizing cow dung based bioformulations supports sustainable soil management practices by replenishing soil nutrients, enhancing water retention and fostering beneficial soil microorganisms. This natural approach to soil enrichment minimizes environmental impacts and preserves soil health for long-term agricultural productivity.

Agroecological Integration and Crop Diversity

Indigenous cows contribute to agroecological diversity by supporting integrated farming systems. They graze on diverse vegetation, promoting natural weed control and nutrient recycling in agroforestry and mixed-cropping systems. This integration enhances biodiversity, reduces pest pressure, and supports sustainable land use practices.

Climate Resilience and Resource Efficiency

Indigenous cows are well-adapted to local climatic conditions and require minimal external inputs for maintenance. Their grazing habits and browsing behaviors contribute to sustainable land management, preventing soil erosion and promoting vegetation regeneration. This resilience helps mitigate climate risks and supports ecosystem stability.

Cultural and Socioeconomic Benefits

Indigenous cows hold cultural significance in many communities, representing traditional knowledge and heritage. Their role in agriculture strengthens local economies through dairy production, meat consumption and value-added products like ghee and biogas. This economic diversification enhances livelihoods and fosters rural development.

Conservation of Genetic Diversity

By preserving indigenous cow breeds, farmers contribute to conserving genetic diversity and bio-diversity in agriculture. These breeds often exhibit disease resistance, adaptation to local environments, and unique traits that can be valuable for breeding programs and sustainable livestock management.

Promoting Natural and Sustainable Farming Practices

Integrating indigenous cows into natural farming systems supports sustainable agricultural practices that prioritize soil health, biodiversity conservation and natural resource management. Their role in nutrient cycling and natural pest control aligns with natural certification standards and promotes eco-friendly farming methods.

Synergistic Effects of Microbes and Earthworms in Agriculture

The synergistic effects of microbes and earthworms in agriculture underscore their critical roles in promoting sustainable farming practices and enhancing ecosystem services. By harnessing their combined benefits, farmers can improve soil health, increase crop yields, and mitigate environmental impacts, contributing to resilient and productive agricultural systems.

Soil Structure and Aggregation

Earthworms contribute to soil health by burrowing through the soil, creating channels that improve aeration and water infiltration. These activities enhance the habitat for beneficial microbes, promoting their growth and activity in the soil. Microbes, in turn, break down organic matter into nutrients that earthworms can ingest and further decompose, creating nutrient-rich casts that improve soil structure and fertility.

Nutrient Cycling and Matter Decomposition

Microbes and earthworms work together to break down matter, such as crop residues and manure, into simpler forms that plants can readily absorb. Earthworms ingest material, digest it, and excrete nutrient-rich casts that are enriched with microbial activity. This enhances nutrient cycling in the soil, making essential nutrients like nitrogen, phosphorus and potassium more available to plants.

Enhancement of Plant Growth and Root Development

Microbes support plant growth by facilitating nutrient uptake and producing growth-promoting substances such as phytohormones. Earthworm activities enhance root proliferation by improving soil structure and nutrient availability, which enhances plant resilience to environmental stresses and promotes overall crop productivity.

Pest and Disease Suppression

Microbes contribute to natural pest management by producing compounds that inhibit pathogen growth and stimulate plant defences. Earthworms indirectly aid in pest suppression by enhancing soil health, which supports healthy plant growth and resilience to pest pressures. This reduces the need for chemical pesticides and promotes sustainable pest management practices.

Climate Resilience and Carbon Sequestration

The combined activities of microbes and earthworms contribute to climate resilience by improving soil matter content and enhancing carbon sequestration in the soil. Earthworm burrows and microbial decomposition processes facilitate the storage of carbon in stable forms, mitigating greenhouse gas emissions and enhancing soil fertility.

Promotion of Sustainable Farming Practices

Integrating microbes and earthworms into agricultural systems promotes sustainable farming practices that prioritize soil health, biodiversity conservation, and ecosystem resilience. Their synergistic interactions reduce dependency on synthetic inputs, enhance soil fertility and support long-term agricultural productivity in a changing climate.

Conclusion

Incorporating these sustainable practices - leveraging the benefits of microbes, earthworms, crop diversification, natural farming, and indigenous cows - presents a holistic approach to modern agriculture. These practices collectively contribute to resilient farming systems capable of sustaining productivity, mitigating environmental impacts, and adapting to global challenges such as climate change. By understanding and integrating these elements, farmers can foster sustainable agricultural landscapes that ensure food security, environmental health and economic viability for future generations.

Future prospects

The future of sustainable agriculture holds promising prospects as advancements in research, technology and farming practices continue to evolve. The integration of microbes, earthworms, crop diversification, natural farming and indigenous cows into agricultural systems presents numerous opportunities to enhance productivity, resilience and environmental sustainability. Research in microbiology and biotechnology is expected to lead to the development of more efficient and targeted microbial strains, enhancing nutrient cycling, disease resistance and plant growth. The use of advanced technologies such as remote sensing, drones and soil health sensors will enable real-time monitoring of soil conditions, helping farmers make informed decisions on crop management, irrigation and fertilization. As the benefits of crop diversification become more widely recognized, there will be increased adoption of diverse cropping systems, including intercropping, agroforestry, leading to enhanced biodiversity and improved pest management. The future will also see the refinement and widespread adoption of natural farming techniques that minimize external inputs and promote ecological balance. There will be a greater emphasis on conserving and utilizing indigenous livestock breeds for their unique traits and adaptability, involving breeding programs and integrating livestock into sustainable farming systems. Smart farming technologies, including precision agriculture, IoT devices and data analytics, will revolutionize farming practices by enabling precise application of inputs, efficient resource management, and improved crop performance. Governments and international organizations are expected to provide more policy support and incentives for sustainable agriculture practices, including subsidies for inputs, funding for research, and programs promoting farmer education. The future will also see a rise in community and farmer-led initiatives that promote knowledge sharing, cooperative farming and local food systems, empowering farmers and strengthening rural economies. Climate-smart agriculture (CSA) practices will be increasingly adopted to mitigate the impacts of climate change, including efficient water management. Enhanced global collaboration and knowledge exchange among researchers, farmers, policymakers and stakeholders will drive the adoption of sustainable agricultural practices. International partnerships and networks will facilitate the sharing of best practices, innovations and research findings. The future of agriculture lies in embracing sustainable practices that harmonize with nature, promote biodiversity and ensure long-term productivity, contributing to food security, environmental conservation, and the well-being of farming communities worldwide.

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Chapter- 3

Impact and Potential of Natural Farming

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Abstract

Rice-wheat is the predominant cropping system of North-Western India. Intensive agricultural practices adopted in this system, has lead to significant soil degradation and depletion of natural resources. The adoption of natural farming methods presents a promising solution to the challenges encountered under the prevailing conditions. This chapter explores the potential of natural farming practices in restoring soil health, enhancing the activities of soil microbiome and increasing the productivity of crops and the role of bio-formulations like Jeevamrit and Ghan Jeevamrit in natural farming. Additionally, the chapter discusses the formation of humus, its relationship with organic carbon and bioremediation of problematic soils and underground water and finally underscores the potential of natural farming to revitalize agriculture in this region by ensuring long-term sustainability and environmental preservation.

Keywords: *Microbes, earthworms, soil health, nutrient cycling, biological diversity, soil ecosystem, climate resilience*

Introduction

North-Western India, encompassing Punjab, Haryana and Western Uttar Pradesh is recognized as the High Productivity Zone. This area primarily follows a paddy-wheat crop cycle, with these two crops contributing approximately three-fourths of the country's food security since the 1990s. This region plays a critical role in India's foodgrain production. However, the intensive paddy-wheat cycle has led to significant soil health deterioration and depletion of other natural resources, such as underground water. The ongoing degradation of these natural resources poses a serious concern. Despite numerous efforts, crop diversification has not been successful in this area. The soil health has deteriorated to the point where farmers find it risky to grow crops other than paddy and wheat. Therefore, restoring the soil health and conserving other natural resources in this region is crucial for maintaining the country's food security and environmental sustainability. Scientific research indicates that each year, rice and wheat crops absorb approximately 300 kg of nitrogen, 30 kg of phosphorus, 300 kg of potassium and various micronutrients from the soil (1). In Haryana's Kurukshetra district, groundwater levels have steadily declined, with rates accelerating significantly from the 1970s to the present. Between 1974 and 2001, groundwater levels dropped by about one foot per year, followed by a faster decline of three to four feet per year from 2001 to 2011, and a more severe decrease of four to six feet per year from 2011 to 2021. This alarming trend of declining groundwater levels is mirrored across the entire Indo-Gangetic plain, posing a critical concern for sustainable water management (2). Consequences of post harvest residue burning by famers are becoming discernible in terms of soil health, environment and global warming (2). For this, Government of India announced a scheme for the farmers in the year 2018, under which 80% subsidy was given to the farmers to purchase machinery to incorporate these residues in soil itself. In initial phase, scheme was implemented for 2 years i.e. 2018-19 and 2019-20 with a grant of Rs 1152 crore (3) but after observing high utility and success of the scheme, it is being implemented till now. If the problem of crop residue is not resolved in an environment friendly manner, then the possibilities of increasing global warming cannot be denied. Due to the excessive use of chemical fertilizers and chemical pesticides, the possibilities of increased emissions of carbon dioxide, methane and nitrous oxide, which increase global warming, are being expressed. Even during manufacturing process of nitrogenous fertilizers, greenhouse gases are emitted into the atmosphere (4) and even after their application in the crop, greenhouse gases continue to be emitted from the soil (5). Despite the adverse effect on soil health, micro-organisms and environment during the manufacturing of chemical fertilizers and after their application in the crop, the Government of India had to give a subsidy of Rs 1.62 lakh crore to the farmers on these fertilizers in the year 2021-22 (6).

In organic farming too, large amounts of green house gases are emitted by abundant application of inputs like farm yard manure (FYM) and vermicompost. Scientific research confirms that global warming gases emission on yield-scale equivalence is many times higher in organic farming than chemical farming. According to a research, in organic farming greenhouse gases emission is 10.6% higher than conventional farming (7). According to other research findings, if all conventional farming is converted to organic farming, it will increase the emission of greenhouse gases by 21% (8). The results of studies conducted on natural farming in different parts of the country clearly indicate that natural farming is fully capable of combating all these problems and challenges mentioned above. Studies in Andhra Pradesh show that natural farming increased crop yields and gross and net income by 14.2 to 50% while reducing crop costs by 23.7%. In addition, there was a significant improvement in earthworm activity and soil health (9). According to the results of the study conducted in Karnataka, 85% of the 97 farmers said that their income increased, 90% of the farmers expressed that the cost of the crop decreased, 92% of the farmers opined that they felt less need to take loans, 91% of them said that the quality of their produce improved and 78% said that practicing natural farming increased crop yield (10). Similar results were obtained from Himachal Pradesh, according to which 54% reduction in crop cost and 27% increase in production was achieved in horticultural crops. Natural farming provides solution to all the problems faced in today's agriculture system whether it is related to the health of the soil or depleting natural resources, rising costs of cropping, declining productivity or issues such as global warming (11–13).

Sustainability aspects of Natural Farming

Improvement in soil health: To assess soil health, soil from Gurukul Kurukshetra's farm in Haryana, where 72 hectares are cultivated using natural farming methods, was tested. Additionally, the Agriculture Department collected and analyzed 1,701 soil samples from approximately 225 villages across four blocks (Thanesar, Ladwa, Shahbad and Babain) in

Kurukshetra district. The results indicated significant depletion of organic carbon in the soil from these blocks. The average organic carbon content in these samples was classified as poor, ranging from 0.34% to 0.46%, with only four samples having sufficient organic carbon content. In 2017, after harvesting wheat on Gurukul Kurukshetra's farm, soil testing revealed an average organic carbon content of 0.61%, with 30% of samples exceeding 0.75%, thus falling into the rich category. This included fields that had practiced organic farming for the past 3-5 years. When this investigation was repeated in 2018, the average organic carbon content had increased to 0.91%, with 95% of the fields classified as rich. Similarly, in 2019 and 2020, over 90% of the samples showed sufficient amounts of organic carbon. The testing of samples from Gurukul farm highlighted that fields with more tillage and bed sowing of crops like sugarcane, potato, and vegetables had lower organic carbon increments compared to fields with minimum tillage, crop residue and dhaincha green manuring. Fields with extensive ploughing (8-10 tillage operations/year) saw an increase in organic carbon from 0.65% to 0.82% over two years. In contrast, fields with less ploughing (2-5 tillage operations/year) and the use of residues and green manure experienced an increase from 0.43% to 1.03% within the same period (14). Such a remarkable increase in organic carbon within two years is unattainable with current chemical or conventional farming methods. This demonstrates that natural farming significantly enhances the chemical, biological and physical properties of the soil.

Role of Biocatalysts / Bioformulations (*Jeevamrit* and *Ghan Jeevamrit*)

Jeevamrit and *Ghan Jeevamrit* are bio-formulations used in natural farming to enhance the activity and population of microorganisms and earthworms in the soil. *Jeevamrit* is a crucial bioformulation in natural farming that acts as a catalyst for soil microorganisms, continuously increasing their population. These microorganisms fix atmospheric nitrogen in the soil and make otherwise inaccessible soil nutrients available to plants, thereby boosting crop yield. A scientific study at the Agricultural University of Pantnagar (Uttarakhand) showed that using 4000 to 5000 litre per hectare of Jeevamrit on the medicinal crop Brahmi increased yields by 72 to 84% compared to the use of recommended chemical fertilizers(15).GhanJeevamrit, along with *Beejamrit* and *Jeevamrit*, is a bio-formulation that supports the growth of microorganisms. Initially, microorganisms are cultured in *Jeevamrit* using cow dung, cow urine, jaggery and pulse flour. These microorganisms' populations are further increased in the field by using crop residues, green manure, mulching etc. Crop residues and green manure provide carbon and nitrogen sources, essential for microbial multiplication. While cereal crop residues supply the carbohydrates (carbon, hydrogen, and oxygen), pulse green manure also provides nitrogen, facilitating rapid decomposition and nutrient supply to standing crops. This symbiotic relationship among plants, microorganisms, and earthworms enhances soil fertility. Microorganisms like *Azotobacter, Azospirillum*, and *Mycorrhizae* around plant roots create a micro-environment that forms a significant amount of humus in the rhizosphere, ensuring optimal nutrient, moisture, and air availability to plants.Similar to Jeevamrit, GhanJeevamrit boosts the population of microorganisms and earthworms in the soil.GhanJeevamrit can be prepared using fresh cow dung, well-decomposed cow dung manure, or dry biogas slurry.

Creation of Humus and Micro-Environment

a) Formation of Humus: Humus, often referred to as the life energy or food reserve of soil, is a dark brown to brownish-black substance crucial for plant growth. Composed primarily of carbon (10-12 parts) and nitrogen (one part), with traces of elements like phosphorus and sulfur, humus forms through the decomposition of organic matter. This process creates an optimal environment around plant roots, providing essential nutrients, proper air, and moisture in balanced proportions. Humus plays a critical role in forming wapsaa (proper air and moisture provision) around plant roots. Excessive watering near roots or frequent ploughing can negatively impact wapsaa and humus formation itself (11). The formation and stability of humus are influenced by both soil and atmospheric conditions. Carbon is the primary component of humus, and its stability can be affected by high temperatures exceeding 35°C and excessive ploughing of the field (14). However, with sustainable practices and proper conservation measures, humus can persist for many years, benefiting soil health significantly.

Increasing humus content by just 1% in soil can more than double its water holding capacity, demonstrating its crucial role in soil fertility and water management. While humus develops throughout the entire field, it is especially nurtured and conserved in the rhizosphere—the zone around plant roots. This micro-environment supports optimal conditions for plant growth by providing essential nutrients, adequate air, and moisture. Moreover, humus acts as a barrier, preventing harmful chemicals and organisms from reaching and infecting plant roots, thus contributing to overall plant health and productivity.

Plants contribute to this process by allocating synthesized food to root development. Chemical substances, including allelochemicals, are exuded by roots. These substances—sugars, amino acids, organic acids, vitamins, and high-molecular-weight polymers—nourish microorganisms in the rhizosphere, accelerating humus formation. In natural farming, which centers on microorganism-based practices, this cycle is efficiently completed. Chemicals released by plant roots also regulate soil pH and EH (redox potential) in the rhizosphere, enhancing nutrient availability. pH influences soil acidity and alkalinity, while EH indicates soil oxygen status—both crucial for microbial growth and humus formation.

b) Relationship of Humus and Organic Carbon: Organic carbon is essential for humus formation; however, adequate organic carbon doesn't guarantee sufficient humus development. Humus must be specifically formed around plant roots to support plant and root growth effectively. Factors like excess water or dryness around roots can hinder humus formation. Humus serves as a pre-made nutrient source for microbes and plant roots, containing hormones and enzymes that coordinate soil and plant processes.

Bioremediation of soils

High salt concentrations in soil adversely affect microorganism activity. In Haryana, soil pH typically ranges from 7.2 to 8.2. Adjusting pH closer to neutral enhances microorganism activity and nutrient availability. Approximately 65% of Haryana's groundwater contains salts, which settle in soil layers when used for irrigation via tube wells. There are two types of salts: soluble and insoluble. Soluble salts, predominantly chloride and sulfate ions, increase soil Electrical Conductivity (EC), while insoluble salts, mainly carbonate and bicarbonate of sodium, raise soil pH. Gypsum is effective in neutralizing insoluble salts, while soluble salts require careful field and crop management.

It's essential for farmers to periodically test soil and underground water, ideally every 3 to 4 years post-Rabi crop harvest, to identify salt types and manage them accordingly. Natural farming practices have shown that increased microorganism and earthworm populations enhance soil health (16). At Gurukul Kurukshetra farm, the average pH decreased from 7.88 in 2017 to 7.60 in 2019, indicating positive changes due to natural farming practices. Direct seeding of rice has proven effective in managing salt-affected soils in Kaithal district, mitigating salt's adverse effects on crop productivity (17).

Management of Nutrients and Crop Productivity in Natural Farming

Plants require 17 essential nutrients for their growth and development, categorized into 9 major (macro nutrients) and 8 minor (micro nutrients). The major nutrients include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur, while the micro nutrients comprise zinc, iron, copper, manganese, boron, molybdenum, chlorine, and nickel. Carbon, hydrogen and oxygen are sourced directly from air, water and soil with carbon dioxide and water being converted into starch and sugars through photosynthesis, driven by solar energy.The remaining 14 nutrients are obtained from the soil, absorbed by plant roots when dissolved in water. It is crucial for these nutrients to be present in adequate quantities in the soil for optimal plant development. A deficiency in any single nutrient can impair the plant's ability to utilize the others effectively. Nitrogen, phosphorus and potassium are considered primary nutrients due to their essential roles in plant metabolism, while calcium, magnesium, and sulphur are classified as secondary nutrients. Among these nutrients, nitrogen stands out for its extensive involvement in virtually all plant processes. It is vital for protein and amino acid formation, aids in carbohydrate synthesis and is a key component of chlorophyll, thereby significantly influencing overall plant growth and development.

The level of organic carbon in soil plays a critical role in supporting crop growth. Soil with less than 0.50% organic carbon is categorized as 'poor,' while levels above 0.75% are considered conducive to plant growth. In many parts of India, particularly in the plains, organic carbon content in soil is generally below 0.50%. In the high productivity regions of North-Western India (Punjab, Haryana, Western Uttar Pradesh), organic carbon levels typically range from 0.30% to 0.40%. In Rajasthan and adjoining areas, it can drop to 0.10% to 0.20%, whereas soils in colder regions like Himachal Pradesh, Uttarakhand, and Jammu-Kashmir tend to have higher organic carbon content compared to other regions. Approximately 90% of nitrogen in soil is bound to organic carbon. When organic matter undergoes mineralization in soil - breaking down into inorganic components - it enhances nitrogen availability. The carbon within humus, a stable form of organic matter, can persist in soil for extended periods under natural conditions, contributing to soil fertility and supporting sustainable agriculture practices.

Stable and unstable carbon in soil exhibit a positive relationship under normal conditions, where higher total organic carbon content generally correlates with increased stable carbon. Unstable carbon exists in various forms such as particulate organic matter carbon, microbial biomass carbon, water-soluble carbon and mineralization carbon. On the other hand, stable carbon resides in soil as humic acid and fulvic acid within humus, providing a stable reservoir of energy (in the form of moisture and nutrients) readily available for micro-organisms and plants. Humus, the end product of decomposed organic matter, plays a crucial role in soil fertility and ecosystem health.Collectively, stable and unstable carbon is termed 'Total Organic Carbon' (18, 19).

Conservation agriculture shares principles with natural farming, particularly in the exclusion of chemical inputs and reliance on natural bio-formulations instead. Conservation farming, derived from principles like "no-till" farming or "do-nothing" farming popularized by Masanobu Fukuoka, emphasizes minimal disturbance to soil and avoidance of synthetic fertilizers and pesticides. These principles align closely with those of natural farming, emphasizing sustainable crop management practices and nurturing soil biota. Water saving emphasis prevails in both natural and conservation farming (20). Research in conservation farming has shown that while organic carbon levels in fields may increase, crop yields sometimes fail to rise as expected, necessitating the use of chemical inputs. This could be attributed to insufficient improvement in stable organic carbon levels that create a beneficial micro-environment around plant roots. In contrast, consistent enhancement of humus content can significantly improve the physical, chemical, and biological conditions of soil, thereby enhancing crop yields sustainably.

Moreover, the use of chemical fertilizers can adversely impact soil micro-organisms critical for nitrogen fixation and pest control. Nitrogen-containing chemical fertilizers, for instance, can suppress the population and activity of nitrogen-fixing bacteria like *Azotobacter* and *Rhizobium*, thereby reducing their beneficial effects on crop growth and yield (21, 22). Similar effects have been observed with bacteria involved in phosphorus availability, such as PSB (phosphate-solubilising bacteria). Overall, micro-organisms play crucial roles in enhancing soil fertility and supporting plant growth processes. They contribute to nutrient cycling, disease suppression and resilience to environmental stresses like salinity and drought. Therefore, minimizing reliance on chemical inputs and fostering a healthy soil microbial community are integral to sustainable agriculture practices like conservation farming and natural farming.

The use of chemical fertilizers significantly impacts soil micro-organisms, hormones and enzymes, crucial components that drive soil and plant health. Farmers often apply nitrogen-containing fertilizers excessively, which disturbs the balance of nutrients and adversely affects soil organisms like microorganisms and earthworms. This imbalance can lead to suboptimal crop yields despite adequate organic carbon content in the soil. Excessive nitrogen uptake by plants can cause internal metabolic disruptions and toxicity, affecting their overall health and productivity. This toxicity extends to soil and surrounding environments, impacting microbial populations and their activities. Microorganisms play vital roles in nutrient cycling, disease suppression, and maintaining soil health, making their conservation crucial for sustainable agriculture.

Research demonstrates that micro-organisms like *Clostridium*, *Rhizobium*, *Azotobacter*, *Azospirillum*, *Herbaspirillum* etc. can fix substantial amounts of nitrogen in agricultural soils (23-25). These bacteria operate in both symbiotic and non-symbiotic relationships with plants, enhancing nitrogen availability and reducing the need for synthetic fertilizers. Natural farming practices amplify these beneficial microbial interactions by creating environments conducive to microbial growth and activity through practices like minimal tillage, mulching, use of crop residues, wapsaa, biodiversity etc. (9, 26). Thus, minimizing reliance on chemical fertilizers and nurturing soil microorganisms through natural farming practices are essential for sustainable agriculture. These practices not only improve soil fertility and crop productivity but also contribute positively to environmental health and long-term agricultural sustainability.

Micro-organisms play crucial roles in enhancing nutrient availability and supporting plant growth in natural farming systems through various mechanisms:

1. Nitrogen fix through symbiotic and non-symbiotic means.

2. Nutrient Cycling through Humus Formation: Microorganisms and earthworms contribute to nutrient cycling by decomposing organic matter. When they die and decay, their bodies turn into humus, enriching the soil with essential nutrients and activating primary and secondary metabolites. This bio-geochemical cycle sustains soil fertility.

3. Nutrient Solubilisation: Nutrient-solubilizing microorganisms break down complex organic and inorganic compounds, making nutrients more available to plants. This enhances the uptake of recalcitrant and unavailable nutrients present in the soil.

4. Beneficial Microbial Associations: Microbial associations like *Mycorrhizae*, *Trichoderma*, and *Pseudomonas* not only protect plants from pests and diseases but also facilitate nutrient uptake. *Mycorrhizal* fungi form symbiotic relationships with plant roots, extending their nutrient absorption capacity, particularly for phosphorus.

5. Photosynthetic Bacteria: Photosynthetic bacteria such as *Cyanobacteria* and *Rhodospirillum* contribute to nutrient availability through nitrogen fixation and other metabolic activities. *Cyanobacteria*, for instance, work in symbiosis with plants like *Azolla* fern, enhancing nitrogen fixation capabilities.

6. Enhancing the availability of nutrients through bioremediation of problematic soils.

7. Through the regulation of soil reaction.

Further research is needed to fully understand the impacts of photosynthetic bacteria like *Rhodospirillum rubrum* and various interactions of microbes with plant-soil interfacial system under different agroclimatic conditions in natural farming. These bacteria hold promise in contributing to sustainable agricultural practices by enhancing nutrient availability and reducing reliance on synthetic inputs.

Conclusion

Natural farming provides a sustainable pathway to address the challenges of modern Indian agriculture. By focusing on soil health, water efficiency and sustainable practices, natural farming can ensure long-term productivity and environmental sustainability, safeguarding food security and ecological balance for future generations. Soil health is the most crucial factor for sustainable farming. Natural farming has demonstrated significant improvements in organic carbon content and overall soil quality, enabling crop diversification and reducing dependency on rice-wheat cycles.

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Chapter- 4

Low Input IFS for Small and Marginal Farmers

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Introduction

Globally, 84% of farms are smaller than 2 hectares, managing approximately 12% of the farmland. Conversely, 16% of farms worldwide are larger than 2 hectares, yet they oversee 88% of the farmland (Lowder et al., 2016). This stark contrast in land distribution highlights a significant disparity among growers globally. Many agricultural schemes developed so far have predominantly favored large farmers or landowners, neglecting the needs of smallholders and marginalized farmers. Addressing the challenges faced by smallholders is crucial to realizing the food security goals set by the Indian government. Research incorporating location-based systems technology has revealed insights into India's agricultural landscape. According to the 10th Agriculture Census (2015-16), the average operational holding size in India decreased to 1.08 hectares in 2015-16 from 2.28 hectares in 1970-71. Small and marginal holdings, together comprising those below 2.00 hectares, accounted for 85.01% of holdings and 44.58% of the operated area. Analysis over the past 40 years indicates a relatively stable holding size across all groups, with slight changes noted among medium-scale farmers. This suggests a trend where medium and large farmers transition into marginal and semi-marginal farmers as land passes through generations and divides among shareholders from ancestral properties. Narayanan and Gulati (2002) describe small farms as those where farmers practice a mix of market-oriented and subsistence farming, relying mainly on household labor for farm work and considering the farm as their primary source of income. They note the bias in comparing land sizes, especially between irrigated and rainfed holdings or between plantation and stable cereal crop fields (such as rice, wheat, and pearl millet). Small farmers often lack political influence, face capital deficits, rely on external sources for machinery, are hesitant to take investment risks for farm infrastructure, use low-quality seeds, and make farming decisions based on financial constraints (Adams and Coward, 1972; Devendra, 1993; World Bank, 2003). Machinery ownership is closely tied to household assets, credit availability, electricity supply, and connectivity (Mottaleb et al., 2016). The primary strength of small farmers lies in their livestock management and efficient utilization of family labor in farming (Devendra, 2007). Small farms exhibit unique characteristics, including resource scarcity, geographic isolation, harsh conditions like rainfed farming and degraded land, prevalent hunger and poverty, risk aversion, limited adoption of new technologies, higher involvement of women and children in farm and livestock management alongside household responsibilities (Devendra, 1983; 1993).On-station studies suggest that Integrated Farming Systems (IFS) have the potential to boost overall farm income. However, replicating the exact on-station IFS model directly on farmers' fields is challenging due to the higher initial costs involved. To address this, the All India Coordinated Research Project on Integrated Farming Systems (AICRP-IFS) has initiated On-Farm Research (OFR) programs.

These programs intervene at critical input stages of IFS implementation on farmers' fields, demonstrating that farm incomes can be increased by 2 to 5 times with lower input costs.

Integrated Farming System (IFS)

Integrated Farming Systems (IFS) involve integrating various farming components such as cropping systems, dairy, fisheries, beekeeping, vermi compost, poultry, agroforestry, mushroom cultivation, biogas, piggery, and sericulture. The goal is to create a symbiotic relationship where the output of one enterprise serves as input for another, enhancing overall productivity and sustainability. While farmers in India and South Asian countries have historically practiced integrated farming, IFS emphasizes the deliberate and scientifically approved integration of non-conventional elements to make farming systems more profitable and ecologically sound. A key principle of IFS is the efficient utilization of resources, where waste from one enterprise becomes a valuable input for another, promoting resource conservation and maximizing output.

The Objectives of Integrated Farming Systems (IFS) are as follows:

Recycling of resources: Reduce the dependency of farmers on market inputs by efficiently recycling resources within the farm system.

Optimal resource allocation: Allocate resources in a way that maximizes space utilization through horizontal and vertical integration. Examples include boundary plantations that optimize land use.

Year-round farmer involvement: Ensure farmers are engaged in different farming components throughout the year, maximizing the utilization of human resources available on the farm.

Steady income throughout the year: Provide farmers with a continuous income stream throughout the year, enabling them to withstand small financial setbacks or emergencies.

Long-term financial planning: Include fixed deposit components such as agroforestry to meet future financial needs like higher education expenses, marriage costs, or health complications.

Labor-intensive commercial crops: Integrate labor-intensive commercial crops into the cropping system or farming components to efficiently utilize family women labor, who can contribute during free time in the day.

Crop diversification for nutritional security: Implement crop diversification in the cropping system to enhance nutritional security and promote a balanced diet.

How IFS is Helpful for Small Holders?

IFS in developing countries like as India and South East Asia mainly focus on the sustainable development of agriculture and achieve livelihood security for small and marginal farmers (Behera et al 2015). What is the role of IFS in small holder’s life can be explained in detail as the key point suggested by (Gangwar and Ravisankar 2014).

Reduce the Biotic and Abiotic Stress

Monocropping on large scale causes the sudden burst of the pathogen and disease which grounds the total crop failure on large scale example of white fly attack in Bt cotton belt of Punjab and Haryana is an epitome (Vasudev 2015; Vasudev 2016; Singh 2016) Due large-scale cultivation of Bt cotton in Punjab and Haryana minor pest like as white fly transformed in major pest from 2015 onward. Diversified field balance host parasite relation and never allow any pest to cross threshold level

Market Price Fluctuations

Diversification in the IFS gave safeguard against the price fluctuation of the product. In the IFS farmer have many diverse products so it gets a stable income.

Food, Feed, Fiber, Fuel and Fertilizer

Main advantage of the IFS that it has diverse product, so it fulfills the requirement balanced food for farmer family (cereal as well as legume), feed for their animal, fiber for the home consumption, fuel for their kitchen and other daily requirement and fertilizers demand organic source available to strength the soil physical and biological condition.

Nutritional Requirement of Family

After independence country achieve tremendous growth in agriculture sector but still lacking in nutritional standard. Demand and supply imbalanced in agriculture mainly due to the green revolution technology and government policy biased towards cereal crops, one side we have surplus have more than 60 million tons of food grain in public stock but on other side we import huge number of pluses and oil to fulfill the domestic demand.

Improved Income and Employment

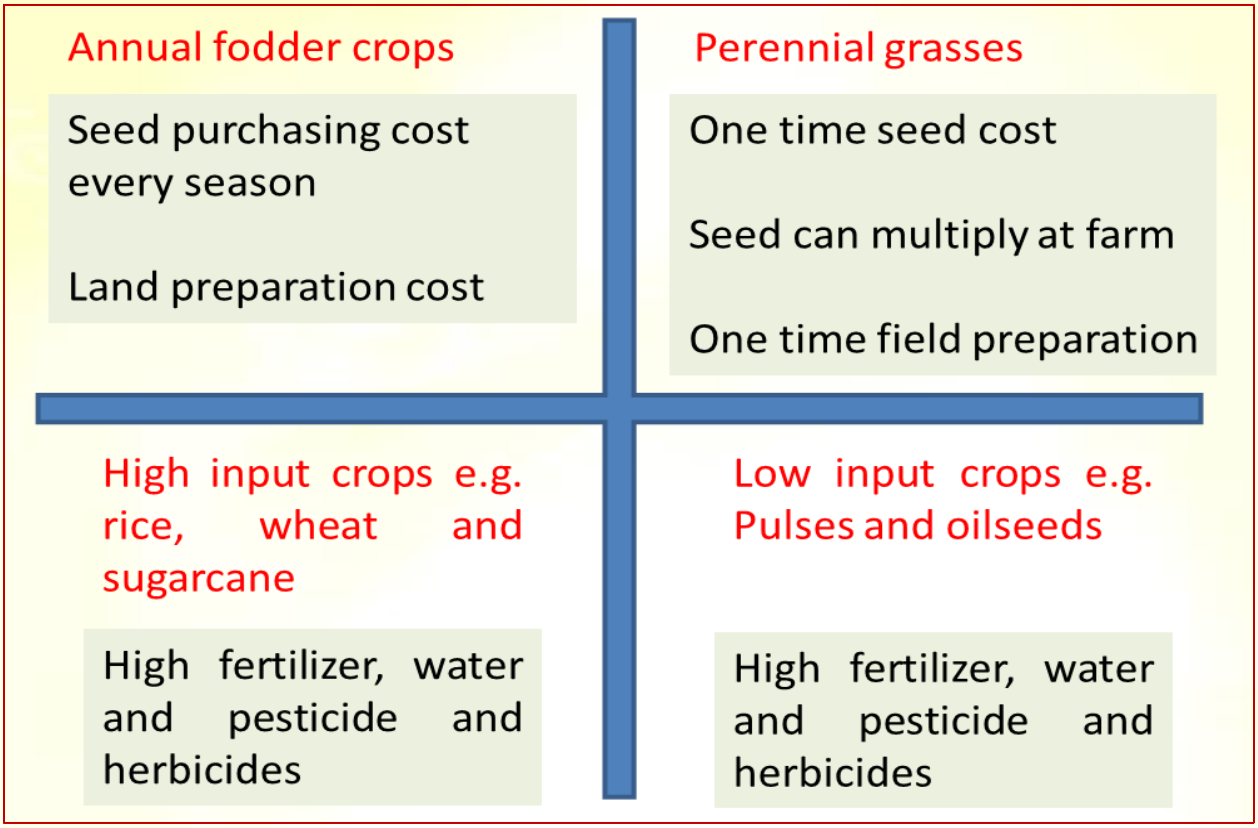
The question of increasing farmers' income is a significant concern for bureaucrats, policymakers, and governments. Despite farmers often achieving bumper harvests, they encounter substantial challenges due to price drops, leaving the government feeling powerless. One major contributing factor is the lack of diversification in farming practices. Vertical intensification, combined with diversification, offers new avenues for income generation. Integrated Farming Systems (IFS) address these issues using a scientific approach. In monocropping, farmers are only actively involved during sowing and harvesting, leaving them with unproductive time. This underutilizes farmers' skills and resources.

Low Input IFS

Integrated Financial Systems (IFS) consistently adhere to the principle of integration, minimizing reliance on external inputs. They utilize both input and output (by-products) within the system, emphasizing recycling as core strength. However, it's crucial to maintain a module-wise approach to ensure minimal input during IFS design.

Module wise Intervention for Low Input IFS

Crop module	Crop diversification	Crop diversification solve the issues of herbicide/pest resistance so reduce input cost involved on multiple spray of herbicides and insecticides e.g. Phalaris Minor in IGP Rumex Dentatus in IGP Pink bollworm in cotton
		Rational area under high input crops like rice, wheat and sugarcane reduce fertilizer, pesticides and irrigation expenses
	Legume	Include the legume in the cropping system module so less dependency on purchase fertilizer.
	Cover crop/mulching /intercropping	Use cover crops, mulching of crop residue and follow intercropping so it reduce cost on herbicides and after decomposition they add organic matter to soil.
	Oilseeds	Low input crops, fulfill oil demand of family and oil cakes used for animal feeding as well as surplus oil cake also used for soil feeding mainly in fruit crop.
	Natural Farming concoctions	Use different Natural Farming concoctions e.g. jeevamrit, beejamrit, ghanjeevamrit and dashparni so increase soil microbes activity and reduce cost on fertilizer and insecticides.
Livestock module	Perennial grasses with legume intercropping	Include perennial grasses like BNH, Guinea grass and Para Grass so reduce input cost viz. land preparation seed etc again and again to grow green fodder.
		Round the year fodder production so no need to purchase fodder and roughage from outside in lean period
		Balance animal feeding also reduce problem of infertility and repeat breeding so its reduce vet medical expenses
	Back yard poultry	It is less input requiring and efficient protein source for family
On farm processing & value addition	Use of surplus product for off season	Processing is not only target to market traditional method of vegetable drying and preservation can also reduce cost on vegetable purchasing in off season
Optional	Kitchen gardening	Help to save expenditure on purchase of vegetables, effective utilization of kitchen waste water and kitchen waste materials.



Low input IFS basic principal: Choose intervention wisely who support directly (low input) as well as indirectly require less field operation and propagate planting material at field

Designing of Farming Model

First step-Identify the constraint/characterization

- Holding/purchasing power (irrigation/sprayer tank)
- Wild animal issue (Neel gai, Wild boar, Monkey, Indian palm squirrel and Indian porcupine etc)
- Status of incidence of insect-pests and diseases
- Problem of infertility in cattle/buffalo (cows)
- Technology know how
- Suitable market
- Machinery

Second step-Intervention

- Improvement in existing crop by high yielding verities/suitable varieties e.g. late sown, short duration suitable for localised crop cycle demand
- Improvement in livestock productivity by offering comfort and address multi-nutrient deficiency so regularise breeding cycle
- Introduction of new crop either by replacing exist one/adjusting in cropping system

- Crop diversification by intercropping or breaking in mono-cropping
- Introducing new farming system component e.g. poultry, verimbed, goatry etc
- Intervention for resource recycling
- Boundary plantation as fix deposit and live hedge

Third step-Give training /Technological back supporting

Regular training and technology back stopping is mandatory so that whatever technology introduced will implement in a right way some time at initial stage poor know how is major cause of technology failure

Fourth step-Take feedback/Explore possibilities of further improvement

Farmer feedback is very crucial so that it can be further improved

Fifth step- refines technology at institute/university level

Some technology needs some modification at a particular region for it gets fit localities so at institute level it should be refined through research trial

Sixth step- identify the innovative farmer as well as laggard and wild figure

Innovative farmers should be encourage so they become key farmers or disseminators of technology and wild figure should be avoided for smooth functioning of programme

Seventh step- make group of progressive farmer and connect them

Now days through social media and other means make a group of the progressive technology adopters

Eighth-impact assessment

Last very important to go for impact assessment and to record about full adoption, partial adoption or non-adoption and factor for adoption and non-adoption

Points Keep in Mind while Designing Farming Model

- Better utilization of farm labour/ensure throughout year involvement
- Ensure round the year fodder production day by land holding size is decreasing so in few area farmer not allocating separate land for fodder crops that's compromising with animal health. Poor nutrition is responsible for infertility or repeat breeding
- Social obligations of locality (Pig farming/poultry in North India) while introducing a new farming component in an area
- Integration compatibility/competition between different component
- Intervention cost should be low at initial stage so first emphasize on critical input later on step by go for higher cost involving items
- Avoid catchy item/buzz word (black rice, black wheat and black turmeric) without a scientific evidence of suitability or profitability in a region
- While introducing component it should have with in system different utilization if suitable market not available in nearby at least farmer use it at home or with in system

On Farm Research for Tailor Made Technologies: Lessons Learnt from IFS in Country

The analysis made on on-farm production and inter-relationship of different enterprises within the system envisage that more than 57 percent of the total cost on farm production Rs.1,97,883 per annum generated within the system itself. An IFS model was evaluated by Swarnam et al (2014) in farmer's field on participatory approach in two tribal villages of Car Nicobar. From the system about 300 kg of seasonal vegetables, 117 kg of greens, 214 kg of tubers, and 200kg of fruits were produced from an area of 400 m^2. The egg production has also increased resulting in improved consumption. After the intervention the consumption of vegetables including greens, fruits and egg increased significantly from 50 to 250 % due to on farm production and availability. The consumption of tubers decreased by 25% with increased consumption of other food items indicating a change in dietary pattern more towards balanced nutrition. After consumption the sale of surplus farm produce and goat kids resulted in supplementary household income of about Rs.7500/- from the system. A total of 95man days were generated by the system viz., 52man days in home garden, 40 man days in livestock rearing and 3 man days in composting spread throughout the year. At Raichur district of Karnataka IFS under the irrigated ecosystem evaluated and found that continuously increase in net income from first year to third year. Higher return in third year mainly due the benefit of resource recycling now harvested by the system and horticulture components like as drumsticks, curry leaf, floriculture and vegetables as per season now start to given return (Desai,2017). In western Uttar Pradesh at underprivileged household targeted approach resulted in a significant reduction in the cost of interventions, with only Rs 1520 being spent on critical inputs in 2022-23. Despite this modest investment, the overall Benefit-Cost (B:C) ratio stood at an impressive 2.02. Farmers experienced an additional income of Rs 34,588 due to interventions on critical inputs during the same period. This demonstrates that by judiciously investing a relatively small amount in critical inputs through a scientific approach, it is indeed possible to boost the income of underprivileged households.

IFS are best example to harvest the advantage of vertical intensification or multistoried farming like as homestead garden in Kerala.

- A suitable IFS can effectively utilize the free time of farm man and woman throughout the year so best example of human resource utilization with in farm.
- IFS can provide some return throughout the year so less dependency on the arhatiya and also save from vulnerability of price fluctuation.
- IFS fulfill the Food, Fodder, Fiber, Fuel, Fertilizer demand of farm household and boundary plantation like as fix deposit saving for future.
- Under IFS suitable interaction (Waste of one enterprise - Best of another enterprise) this hidden saving is behind the success of this system.

Constraints

- Farmers feel reluctant to engage in multiple IFS component and it also labourinstensive so farmers prefer mechanized cropping system
- To find out suitable market to sale small production amount from diversified component is a big issue for farmer
- Tipraqsa*et al.* (2007)concluded that the high start-up costs may constrain farmers from switching to IFS and from exploiting the benefits of resource integration.
- Nageswaran *et al.* (2009) identified the following constraints procuring the improved breeds of livestock, timely availability of fish seed and feed, low cost energy efficient pumping machine, information on government schemes and credit support from financial institutions.
- Social barrier restrict to adopt few promising enterprise without those component IFS cant be so profitable than conventional farming

Conclusion

Integrated farming systems, such as homestead gardens in Kerala, exemplify the benefits of vertical intensification or multistoried farming. Low-input IFS reduces reliance on external resources, making it more sustainable financially and in terms of natural resources. Despite government and naturalist efforts to promote IFS, adoption among farmers remains moderate due to high startup costs. However, advocating for low-cost IFS can accelerate its adoption and benefit more farmers.

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Chapter- 5

Enhancing Soil Carbon Sequestration through Natural Farming Practices: A Sustainable Solution for Water Resilience, Climate Change Mitigation and Food Security

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Abstract

The increasing global population's demand for food compels the agricultural sector to adopt advanced technologies, often at the expense of traditional practices, impacting soil quality and sustainability. Intensive farming practices accelerate soil organic carbon (SOC) loss, contributing to significant greenhouse gas emissions. This review explores the causes of SOC loss, including environmental factors, crop residue burning, and excessive tillage. It also discusses the benefits of soil carbon sequestration as a strategy to enhance food security and mitigate climate change. Natural Farming practices, such as minimal soil disturbance, residue mulching, and promoting soil microbial diversity, are highlighted as effective methods to sequester carbon. The impact of agroforestry and residue mulching on SOC, and the role of soil organic matter (SOM) in improving soil water retention, are examined. Increasing SOM levels can mitigate drought risks and reduce reliance on supplemental irrigation, offering a sustainable solution to agricultural challenges in the context of climate change.

Keywords: *Microbes, earthworms, soil health, nutrient cycling, biological diversity, soil ecosystem, climate resilience*

Introduction

The growing global population's increasing demand for food is compelling the agricultural sector to adopt advanced technologies, often at the expense of traditional practices. This shift has significant implications for the sustainability of crop production systems, which depend heavily on soil quality. Intensive crop cultivation practices, such as the use of imbalanced fertilizers, high nutrient mining through monoculture, excessive tillage, and the removal of crop residues through burning, accelerate the decomposition of soil organic matter. India's agricultural sector ensures food and livelihood security for millions of rural households. However, the adverse effects of climate change pose a severe threat to agricultural sustainability. Compared to conventional practices, sustainable farming offers significant environmental benefits and helps to mitigate climate change impacts (Kumara et al, 2023). This process can lead to considerable soil carbon loss, with estimates ranging from 20% to 67% (Yang et al., 2009). Bhullar and Sidhu (2006) highlighted the critical state of agriculture in Punjab, attributing it to the excessive depletion of natural resources like land and groundwater. They noted that government policies, particularly subsidies for nitrogen fertilizers and electricity, as well as the minimum support price (MSP) for water-intensive crops like paddy and wheat, have incentivized their cultivation. This shift has significantly strained soil fertility and groundwater reserves. Such practices contribute to soil degradation, affecting its physical, chemical, and biological properties (Lal et al., 2014). A notable loss of soil organic carbon (SOC), ranging from 42% to 59%, has been reported when land use changes from forest or pasture to crop cultivation (Guo et al., 2019). Overall, agricultural dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (Smith et al., 2007). Carbon farming encompasses a range of agricultural techniques (cover cropping, no till farming, agroforestry, crop rotation, organic farming, use of perennial crops, managed grazing, wetland restoration, use of biochar, compost and mulching, reforestation and afforestation) designed to capture atmospheric carbon and store it within the soil and in crop roots, wood, and leaves (Avasiloaiei et al, 2023).

Natural Farming is increasingly promoted as an alternative to conventional agricultural practices that deplete soil fertility in the pursuit of short-term productivity gains (Kassam *et al.*, 2009). Natural Farming practices are known to enhance SOC content in agricultural soils. Key principles of Natural Farming include minimal soil disturbance, maintaining permanent soil cover or using cover crops, mixed cropping, mulching with crop residues, and using on-farm bio-inputs like beneficial microbial inoculants and fermented botanical solutions for pest control. By adopting Natural Farming practices, it is possible to address the dual challenges of food insecurity and climate change through the restoration of soil carbon.

Causes of Carbon Loss from Soil

The loss of carbon from the soil organic carbon (SOC) pool primarily occurs as carbon dioxide (CO_2) and methane (CH_4). Environmental factors, such as increased soil temperature, mainly stimulate the mineralization of the SOC pool. Climatic conditions can cause calciferous materials to dissolve carbonates and bicarbonates, releasing CO_2 into the atmosphere. Practices such as burning crop residues, mono-cropping, summer fallow, intensive cropping, excessive tillage, and water deficiency significantly contribute to SOC loss.

Sequestration of Soil Carbon

The government promotes soil organic carbon (SOC) sequestration to enhance food security and combat climate change. The goal is to offset anthropogenic greenhouse gas (GHG) emissions by increasing global soil carbon stocks by 0.4% annually in the top 40 cm of soils. Conventional agricultural activities and land-use changes contribute significantly to GHG emissions approximately 25% of CO_2, 50% of CH_4, and 70% of N_2O emissions. Soil carbon sequestration involves capturing atmospheric CO_2 and converting it into soil organic matter (SOM), where carbon in recalcitrant forms is less prone to decomposition. The objective is to retain atmospheric CO_2 in the slow SOC pool. However, the stable pool has limited potential for carbon sequestration due to its resistance to changes from management practices (Kane *et al.*, 2015). In the short term, managing easily decomposable SOM is crucial. Increasing cropping intensity can significantly impact microorganisms and humic complex production, facilitating carbon sequestration.

Increasing available organic C in soil through enhanced carbon sequestration can increase soil microbial mass (Fierer, 2017) and the network complexity of soil communities, including keystone microbe and mycorrhizae species that play an important role in soil life, plant life, and carbon cycling (Xue et al., 2020). However, soil organic C stocks globally in agricultural soils are declining (Wiesmeier et al., 2019). Soil management practices can cause carbon to be absorbed by soil (act as a carbon sink) or emitted from the soil to the atmosphere (act as a carbon source). Therefore, identifying and quantifying practices that can sequester soil organic C is vital to counteract climate change and soil degradation.

Key Natural Farming Practices for Carbon Sequestration

Jeevamrita (Live Elixir):

- A concoction of cow dung, cow urine, jaggery, pulse flour, and soil, Jeevamrita is a microbial powerhouse.
- It enhances soil microbial activity, which is crucial for breaking down organic matter and storing carbon.
- Improves soil structure, water retention, and nutrient availability.

Mulching:

- Covering the soil with organic materials like crop residues, leaves, and compost.
- Protects soil from erosion, reduces water evaporation, and increases organic matter content.
- As organic matter decomposes, carbon is stored in the soil.

Cover Cropping:

- Planting crops between main crop cycles to protect the soil.
- Increases organic matter input, improves soil structure, and prevents nutrient leaching.
- Leguminous cover crops can fix atmospheric nitrogen, reducing the need for chemical fertilizers.

Composting:

- Converting organic waste into nutrient-rich compost.
- Improves soil fertility, enhances water-holding capacity, and increases soil organic carbon.
- Reduces waste and greenhouse gas emissions.

Mixed Cropping and Crop Rotation:

- Growing different crops together or in succession.
- Enhances soil biological activity, improves nutrient cycling, and reduces pest and disease pressure.
- Diverse root systems contribute to better soil structure and carbon sequestration.

Zero Tillage or Minimum Tillage:

- Reducing soil disturbance through minimal or no plowing.
- Protects soil structure, prevents carbon loss through oxidation, and enhances soil microbial activity.
- Increases water infiltration and retention.

Livestock Integration:

- Integrating livestock with crop production.
- Manure and urine provide organic inputs, improving soil fertility and carbon content.
- Grazing can stimulate plant growth and increase carbon sequestration.

Use of Local Seed Varieties:

- Promotes genetic diversity and adaptability to local conditions.
- Reduces reliance on external inputs and promotes sustainable agriculture.
- Local varieties often have deep root systems, contributing to carbon sequestration.

Water Harvesting and Conservation:

- Efficiently capturing and storing rainwater.
- Reduces water stress on crops, leading to better growth and carbon sequestration.
- Improves soil moisture, enhancing microbial activity and carbon storage.

Carbon Stabilization by Physical Protection in Aggregates

In most soils, the formation of young and unstable macro-aggregates is driven by biological processes such as root growth, fungal and bacterial activity, and soil fauna actions. These processes mix fresh organic matter with soil particles and exudates. As partially decomposed organic matter becomes encapsulated within macro-aggregates, along with clay minerals and microbial products, micro-aggregates are formed. This leads to the long-term stabilization of carbon within macro-aggregates, as it is shielded from rapid mineralization. Tiny particles of carbon, such as partially decomposed plant residues, become trapped within the center of aggregates. These particles are physically shielded from microbial degradation because microbes cannot penetrate the core of these stable aggregates, where oxygen and water levels are low. As a result, microbial metabolism is inhibited in this environment (Six *et al*., 2000). Research indicates that the turnover time of carbon is longer in micro-aggregates (412 years) compared to macro-aggregates (140 years) (Jastrow et al., 2006). This difference is attributed to the greater physical protection of organic matter within different aggregate-size classes, which depends on the quantity and composition of clay in the soil (Hassink *et al*., 2007).

Impact of Tillage on Soil Organic Carbon

Conventional tillage practices disrupt soil aggregates in surface layers and increase aeration, which reduces total carbon by enhancing the microbial decomposition of soil organic carbon to CO2, particularly in macroaggregates. Conversely, adopting zero tillage reduces the number of micropores (15-150 μm) in the soil, which are crucial for microbial activity, thereby improving the physical conservation of soil organic carbon. By minimizing soil disturbance through zero tillage practices, CO2 emissions from the soil to the atmosphere can be reduced, contributing to the mitigation of global climate change and improving soil organic carbon status. A study under zero tillage recorded an average sequestration of 570,000 grams of organic carbon per hectare per year up to a soil depth of 30 cm (West and Post, 2022).

Impact of Residue Mulching on Soil Organic Carbon

The widespread practice of burning crop residues to manage stubble loads leads to nutrient loss, air pollution, and soil health deterioration. This practice contributes to a decline in SOC, as evidenced by a field trial conducted over 19 years in South-Eastern Australia, which reported a substantial loss of 175,000 grams of carbon per hectare per year in the 0–10 cm soil layer (Poeplau *et al*., 2015). Conversely, Singh *et al*. (2016) found that applying residue mulch treatments resulted in notable SOC content sequestration, increasing from 0.45% to 0.55%. Retaining crop residues has been shown to enhance SOC content, particularly in the initial two decades, with benefits diminishing over the long term (Kirkby et al., 2016). The application of residue mulching in crops creates favourable conditions and provides food for microbes and earthworms (Bhimani *et al*. 2021). Additionally, root exudates in the rhizosphere, along with on-farm bio-inputs, enhance the degradation of residue to form humus, an organic substance resistant to degradation. Humus can make plant nutrients available and hold 80-90% of its weight in water.

Agroforestry and Soil Carbon Sequestration

Agroforestry systems provide agricultural crops, fodder, and firewood/timber, along with numerous environmental benefits and ecosystem services. These include erosion control, improved water availability, increased species diversity, enhanced aesthetics of agricultural landscapes, and improved soil fertility through SOC sequestration. Agroforestry contributes to carbon fixation in tree biomass and the deposition of carbon-containing materials in both top soil and subsoil. It also results in decreased decomposition of resistant litter, reduced soil disturbance, and enhanced physical protection of organic matter through aggregates (Hassink *et al*., 2013).

Carbon Stabilization by Cover Crop

When cover crops are integrated with zero tillage practices, they play a crucial role in enhancing water availability through carbon sequestration, improving soil structure, enhancing biological activity, and reducing evapotranspiration (Bhadha *et al*., 2017). Furthermore, combining cover crops with zero tillage and crop residue mulching contributes to further reductions in evapotranspiration and the degradation of organic carbon, as highlighted by Joyce *et al*. (2002). Cover crops also foster dynamic living root systems that establish symbiotic associations with fungi (Steenwerth and Belina, 2008).Mycorrhizal fungi, which associate with nearly 90% of global plant species, rely on living roots for sustenance since they do not produce their own food. This mutualistic relationship involves the exchange of carbohydrates from living roots to fungi, which in turn supply nutrients and water from the soil to the roots. This symbiosis extends to the release of polysaccharides and sugars by fungi, which nourish soil bacteria and establish a balanced ecosystem that enhances soil health (Bhimani *et al*. 2023).

Soil Organic Matter content and Soil Water Retention

Soil organic matter (SOM) plays a critical role in influencing soil water retention within the root zone, especially under the pressures of anthropogenic climate change, as emphasized by Wiesmeier *et al.* (2016). The connection between SOM content and soil water retention (SWR) has garnered increasing attention. Gould (2015) highlighted that increasing SOM from 1 to 2% can potentially increase water holding capacity by up to 2.84 litre per cubic foot of soil. Similarly, Sullivan *et al.* (2002) reported that a 1% increase in SOM can hold an additional 1.42 litre of plant-available water per cubic foot of soil. Scott et al. (1986) noted that soil with higher SOM levels could hold an extra 16,500 gallons of plant-available water per acre-foot. Moreover, USDA-NRCS estimates suggest that each 1% increase in soil organic matter allows soils to retain up to 20,000 more gallons of water per acre (Bryant, 2015). Therefore, increasing SOM levels in degraded and depleted soils could potentially mitigate drought risks exacerbated by climate change and reduce the need for excessive withdrawal of scarce water resources for supplemental irrigation.

Carbon Sequestration Practices and Their SDG Impacts

Carbon sequestration, the process of capturing and storing atmospheric carbon dioxide, is a critical strategy for mitigating climate change. Moreover, it is deeply interconnected with several Sustainable Development Goals (SDGs), offering a holistic approach to sustainable development.

Agroforestry

Practices: Integrating trees with crops and livestock. This involves techniques like alley cropping, silvopasture, and agroforestry corridors.

SDG Impacts:

- **SDG 2: Zero Hunger:** Provides food security through crop and livestock production, improves soil fertility for higher yields.
- **SDG 3: Good Health and Well-being:** Trees can provide medicinal plants and improve air quality.
- **SDG 6: Clean Water and Sanitation:** Trees help in water conservation, reducing soil erosion, and improving water quality.
- **SDG 13: Climate Action:** Sequesters carbon through tree biomass and soil carbon.
- **SDG 15: Life on Land:** Enhances biodiversity, protects soil, and prevents deforestation.

Conservation Agriculture

Practices: Minimum tillage, crop rotation, and cover cropping.

SDG Impacts:

- **SDG 2: Zero Hunger:** Improves soil health, leading to higher yields and food security.
- **SDG 6: Clean Water and Sanitation:** Reduces soil erosion, improves water infiltration, and maintains water quality.
- **SDG 13: Climate Action:** Sequesters carbon in the soil, reducing greenhouse gas emissions.
- **SDG 15: Life on Land:** Enhances soil biodiversity, protects soil structure.

Blue Carbon

Practices: Protecting and restoring coastal ecosystems like mangroves, salt marshes, and seagrasses.

SDG Impacts:

SDG 2: Zero Hunger: Supports fisheries and coastal communities.

SDG 6: Clean Water and Sanitation: Protects water quality, reduces coastal erosion.

SDG 13: Climate Action: Highly efficient carbon sequestration.

SDG 14: Life Below Water: Protects marine biodiversity and ecosystems.

SDG 15: Life on Land: Protects coastal habitats and biodiversity.

Soil Carbon Management

Practices: Implementing practices to increase soil organic carbon, such as compost application, cover cropping, and reduced tillage.

SDG Impacts:

SDG 2: Zero Hunger: Improves soil fertility, leading to higher crop yields and food security.

SDG 6: Clean Water and Sanitation: Enhances water retention, reduces soil erosion, and improves water quality.

SDG 13: Climate Action: Sequesters carbon in the soil, mitigating climate change.

SDG 15: Life on Land: Improves soil health, biodiversity, and ecosystem services.

Additional Considerations

SDG 7: Affordable and Clean Energy: Bioenergy with carbon capture and storage (BECCS) can contribute to carbon sequestration while generating renewable energy.

SDG 8: Decent Work and Economic Growth: Carbon sequestration practices can create green jobs and contribute to rural economies.

SDG 11: Sustainable Cities and Communities: Urban green spaces and green roofs can contribute to carbon sequestration and improve urban living conditions.

It's crucial to note that the success of these practices depends on various factors, including policy support, financial incentives, technology transfer, and capacity building. A holistic approach that integrates carbon sequestration with other sustainable development goals is essential for achieving long-term benefits.

Carbon Credits and Natural Farming in India

Understanding Carbon Credits

Carbon credits represent the right to emit a specific amount of carbon dioxide or other greenhouse gases. When an entity reduces its emissions or sequesters carbon, it earns credits. These credits can be traded on carbon markets, providing financial incentives for sustainable practices.

The Role of Natural Farming

Natural farming, with its focus on soil health, biodiversity, and minimal external inputs, is a prime candidate for carbon credit generation. Key practices that contribute to carbon sequestration include:

Soil Organic Carbon (SOC) Enhancement: Practices like mulching, cover cropping, and composting increase SOC, a primary component of soil carbon.

Reduced Emissions: By eliminating or minimizing the use of chemical fertilizers and pesticides, natural farming reduces greenhouse gas emissions associated with their production.

Improved Soil Structure: Healthy soil with good structure can store more carbon.

Potential of Carbon Credits in India

India, with its vast agricultural land and a significant population dependent on agriculture, has immense potential for carbon credit generation through natural farming. Some estimates suggest that India could generate billions of dollars annually from carbon credits.

Key benefits:

Additional Income: Farmers can earn extra income by selling carbon credits, improving their livelihoods.

Incentive for Adoption: Financial rewards encourage more farmers to adopt natural farming practices.

Climate Mitigation: Carbon sequestration through natural farming contributes to mitigating climate change.

Soil Health Improvement: The focus on soil health leads to increased agricultural productivity.

Challenges and Opportunities

While the potential is significant, several challenges need to be addressed:

Measurement and Verification: Accurate measurement and verification of carbon sequestration are crucial for issuing credible carbon credits.

Market Development: Developing a robust and transparent carbon market in India is essential for farmers to benefit.

Capacity Building: Farmers require training on carbon sequestration, market dynamics, and certification processes.

Policy Support: Government policies that incentivize carbon credit generation through natural farming are crucial.

Opportunities:

Public-Private Partnerships: Collaboration between government, private sector, and farmers can accelerate the process.

Technology Adoption: Leveraging technology for monitoring and verification can improve efficiency.

Certification Standards: Developing clear and standardized certification processes is essential.

Conclusion

Adopting sustainable agricultural practices such as Natural Farming, residue mulching, zero tillage, and agroforestry can mitigate soil degradation and enhance soil organic carbon levels. These practices promote soil health, reduce CO_2 emissions, and improve carbon sequestration, contributing to food security and climate change mitigation. Prioritizing soil conservation and carbon sequestration is crucial for building resilient agricultural systems that benefit both people and the environment. Carbon sequestration, the process of capturing and storing atmospheric carbon dioxide, is a critical strategy in mitigating climate change. Agriculture, a significant contributor to greenhouse gas emissions, also presents a substantial opportunity for carbon sequestration. Natural farming, a traditional and sustainable agricultural practice, emerges as a promising approach to harnessing this potential. By prioritizing soil health, biodiversity, and ecosystem balance, natural farming diverges significantly from conventional agriculture, which often relies heavily on synthetic inputs. Core practices such as mulching, cover cropping, and composting enhance soil organic matter, a primary carbon sink. These practices not only sequester carbon but also improve soil structure, water retention, and nutrient cycling. Moreover, the elimination of chemical fertilizers and pesticides reduces direct and indirect greenhouse gas emissions. Natural farming's contribution extends beyond carbon sequestration. It aligns with multiple Sustainable Development Goals (SDGs) by enhancing food security, improving water quality, and promoting biodiversity. By fostering resilient agricultural systems, natural farming can contribute to climate adaptation and rural livelihoods. However, challenges such as accurate carbon measurement, market development for carbon credits, and farmer capacity building hinder the widespread adoption of natural farming for carbon sequestration. Overcoming these obstacles requires concerted efforts from policymakers, researchers, and farmers. Despite these challenges, the potential of natural farming to mitigate climate change through carbon sequestration is undeniable. By integrating natural farming practices into broader agricultural policies and providing adequate support to farmers, it is possible to create a more sustainable and climate-resilient future.

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Chapter- 6

Role of Livestock in Natural Farming System

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Abstract

Organic agriculture, natural farming, regenerative agriculture and agro-ecological agriculture etc. are currently the budge words, being talked about at various platforms globally. The adverse effects of chemical based input intensive agriculture practiced during the last 60-70 years, coupled with an enhanced consumer awareness of food safety issues and environmental concerns have increased the demand of organic or natural food products internationally and locally in India as well. This has led to rapid developments in the area of organic farming all over the world. India with its enormous variety of livestock population and indigenous methods of agriculture production has comparative advantage in conversion to organic farming including natural production. The Indian small scale farmers & livestock farmers in particular may find it worthwhile to try and switch over to organic & natural farming, which depends on certain rules, procedure, practices and standards to be observed. A farmer who would like to switch over from conventional livestock production to organic production should be familiar with the organic farming standards including organic livestock & poultry production standards. As compared to organic crop production, organic livestock production has not yet much developed in India mainly due to limited export opportunities. Nevertheless, it is slowly coming up. The recent emphasis of the Government of India on natural farming underscores the importance of livestock since in natural farming; livestock are essentially integrated with crops as a part of circulatory agriculture systems emphasized under natural production. Organic agriculture & natural farming though mostly similar but have some minor differences in production practices. However, here both the production systems are treated as similar so these terms are used interchangeably.

Keywords: *Livestock, Natural Farming System, organic farming standards,*

Introduction

Increasing health consciousness and awareness on harmful effects of agrochemicals and environmental pollution is creating demand for chemical-free foods world-over. Consumers are becoming more health-conscious owing to the harmful effects caused by the presence of chemical pesticides in food products. According to a UN report, around 200,000 people die every year due to the toxic effects of pesticides on food products. This is causing consumers to shift their focus towards organic food products. The global organic food market grew from

$259.06 billion in 2022 to $294.54 billion in 2023 at a compound annual growth rate (CAGR) of 13.7%. The organic food market is estimated to be about $512.01 billion in 2027 at a CAGR of 14.8%. India is one of the leading producer and exporter of organic products that includes cereals and pulses too. As per APEDA, the total volume of export of organic food products during 2021-22 was 460320.40 MT. The organic food export realization was around ₹ 5249.32 Crore (US$771.96 million). Organic products are exported to several countries including USA, European Union, Canada, Great Britain, Switzerland, Turkey, Australia, Ecuador, Korea Republic, Vietnam, Japan, etc. In terms of export value realization Processed foods including soya meal (61%) lead among the products followed by Oilseeds (12.85%), Cereals and millets (12.71%), Sugar (4.77%), Plantation crop products such as Tea & Coffee (2.16 %), Spices and condiments (1.72%), Pulses (1.1%) and others. Organic farming offers opportunity to developing country producers to cash upon the growing interest of consumers on organic/natural food products. This is what emphasizes the importance of improving the productivity under organic production of cereals, fruits, pulses, spices, fiber, oilseeds and livestock products like milk, meat, eggs, ghee, *paneer* etc.

The growing market for organic and natural food products including for animal products underscores the need for improving the production and productivity of certified agricultural products which can be made available to domestic consumers and export markets. This is possible only when the traditional knowledge and ancient Indian wisdom is effectively blended with modern science, especially when chemicals need to be substituted with natural ways and bio-inputs. At the moment, the alternatives to chemicals are not sufficient and effective enough to meet the requirement. While the need to increase food production for an increasing population is unquestionable, the focus should be not only on producing more food but also on producing better food. The research efforts need to be intensified to develop technologies which can effectively substitute chemicals like fertilizers, weedicides, pesticides, antibiotics, feed additives, allopathic medicines etc. At the same time, there is need to document, validate and popularize traditional ancient knowledge with respect to crop and livestock production. When there were no chemicals, farmers were still practicing agriculture and rearing animals with their conventional wisdom and knowledge acquired through trial & error and accumulated experience of generations. This knowledge can be utilized to help ease out chemicals from agricultural production.

Over the last 70 years, the level of vitamins and nutrients in food has drastically decreased, and it is estimated that 2 billion people worldwide suffer from lack of micronutrients, known as hidden hunger because it is difficult to detect. About 95 percent of our food nutrients come from soils, which have a natural capacity to provide nutrients to support crop growth. Soil health and fertility have a direct influence on the nutrient content of food crops. The lack of essential nutrients, including macro and micronutrients, leads to the underdevelopment of plants and a decrease in yield and in crop nutritional value. Efforts and investments focused on increasing plant nutrient uptake and balance, and ultimately, human and animal nutrition can be lost if soils are not healthy. On earth, there are 92 naturally occurring chemical elements, 18 are essential to plants and 15 of them are supplied by soils. When soils are compacted, eroded, have their nutrient and soil organic matter (SOM) depleted, or have chemical toxicity issues due to contamination by pollutants, acids, or salts, they cannot produce food that contains the nutrients necessary for human health or even assimilate nutrients added by fertilizers application. This necessitates the focus on soil health, which can be ensured by following good soil management practices. The agronomic practices like crop rotation, fallow, flooding, deep ploughing, soil solarization-which involves a combination of physical and biological process, adjusting sowing/planting dates, irrigation, fertilization, sanitation tillage etc. Practicing good agronomic practices and paying attention to habitat management, including conserving and encouraging the spread of natural enemies can suppress and mitigate the damage created by pests. Crop rotations have been age-old traditional practices which are still promising and will continue to be important. In farming, these practices should be used more over the dependence on chemicals.

By developing efficient resource use and sustainable agronomic practices for crop-fertilization, irrigation and protection, a significant reduction in the demand for synthetic chemical fertilizers, fresh water and chemical pesticides in agriculture could be achieved without compromising yield and quality (Young et al, 2021). Application of soil-borne biocontrol agents (e.g., Trichoderma, Beauveria, Bacillus, Pseudomonas) may also help ensure plant protection against several diseases. Consequently, the use of chemical pesticides is significantly reduced, with potential benefits for beneficial microbes and the environment (Niu et al 2020 & Negi et al, 2021). Intercropping, organic agriculture and minimum- to no-tillage management are some of the most important sustainable agronomic practices, with applications that resulted in increased soil biodiversity and improved soil structure and health (Morugán-Coronado et al 2020). In case of pulses, N-fertilization can be effectively reduced via improved N-fixation through rhizobia inoculation to optimize crop performance and sustainable management of pulses. The pulses can be good for livestock too, as a part of food feed system supplying nutrients to humans and livestock both. In much of the farming world especially in developing countries, sowing of crops including pulses is still done following broadcast method, which leads to low productivity and hampers cultural operations. Farmers need to be educated and provided support for using seed drills for improving productivity since it helps in distribution of seeds, placement of seeds at appropriate depths, better plant stand, and ease in performing cultural operations and improves drainage of excess water from fields. Many fruits of scientific advancements like introduction of high yielding cultivars with superior product qualities and increased tolerance to biotic and abiotic stresses, as well as application or/and encouragement of beneficial microorganisms (e.g., bacteria, algae, fungi) with the potential to increase nutrient and water uptake without compromising environment functions should also be considered as viable sustainable agronomic practices to improve plant performance and productivity (Alvares et al 2016, and Rai et al, 2020). Good plant performance helps better productivity, in terms of grains & fodder for animals.

Considering the high emphasis placed by Government of India on natural farming, the practices recommended under natural farming can be tried to see their efficacy in improving productivity. The components of natural farming like Jeevamrit, beejamrit, whapasa mulching etc. are ancient techniques said to be sustainable (NITI Aayog, 2023, https://naturalfarming.niti.gov.in/components/). The universal principles of natural farming as propagate by NITI Aayog, need to be studied, understood and applied wherever applicable for improving the productivity without use of chemicals. For instance, Beejamrit is used for seeds, seedlings or any planting material. It is said to be effective in protecting young roots from fungus. Beejamrit is a fermented microbial solution, with loads of plant-beneficial microbes, and is applied as seed treatment. It is expected that the beneficial microbes would colonize the roots and leaves of the germinating seeds and help in the healthy growth of the plants. The research institutions including Krishi Vigyan Kendras are conducting trials on these techniques to see efficacies and once found efficacious may recommend for large scale adoption by farmers to replace agrochemicals. In natural farming, dependence on markets for inputs is nearly zero, practically all inputs are drawn from the farm itself by circulating the on-farm resources.

Circular Economy and Natural Farming

There is high interdependence of crops and livestock and it becomes even more relevant when we talk of circular economy and natural farming. Circular agriculture focuses on using minimal amounts of external inputs, closing nutrients loops, regenerating soils, and minimizing the impact on the environment. If practiced on a wide scale, circular agriculture can reduce resource requirements and the ecological footprint of agriculture. It can also help ensure a reduction in land-use, chemical fertilizers and waste, which makes it possible to reduce global CO_2 emissions. Rice residues account for 40% of the total crop residues burnt, followed by wheat residues (22%) and sugarcane residues (20%). Instead of burning & polluting, several alternative uses of rice straw such as livestock feed, biethanol, biochar, biogas, electricity, mushroom and paper, can add prosperity to rice farmers' life by fetching extra income. Crop residues are used as animal fodder, for bedding, sheltering, packing, recycled along with animal dung and urine as manure, compost, mulching, green manure, domestic and agro processing waste since centuries in India.

Circular agriculture is closely connected with the concept of mixed crop-livestock farming. Mixed farming, for example, may imply a switch away from mono-crop agriculture to growing a set of interdependent crops where the cultivation of one creates favourable conditions for others on the same land. Crop diversity becomes an effective practice to reduce inputs, manage soil fertility, and enhance resilience, and the combined production of different crops and legumes can raise yields in a sustainable way. Mixed farming that combines crop cultivation with animal husbandry offers additional opportunities to deepen circular agriculture. Use of locally produced feed and manure instead of imports and chemical fertilizers, for example, can contribute to reduced CO_2 emissions of agriculture. The objective of circulatory agriculture is to capitalize on the synergy that exists between crops and livestock to create a circular food system. In circular agriculture, all steps of the food system from growing, harvesting, packing, processing, transporting, marketing, consuming and disposing food are designed with a view to promoting sustainable development. Livestock play a crucial role in natural farming systems, contributing to the sustainability and productivity of the agricultural ecosystem. Properly managed livestock can enhance the sustainability and productivity of natural farming systems.

Livestock Sector in India vis a vis Organic Farming

Indian economy is increasingly looking forward to its livestock sector for growth, since India is the world's largest livestock owner, at about 536.76 million. There are 100.8 million households and household enterprises with at least one livestock or poultry. Indian livestock sector is vibrant with high potential for growth including for the development of organic animal husbandry due to certain favorable features like mixed farming system, native breed adaptability to local situations and its disease resistance and its on-farm diversity. Considering these natural advantages India has in conversion to organic farming; organic animal husbandry may offer an added opportunity. With increasing concern for environment and rising consumer awareness about safe and quality foods, the organic foods are attracting ever-increasing number of consumers. Moreover, the demand for organic products has created new export opportunities for the developing countries. In view of the increasing demand for organic livestock products, Indian dairy farmers who are contributing towards India’s number one position in global milk production are increasingly looking for information on organic dairy farming and its requirements to meet the demand of export and also the local demand in future.

The farmers willing to switch over to organic dairy farming should have knowledge and skills required for the organic production process (Chander, 2001; Chander, 2005; Chander & Mukherjee, 2005; Chander & Subrahmanyeswari (2007); Chander & Subrahmanyeswari, 2013; Chander, Subrahmanyeswari, Mukherjee & Kumar, 2011; Chander, Subrahmanyeswari & Mukherjee, 2013) .Organic production systems unlike traditional systems of production are governed by a set of standards to be followed strictly by the producers of organic food. For natural production, certification standards and mechanism is under the process of development. The compliance with these standards is verified by certification agencies authorized by the government. Organic certification gives assurance to the consumers about the quality of production, which often more appeals to the consumers. In case of conventional products, there is no way to guarantee the production procedure, but in organic farming production procedure is certified to be safe and sound as well as environment friendly. The standards & procedures are being developed for natural production taking cues from the ancient Indian wisdom for crop and livestock production.

Landless Organic Animal Husbandry is Forbidden

Organic animal husbandry starts from the ground up. The basic requirement is more of a farmland than the cows or buffaloes. Organic farming including livestock production is basically a land based system, and landless animal husbandry system is forbidden in organic livestock farming. So, landless livestock farmers are not eligible for organic farming unless they go for land leasing. Farmers can raise suitable forage crops to feed their cattle and surplus can be marketed to needy farmers of that region. Forage crops should be grown without any chemical fertilizers and pesticides. Animal manure should be diverted to fields to maintain the fertility of the soil. There should be recycling of nutrients between plants and animals. In nutshell, the feed and fodder requirements have to be met on farm as far as possible. The landless farmers may find it difficult to meet this requirement of organic dairying, unless they have control on land for growing feed and fodder. Likewise, natural farming is not possible without livestock on the holding.

Selection of Breeds as a Prelude to Organic Farming

Farmer has to choose a breed that suits local conditions in terms of its disease resistance, maintenance cost and adaptability. If possible, pure breeds have to be maintained. A farmer can maintain an organic farm with local *desi* cattle whose genetic and production potential can be up-graded with bulls of good producing records, if necessary. Farmer can go for native breeds like *Ongole, Vechur, Deoni, Tharparkar, Gir, Sahiwal* and many other indigenous breeds which are proven for their genetic potential and adaptability to local conditions. As per organic standards, all animals should be born and raised on the organic holding. However, a beginner can procure calves from conventional farms, which are of 4 week old that received colostrum and full milk diet. In the same way, breeding stock to a maximum of yearly 10% can be brought in from conventional farms. Animal production record is important along with mothering ability, hardiness and thriftiness, resistance to disease and parasites, ability to forage etc., for which Indian native breeds are naturally endowed. Farmers have to follow natural reproductive techniques. However, technique like artificial insemination is allowed, which is accepted to meet international standards of organic farming. Practices like embryo transfer technique, hormonal treatment, induced birth and genetically engineered breeds, which are high capital intensive, are not allowed in organic farming practices.

Housing as a Means of Providing Natural Habitation

In organic or natural farming freedom to animals to take care of their welfare is very important. Housing usually is not important as such, but it should be according to the behavioral pattern of animals. Farmer should see that there is sufficient free movement with accessibility to fresh air and natural daylight besides protecting the animals from excessive sunlight and rain. Animal should have access to fresh water to meet its requirement. Herd animals shall not be kept individually and tethering is not allowed in organic farming. If tethering is to be done, it should allow the animal to move freely with sufficient space. Overcrowding shouldn’t be done in order to avoid conflict behavior and associated health problems.

Feeding of Livestock in an Organic Farm

A farmer should feed an animal according to its physiological requirements. Diet should be according to animal's natural feeding behavior and digestive needs. Farmer should raise forage crops organically on his/her own, to feed the livestock. She/he should see to maximize production of feedstuffs on his/her farm and the rate of success of organic farm depends on self-sufficiency in feed production. As a rule, 80% of feed should be from organic sources, however, at times of difficulties and emergencies feed from conventional farm may be given with a dry matter content of 15% which has to be gradually reduced to 10% within 5 years. When formulating rations, diet of animal should be balanced by adjusting the protein percentage to complement the forage levels. For example, when rations are based on high protein forage, care should be taken to ensure that energy levels are met by straw or hay to balance the excess protein. Growth regulators, artificial coloring agents, urea, medicated feeds, hormones, chemically extracted feeds, synthetic appetizers etc. are strictly prohibited in feeding the livestock of organic and natural farms. Natural-as the name indicates, it should follow natural processes on farm, not buying anything from outside but meeting all the requirements of animals on-farm in case of natural farming. To supplement the feed of animals, plant based products, byproducts of food industry like molasses; fodder preservatives like bacteria, fungal and enzymatic elements, vitamins, trace elements can be added as per requirement. Raising of calf is more important, as it is the future organic milch animal. Calf may be allowed to suckle according to its natural requirement and proper weaning be done unlike in conventional systems. In case of emergencies, calf may be given milk from non-organic farming systems or dairy substitutes so long as they contain neither antibiotics nor synthetic additives.

Preventive Health Management Plays a Major Role

Health care starts with selection of a breed, which has natural immunity against diseases and with good adaptability to local situation. Health care of livestock depends on the manner in which they are raised and the quality of feed offered, which result in maximum disease resistance. In organic livestock farming, preventive management plays major role and moreover, if any illness occurs, farmer should try to find out the cause, and change the management practices accordingly in order to prevent future outbreaks. For treating the sick animals, farmer should give importance to natural medicines and methods including homeopathy, *ayurvedic* medicine and acupuncture. However, conventional medicines can be used, when no other alternative is available, as the well being of the animal is the primary consideration in organic farming. But, if the animal is on allopathic treatment for two subsequent times, it loses the status of organic. Farmer can vaccinate his/her animals when diseases are known or expected to be a problem in his/her farm region that too with legally required vaccines only. Genetically engineered vaccines are prohibited. Instead of relying on medication, the farmer should strengthen the animal, so the immune system can do its job. So, farmer should be well aware that, health care in organic farming starts with selection of suitable breeds, raising the livestock according to its natural requirement; feeding good quality feed along with required grazing to strengthen the immune system of the animal and providing suitable housing to avoid related stress and associated health problems.

Marketing of Organic Products

Farm branded organic milk can serve as an effective way for a small producer to establish an identity and market niche and present possibilities for supplying to national and international markets. Development of other processed foods may itself create a demand for organic products such as milk powder or butter as ingredients in biscuits and confectionary. Organic indigenous cow milk, organic cow ghee is attracting growing number of consumers in India. There is possibility of exports of leather from organically raised buffaloes.

Record Maintenance - A Must

Farmer has to maintain the records - right from the procurement of livestock, it's feeding, breeding, health care, production, till to the marketing of the product along with the type of labor involved (child labour is not allowed), method of processing, inputs to the farm and animal welfare measures taken which is a must for inspection purpose and certification of the farm and products as organic. Farmer should not be ignorant of this, in spite of his illiteracy and amazing memory, as it is a valuable tool for assessing the performance of one's herd or flock by the certifying agencies, which is mandatory for the milk or other products to be labeled as 'organic'.

To bring a conventional farm to the organic status, the whole farm including dairy animals should be converted according to the standards set down as per the guidelines of National Programme on Organic Production (NPOP, 2014). The milk can be sold as organic only after the farm has been under conversion for at least 12 months, provided the organic production standards have been met for the appropriate time. Once conformity with organic standards has been verified by a certification body, the product is accorded organic label which carries the name of the certification body and the standards with which it complies. To the informed consumer, this label functions as a guide and an assurance of purity. Certification bodies evaluate operations according to different organic standards and can be formally recognized by more than one authoritative body. In India, currently 29 certification agencies are accredited by the Agricultural and Processed food products Export Development Authority (APEDA) for inspection and certification of the organic farms and products. Out of these, about 7 certification bodies are accredited to certify organic livestock operations too. However, for natural farming, the certification standards are still in the process of development.

The Government of India (GOI) has taken several initiatives to boost organic agricultural production in the country. The launching of National Programme of Organic Production (NPOP) in 2000-2001, setting up of National Centre of Organic Farming (NCOF) at Ghaziabad during 2003-04, ICAR Network Project on Organic Farming (2004) are some important milestones. These steps have resulted into significant increase in production and export of certified organic agricultural products from India. Most of the organic agricultural products currently exported from India are of plant origin except honey. Organic Animal products are also showing up in market albeit slowly.

There are 52 certified organic dairy operators, 66 meat operators & 3 certified egg operators in India. The information on domestic sales of organic livestock products indicate the availability of certified organic milk and milk products in India. Also, India exported 2125.6 kg of certified organic *Ghee* (Clarifed butter) to UAE during 2019-20. Recently some private dairy companies have started exporting certified organic *paneer* to the countries in the gulf. Sundarban Dairy Cooperative in West Bengal is marketing certified organic milk & milk products by brand name *Sundarini*. Likewise, some private dairies are now engaged in marketing of certified organic milk & milk products. Animals not only produce products for direct human consumption, but also help produce organic by-products like cattle urine & cow dung used to enhance soil fertility.

India: An organic Success Story

- With 1.6 Million producers India continues to be No. 1 country
- India ranks 2nd in terms of area & 1st in terms of number of certified organic producers
- As on 31st March 2023 total area under organic certification process (registered under National Programme for Organic Production) is 10.17 mha (2022-23). This includes 5391792.97 ha cultivable area and another 4780130.56 ha for wild harvest collection.
- India produced around 2.9 Million MT of certified organic products during 2022-23 which includes all varieties of food products namely Oil Seeds, fibre, Sugarcane, Cereals & Millets, Cotton, Pulses, Aromatic & Medicinal Plants, Tea, Coffee, Fruits, Spices, Dry Fruits, Vegetables, Processed foods etc. The production is not limited to the edible sector but also produces organic cotton fiber, functional food products etc.
- Sikkim with 58,168 ha under organic farming is 1st state in the world to become fully organic
- India exported 312800.51 MT organic products worth US$708.33 million during 2022-23
- GoI is promoting organic and natural farming through various schemes of Paramparagat Krishi Vikas Yojana (PKVY), since 2014
- Under PKVY, as of 16 November 2022, 32,384 clusters totalling 0.64 million ha area and 1.61 million farmers have been covered
- The National Mission for Clean Ganga (NMCG) or "Namami Gange" has initiated a project for promoting organic farming in the villages situated along the river
- Under Namami Gange Programme, 0.12 Million ha area has been covered under organic farming

Government Support to Organic Agriculture and Natural Farming

- In the Union budget 2022-23, the Government of India launched National Mission on Natural Farming (NMNF) by up-scaling the Bharatiya Prakritik Krishi Paddhati (BPKP) for promotion of natural farming on a bigger scale

- The DAC&FW is conducting large scale training of Master Trainers, Champion Farmers and other farmers on latest methods of Natural Farming with the help of National Institute of Agricultural Extension Management (MANAGE) and National Center of Organic and Natural Farming (NCONF). MANAGE has also imparted training on natural farming to Gram Pradhans
- ICAR Institutes including KVKs are conducting training, trials & demonstrations on Natural Farming
- Master's course in Organic Agriculture approved & course curriculum on Natural farming has been developed for certificate, diploma, degree & honours
- Many FPOs/FPCs, SHGs are engaged in organic production, processing & marketing
- On 1st February, 2023, a new programme "PM PRANAM" has been launched to give further boost to chemical free farming

Conclusion

Apart from growing technology and highly sophisticated life, people all over the world are becoming increasingly conscious about the naturally available products and their importance in their daily life. Looking at growing demand for organic animal products, branded and certified animal products including organic milk and milk products are increasingly available now in developed countries as also in Indian metros. Also, some private dairy companies have started exporting certified organic milk products like butter oil/ghee and *paneer* to several countries in Gulf. So, it is the Indian livestock farmers, who have to en-cash the emerging demand. Many dairy farmers including dairy cooperatives are moving towards certified organic milk production by converting conventional dairy farms to organic dairy farms. Thus, demand for information on how to do organic farming is increasing at the level of farmers. The extension agencies especially those who are responsible for catering to the information and skill needs of dairy farmers must equip themselves with the knowledge and skills on organic and natural dairy production particularly about the conversion requirements, organic standards & guidelines. The course curriculum approved for Natural Farming has two courses on livestock, Cow Based Natural Farming and Livestock & Poultry Production. These two courses along with other subjects in curriculum for natural farming are likely to help develop good understanding of role of livestock in natural & organic animal husbandry.

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Chapter- 7

Role of Natural Farming in Health and Nutrition

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Abstract

Agriculture stands as the cornerstone of human civilization, intertwining the cultivation of plants and the rearing of animals to satisfy fundamental needs such as food, fibre and medicinal products. This multifaceted system blends art, science, and commerce to meet daily essentials while playing a pivotal role in global economies, employment and rural development. With a burgeoning world population projected to reach 9.7 billion by 2050, enhancing agricultural productivity sustainably is imperative to meet escalating food demands. India exemplifies this nexus with agriculture ingrained deeply in its cultural fabric, supporting over half of its populace and contributing significantly to GDP. The sector's evolution, catalyzed by advancements like the Green Revolution, underscores its transformative potential in ensuring food security and economic stability. Modern agricultural paradigms emphasize sustainable practices that conserve resources and leverage technologies like precision farming and biotechnology to optimize yields and minimize environmental impact. This review navigates through these themes, highlighting the pivotal role of agriculture in global food security, economic prosperity, and sustainable development.

Keywords: *Natural Farming, Health, Nutrition*

Introduction

What is Agriculture

Agriculture is the foundation of human civilization, encompassing the cultivation of plants and the rearing of animals to provide food, fibre, medicinal plants and other products necessary to sustain and enhance life. It is an intricate system that combines art, science, and business to produce the essentials of daily living. Beyond its primary role in food production, agriculture is a critical component of the global economy, providing raw materials for various industries, creating employment, and fostering rural development. Agriculture is crucial in ensuring a stable food supply for the global population. With the world's population projected to reach 9.7 billion by 2050, increasing agricultural productivity and sustainability is essential to meet the rising food demand. It contributes significantly to the GDP of many countries, particularly in developing regions. It provides livelihoods for billions of people, making it a vital sector for economic stability and growth. Modern agriculture must balance the need for increased food production with the preservation of natural resources. Sustainable farming practices help maintain soil health, conserve water, and protect biodiversity, ensuring long-term agricultural viability. The integration of advanced technologies, such as precision farming, biotechnology, and data analytics, is revolutionizing agriculture. These innovations enhance productivity, improve resource management, and reduce the environmental footprint of farming activities.

In India, agriculture is not just a means of livelihood; it is a way of life deeply embedded in the culture and traditions of the country. It plays a pivotal role in the socio-economic fabric, supporting around 58% of the population. India's agricultural sector has made remarkable strides in achieving self-sufficiency in food production. The Green Revolution transformed India from a food-deficient nation to a food-surplus one, ensuring that the country can feed its vast population. It is the largest employment provider in India, engaging nearly half of the workforce. It is crucial for rural development, poverty alleviation, and reducing urban migration by offering sustainable livelihoods in rural areas. The agricultural sector contributes about 17-18% to India's GDP. It also plays a significant role in international trade, with India being a major exporter of various agricultural products, including rice, spices, and tea.

Agricultural Revolutions: Great Innovations for Mankind

Agricultural revolutions have been pivotal in shaping human history, transforming societies and economies through ground breaking innovations. These revolutions mark significant turning points where the application of new techniques and technologies has vastly improved agricultural productivity, ensuring food security and fostering societal advancements. The first agricultural revolution, also known as the Neolithic Revolution, began around 10,000 BCE. This period marked the transition from nomadic hunter-gatherer communities to settled agricultural societies. The domestication of plants and animals allowed humans to produce food more reliably and in greater quantities. This led to the establishment of permanent settlements, population growth and the development of complex societies. Innovations such as crop rotation, ploughing and irrigation further enhanced productivity, laying the foundation for civilizations to flourish. The second agricultural revolution, occurring between the 17th and 19th centuries, was closely linked with the Industrial Revolution. Mechanization transformed agriculture, with the introduction of machinery such as the seed drill, mechanical reaper and threshing machine. These innovations significantly increased the efficiency and scale of farming operations. Additionally, advancements in selective breeding and the development of crop varieties with higher yields played a crucial role. The application of scientific principles to farming practices, often termed as agronomy, improved soil management and crop care, further boosting agricultural productivity. The Green Revolution of the mid-20th century represents another monumental shift in agricultural practices. Led by scientists such as Norman Borlaug, this period saw the introduction of high-yielding varieties (HYVs) of staple crops like wheat and rice coupled with the extensive use of chemical fertilizers, pesticides, and advanced irrigation techniques. These innovations led to dramatic increases in crop production, particularly in developing countries, averting famines and feeding growing populations. However, the Green Revolution also highlighted challenges such as environmental degradation and the socio-economic impact on small-scale farmers, prompting calls for more sustainable practices.

In recent years, we are witnessing a new wave of agricultural revolution driven by digital technology and biotechnology. Precision agriculture, utilizing GPS, drones and IoT sensors enables farmers to monitor and manage their fields with unprecedented accuracy. Genetic engineering and CRISPR technology have opened new frontiers in crop improvement, allowing the development of disease-resistant and climate-resilient varieties. Sustainable farming practices, such as organic farming and regenerative agriculture, are gaining traction, emphasizing environmental stewardship and long-term soil health.

Emergence of IPM, INM, Organic Farming, and Natural Farming for Food Security, Food Safety and Environmental Security

Integrated Pest Management (IPM), Integrated Nutrient Management (INM), Organic Farming, and Natural Farming have emerged as pivotal practices for ensuring food security, food safety, and environmental security. These approaches offer sustainable alternatives to conventional farming, addressing the challenges posed by modern agricultural practices. PM is a comprehensive approach that combines biological, cultural, physical, and chemical tools to manage pests in an environmentally and economically sound manner. By reducing reliance on chemical pesticides, IPM minimizes the adverse effects on non-target organisms and human health. This method enhances crop resilience and yields, contributing to food security while safeguarding food safety through reduced pesticide residues.

INM involves the balanced use of organic and inorganic fertilizers to maintain soil fertility and health. This approach ensures that crops receive the essential nutrients needed for optimal growth while minimizing nutrient runoff and soil degradation. By promoting efficient nutrient use, INM supports sustainable agricultural productivity, thereby enhancing food security and reducing the environmental footprint of farming. Organic Farming eschews synthetic inputs, relying on natural processes and materials to maintain soil fertility and control pests. This method promotes biodiversity, improves soil structure, and enhances ecosystem services. Organic farming produces food free from synthetic chemicals, appealing to health-conscious consumers and contributing to food safety. Additionally, its environmentally friendly practices support long-term agricultural sustainability.

Natural Farming, often associated with techniques like Zero Budget Natural Farming (ZBNF), emphasizes the use of locally sourced, natural inputs and minimal external intervention. This approach fosters soil health, conserves water, and enhances biodiversity. Natural farming methods improve crop resilience to climate change, contributing to food security by ensuring stable yields in the face of environmental fluctuations.

Collectively, these sustainable farming practices address the pressing need for food security by enhancing agricultural productivity and resilience. They ensure food safety by minimizing harmful residues in food products. Moreover, by promoting ecological balance and reducing the environmental impact of farming, IPM, INM, Organic Farming, and Natural Farming contribute to environmental security, paving the way for a sustainable and healthy future for agriculture.

Indigenous Agricultural Practices in India

India has a rich heritage of traditional agricultural practices that have been honed over centuries. These practices are deeply rooted in indigenous knowledge systems, sustainable methods, and cultural wisdom, offering valuable insights into sustainable farming. This article explores the key elements of these traditional practices, including Indigenous Traditional Knowledge, Biodynamic Agriculture, Agnihotra Agriculture, Panchgavya, and Farming Proverbs.

Indigenous Technical Knowledge

Indigenous Technical Knowledge (ITK) refers to the wisdom, innovations, and practices of indigenous and local communities developed through experience and adaptation to the environment. In Indian agriculture, ITK encompasses a wide range of techniques, from crop rotation and mixed cropping to water conservation and pest management. Farmers utilize local flora for natural pest control, such as neem leaves and cow dung, which act as bio-pesticides and fertilizers. The knowledge of lunar cycles and seasonal changes is also integral, guiding planting and harvesting times to optimize crop yields. This holistic approach not only sustains the land but also preserves biodiversity and enhances resilience against climatic variability.

Biodynamic Agriculture

Biodynamic agriculture, developed by Rudolf Steiner, integrates spiritual and ecological practices. In India, it aligns with traditional agricultural philosophies that view the farm as a self-sustaining organism. Biodynamic practices include crop diversification, composting, and the use of biodynamic preparations made from fermented herbal and mineral solutions. These preparations enhance soil health, stimulate plant growth, and improve resilience to pests and diseases. Biodynamic farming also emphasizes the lunar and cosmic rhythms, dictating planting and harvesting schedules to harmonize with natural forces, thereby enhancing the vitality and nutritional quality of the produce.

Agnihotra Agriculture

Agnihotra, an ancient Vedic ritual, is used in agriculture to purify the environment and enhance soil fertility. This practice involves the daily performance of a small fire at sunrise and sunset, accompanied by the chanting of specific mantras. The ash produced from the Agnihotra fire is rich in nutrients and is used as a natural fertilizer. Agnihotra agriculture claims to improve soil health, increase crop yields, and reduce the incidence of pests and diseases. The practice also fosters a sense of spiritual connection with the land, promoting a holistic approach to farming that benefits both the farmer and the ecosystem.

Panchgavya

Panchgavya is a traditional organic farming input made from five cow-derived products: milk, curd, ghee, dung, and urine. This concoction is enriched with other natural ingredients like banana, tender coconut water, and jaggery. Panchgavya serves as a potent bio-fertilizer and growth promoter, enhancing soil fertility and crop health. It is known to improve seed germination, root development, and resistance to pests and diseases. The use of Panchgavya reflects the deep cultural reverence for the cow in Indian society and underscores the sustainable practices inherent in traditional Indian agriculture.

Farming Proverbs

Farming proverbs, or agricultural sayings, encapsulate the collective wisdom and experiences of generations of Indian farmers. These proverbs offer practical advice on various aspects of farming, from weather forecasting and crop management to resource conservation and animal husbandry. For instance, "Aadi perukki, aavanivelanmai" suggests that if it rains well in July, it is an auspicious time for farming activities in August. Such proverbs guide farmers in making informed decisions, fostering a connection with nature, and ensuring the sustainability of their practices. They serve as a testament to the rich oral tradition and knowledge-sharing culture prevalent in rural India.

Health and Nutrition Perspectives in Natural Farming

Natural farming, a holistic agricultural system, emphasizes minimal human intervention and the natural ecological balance. Pioneered by Japanese farmer and philosopher Masanobu Fukuoka, this method aims to cultivate crops with nature's rhythms, using no synthetic fertilizers or pesticides. With growing concerns over the environmental and health impacts of conventional farming, natural farming is gaining attention for its potential to produce nutritious food while preserving soil health and biodiversity.

Historical Context and Principles of Natural Farming

Natural farming, often referred to as "do-nothing farming," was pioneered by Japanese farmer and philosopher Masanobu Fukuoka in the mid-20th century. Fukuoka's approach emerged as a response to the environmental and health challenges posed by conventional agricultural practices. Influenced by his background in microbiology and a deep observation of natural ecosystems, Fukuoka developed a method that minimizes human intervention, aiming to create a harmonious relationship between farming and nature. Fukuoka's philosophy was heavily influenced by traditional Japanese agriculture, Zen Buddhism, and Taoism, emphasizing the importance of understanding and working with natural processes rather than trying to control them. His seminal work, "The One-Straw Revolution," published in 1975, outlines his methods and philosophy, advocating for a return to simpler, more sustainable farming practices. The core principles of natural farming, as articulated by Fukuoka, are designed to foster a self-sustaining agricultural system that mirrors natural ecosystems. These principles are:

No Tillage: This principle involves avoiding plowing or turning the soil. By leaving the soil undisturbed, its natural structure and the complex web of microorganisms within it are preserved. Tillage can disrupt soil structure, lead to erosion, and negatively impact soil fertility. In natural farming, the soil's innate ability to maintain fertility and structure is trusted, and organic matter is added through mulching and composting to support this natural process.

No Chemical Fertilizers: Instead of relying on synthetic fertilizers, natural farming emphasizes the use of natural compost and mulches to enrich the soil. Chemical fertilizers can lead to soil degradation, reduce biodiversity, and contaminate water supplies. In contrast, natural amendments improve soil health, enhance microbial activity, and promote a balanced ecosystem within the soil, providing plants with a steady supply of nutrients.

No Pesticides or Herbicides: Natural farming utilizes biodiversity and natural predators to control pests, rather than relying on chemical pesticides or herbicides. This approach helps maintain ecological balance and prevent the development of pesticide-resistant pests. By encouraging a diverse range of plant and animal species, natural farming creates an environment where pests are kept in check by their natural enemies.

No Weeding: Rather than removing weeds, natural farming allows them to coexist with crops. Weeds can play a beneficial role in the ecosystem by protecting the soil from erosion, retaining moisture, and enhancing soil fertility. In some cases, they can also act as a habitat for beneficial insects. The presence of weeds is managed through mulching and by planting cover crops that outcompete them without the need for aggressive intervention.

These principles collectively aim to create a farming system that is sustainable, resilient, and in harmony with nature. By mimicking natural ecosystems, natural farming seeks to reduce the environmental impact of agriculture, enhance biodiversity, and produce healthy, nutritious food. The philosophy behind natural farming also advocates for a shift in mindset from domination of nature to collaboration with it, fostering a deeper respect and understanding of the natural world.

Health Benefits of Natural Farming

Natural farming offers a range of health benefits that extend beyond just the absence of chemicals, encompassing nutritional quality, reduced exposure to harmful residues and overall well-being.

1. Enhanced Nutritional Quality

Studies have shown that produce grown through natural farming methods often exhibits superior nutritional profiles compared to conventionally grown crops. Key benefits include:

Higher Antioxidant Levels: Fruits and vegetables grown naturally tend to have elevated levels of antioxidants like flavonoids and polyphenols. These compounds play a crucial role in combating oxidative stress, reducing inflammation, and lowering the risk of chronic diseases such as cardiovascular disease and cancer.

Increased Vitamin Content: Organic farming practices promote the production of vitamins, particularly vitamin C and vitamin E, which are essential for immune function, skin health, and cellular protection against free radicals.

Improved Mineral Density: Naturally farmed crops are richer in essential minerals such as iron, magnesium, and calcium. These minerals are vital for various bodily functions, including bone health, muscle function, and nerve transmission.

2. Reduced Chemical Residue

One of the most significant health advantages of natural farming is the avoidance of synthetic pesticides and fertilizers, which can leave harmful residues on food. Conventional agriculture's reliance on these chemicals has been linked to several health concerns:

Hormonal Disruption: Certain pesticides can disrupt the endocrine system by mimicking hormones or interfering with hormone production, potentially leading to reproductive issues and developmental abnormalities.

Cancer Risk: Prolonged exposure to chemical pesticides has been associated with an increased risk of certain cancers, including leukemia, lymphoma, and breast cancer.

Neurological Disorders: Some pesticides have neurotoxic effects, contributing to the development of neurological disorders such as Parkinson's disease and Alzheimer's disease.

Impact on Soil Health and Nutrition

The health of the soil directly influences the nutritional quality of crops. Natural farming practices contribute to soil health in several ways:

Improved Soil Structure: By avoiding tillage, natural farming helps maintain soil structure, reducing erosion and enhancing water retention capacity. This promotes healthier root systems and better nutrient uptake by plants.

Rich Microbial Activity: Organic farming fosters a diverse microbial community in the soil. These microorganisms play a crucial role in nutrient cycling, decomposition of organic matter, and enhancing soil fertility.

Enhanced Organic Matter: The use of natural compost and mulches adds organic matter to the soil, improving its nutrient-holding capacity and overall fertility. This organic matter serves as a continuous source of nutrients for plants, supporting robust growth and resilience to pests and diseases.

Ecological and Biodiversity Benefits

Natural farming practices are designed to work in harmony with natural ecosystems, promoting biodiversity and ecological resilience. These practices not only benefit the environment but also contribute to sustainable agriculture by enhancing soil health and supporting diverse plant and animal life.

1. Promotion of Biodiversity

Natural farming encourages biodiversity at multiple levels, both above and below the soil surface:

Plant Diversity: Instead of monoculture practices common in conventional agriculture, natural farming often involves planting a variety of crops. This diversity helps reduce the risk of crop failure due to pests or diseases and promotes a more balanced ecosystem.

Pollinator Health: Natural farming avoids the use of harmful pesticides that can harm pollinators such as bees, butterflies, and other insects crucial for crop pollination. Healthy pollinator populations ensure the successful reproduction of many flowering plants, including food crops, fruits, and vegetables.

Beneficial Insects: Biodiverse environments created by natural farming attract and support a wide range of beneficial insects. These insects act as natural predators, helping to control pest populations without the need for chemical interventions. For example, ladybugs prey on aphids, reducing their numbers naturally.

2. Pest Control and Ecosystem Balance

Natural farming practices foster natural pest control mechanisms:

Predator-Prey Relationships: By maintaining a diverse ecosystem, natural farming creates a balance where natural predators keep pest populations in check. This reduces the reliance on synthetic pesticides, which can harm beneficial insects and disrupt natural ecosystems.

Companion Planting: Planting diverse crops together can deter pests. For example, certain plants emit chemicals or compounds that repel pests or attract beneficial insects. This technique minimizes the need for chemical pest control and encourages a healthier, more resilient ecosystem.

3. Soil Biodiversity and Health

A cornerstone of natural farming is the preservation and enhancement of soil biodiversity:

Microbial Diversity: Healthy soils contain a diverse community of microorganisms, including bacteria, fungi, and protozoa. These microorganisms play vital roles in nutrient cycling, decomposition of organic matter, and maintaining soil fertility. Natural farming practices such as no-till and the use of organic composts encourage the proliferation of these beneficial microbes.

Nutrient Cycling: Soil microorganisms break down organic matter into nutrients that plants can absorb. This natural process ensures a continuous supply of nutrients to crops without the need for synthetic fertilizers. By maintaining soil health and fertility through natural means, natural farming supports long-term agricultural productivity.

Benefits to Ecosystem Resilience

Climate Resilience: Biodiverse ecosystems are more resilient to extreme weather events, such as droughts or heavy rains. Healthy soils with rich microbial communities can better absorb and retain water, reducing erosion and runoff.

Reduced Environmental Impact: By minimizing chemical inputs and preserving natural habitats, natural farming practices help mitigate environmental degradation associated with conventional agriculture. This includes reducing water pollution, soil erosion, and greenhouse gas emissions. Natural farming represents a sustainable agricultural approach that emphasizes working with natural processes rather than relying on synthetic inputs like chemical fertilizers or pesticides. It aims to mimic natural ecosystems and promote soil health, biodiversity, and ecosystem resilience. Here's a detailed elaboration on how natural farming contributes to food security:

High-Quality, Nutritious Food: Natural farming prioritizes soil health by enhancing organic matter content, microbial activity, and nutrient availability. Healthy soils produce crops that are richer in essential nutrients, vitamins, and minerals, contributing to higher-quality and more nutritious food.

Sustainability: One of the key aspects of natural farming is its sustainable practices. It promotes practices such as crop rotation, cover cropping, and minimal soil disturbance (no-till or reduced tillage), which help maintain soil structure, fertility, and water retention capacity over the long term. This sustainability ensures that agricultural productivity can be maintained without depleting natural resources or causing environmental harm.

Soil Health and Biodiversity: Natural farming methods enhance soil health by fostering beneficial microbial communities and promoting biodiversity above and below the ground. Healthy soils support diverse ecosystems of microorganisms, insects, and plants, which contribute to nutrient cycling, pest control and overall ecosystem resilience.

Environmental Preservation: By avoiding synthetic chemicals and minimizing external inputs, natural farming reduces pollution of air, water, and soil. This approach helps mitigate the negative environmental impacts associated with conventional agriculture, such as soil erosion, water contamination, and greenhouse gas emissions.

Resilience to Climate Change: Natural farming practices can improve agricultural resilience to climate change. Healthy soils and diverse cropping systems are more resilient to extreme weather events like droughts or heavy rains. Additionally, practices like agroforestry or intercropping can enhance climate resilience by providing natural windbreaks, shade, and moisture retention.

Local and Community Benefits: Natural farming often promotes local food systems and community involvement. It can support small-scale farmers by reducing dependency on costly inputs and providing opportunities for diversified income streams through value-added products like organic produce or agro-ecotourism.

Global Food Security: In a world facing challenges of population growth, climate change, and resource depletion, natural farming offers a viable pathway to ensure food security. By enhancing agricultural productivity sustainably, it helps meet current and future food demands while safeguarding the environment and natural resources for future generations.

Challenges in Natural Farming

Natural farming, despite its benefits, faces several challenges that need to be addressed for widespread adoption. Here are a few important challenges in natural farming:

Initial Transition:

- **Challenge:** Shifting from conventional farming practices to natural farming methods involves a transition period. During this time, soil health may need to recover from the impacts of synthetic fertilizers and pesticides.
- **Impact:** Farmers may experience initial yield reductions or face difficulties in managing pests and diseases without chemical interventions.

Yield Concerns:

- **Challenge:** There is a widespread perception that natural farming yields are lower compared to conventional methods, primarily due to reduced reliance on synthetic inputs.
- **Impact:** Farmers and stakeholders may be hesitant to adopt natural farming practices if they believe it will compromise their yield and economic viability.

Knowledge and Training:

- **Challenge:** Successful implementation of natural farming requires farmers to have knowledge of ecological principles, soil management techniques, and organic pest control methods.
- **Impact:** Lack of education and training can hinder the adoption and effective implementation of natural farming practices.

Solutions to Challenges in Natural Farming

Education and Extension Services:

Solution: Providing comprehensive training and extension services to farmers is crucial. This includes workshops, field demonstrations, and farmer-to-farmer knowledge sharing networks.
Impact: Educated farmers are better equipped to understand the principles of natural farming, implement appropriate techniques, and manage challenges effectively.

Policy Support:

Solution: Governments can play a pivotal role in supporting natural farming through policy measures such as subsidies, grants, and incentives for adopting sustainable agricultural practices.
Impact: Policy support can encourage farmers to transition to natural farming by offsetting initial costs, promoting long-term sustainability, and aligning agricultural practices with environmental goals.

Research and Innovation:

Solution: Continued research and innovation in natural farming techniques are essential. This includes studying soil microbiology, developing organic inputs, and optimizing crop management strategies.

Impact: Research advancements can address yield concerns by identifying best practices, improving pest and disease management, and enhancing overall productivity in natural farming systems.

Case Studied and Success Stories from India

India has seen several successful case studies and initiatives related to health and nutrition through the adoption of natural farming practices. Here are some notable examples:

Andhra Pradesh's Zero Budget Natural Farming (ZBNF):

Case Study: Andhra Pradesh government's ZBNF initiative promotes natural farming methods without synthetic inputs. Farmers are trained in sustainable practices like soil health management, seed treatment, and natural pest control.

Success Story: Farmers practicing ZBNF have reported improved soil fertility, reduced input costs, and higher nutritional quality in crops. Studies have shown that ZBNF methods can increase crop yields and enhance farmer livelihoods while reducing chemical residues in food.

Sikkim's Organic Farming Mission:

Case Study: Sikkim became India's first fully organic state in 2016 by implementing organic farming practices across its agricultural sector.

Success Story: The transition to organic farming in Sikkim has led to improved soil health, biodiversity conservation, and reduced environmental pollution. Organic produce from Sikkim is known for its high quality and nutritional value, contributing to improved health outcomes among consumers.

Bhutan's Gross National Happiness (GNH) and Organic Farming:

Case Study: Bhutan has prioritized organic farming as part of its GNH philosophy, focusing on sustainable development and holistic well-being.

Success Story: Organic farming practices in Bhutan have supported rural livelihoods, preserved traditional farming knowledge, and promoted biodiversity conservation. Bhutanese organic products are valued for their purity and nutritional benefits, contributing to improved health indicators among local communities.

Farmers in Maharashtra and Karnataka adopting Natural Farming:

Case Study: Many farmers in Maharashtra and Karnataka have adopted natural farming practices under various community-led initiatives and NGO programs.

Success Story: Farmers practicing natural farming have reported improved soil fertility, reduced input costs, and better nutritional quality in crops. These practices have also led to enhanced resilience against climate change impacts, such as droughts and erratic weather patterns.

Individual Success Stories:

Example: Padma Shri awardee Subhash Palekar from Maharashtra pioneered the 'Zero Budget Natural Farming' approach, advocating for minimal external inputs and reliance on indigenous techniques.

Success Story: Farmers trained by Subhash Palekar have achieved significant improvements in soil health, crop yields, and financial stability while reducing their dependency on chemical inputs. His methods have been widely adopted across India and have influenced agricultural policies and practices.

Conclusion

Natural farming plays a pivotal role in shaping the landscape of global health and nutrition by offering sustainable agricultural practices rooted in ecological harmony and traditional wisdom. At its core, natural farming emphasizes a holistic approach that respects the integrity of natural ecosystems, promotes biodiversity, and minimizes reliance on synthetic inputs. By cultivating a symbiotic relationship between crops, soil, and surrounding ecosystems, natural farming not only ensures higher yields but also enhances the nutritional quality of produce. Central to the philosophy of natural farming is the principle of soil health. Unlike conventional methods that often deplete soil fertility through chemical-intensive practices, natural farming focuses on building and maintaining soil health through techniques such as composting, mulching, and cover cropping. These methods foster a balanced soil microbiome, which in turn enhances nutrient availability to plants, resulting in crops that are not only more resilient to pests and diseases but also richer in essential vitamins, minerals, and antioxidants. Moreover, natural farming practices prioritize water conservation and efficient resource utilization. Techniques like rainwater harvesting, drip irrigation, and agroforestry not only minimize water wastage but also contribute to the overall sustainability of agricultural ecosystems. By reducing reliance on synthetic fertilizers and pesticides, natural farming mitigates environmental pollution and promotes the health of pollinators and beneficial insects crucial for ecosystem balance. From a nutritional perspective, the produce cultivated through natural farming methods has been shown to have higher levels of essential nutrients and phytochemicals compared to conventionally grown counterparts. This nutritional superiority is attributed to the enriched soil ecology and the absence of chemical residues, making natural farming produce a preferred choice for health-conscious consumers seeking wholesome and sustainable food options. In regions like India, where agriculture forms the backbone of livelihoods and cultural heritage, the resurgence of natural farming represents a return to indigenous agricultural practices that have sustained communities for centuries. By revitalizing traditional knowledge systems and integrating them with modern scientific insights, natural farming not only promises to ensure food security and economic stability but also to foster resilience in the face of climate change and global food challenges. The role of natural farming in health and nutrition transcends mere agricultural practices; it embodies a paradigm shift towards sustainable food systems that prioritize planetary health, human well-being, and ecological resilience in equal measure.

Chapter- 8

Cropping Systems and Crop Geometry in Natural Farming based on Horticultural Crops

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Introduction

The arrangement of the plants in different rows and columns in an area to efficiently utilize the natural resources is called crop geometry. Crop geometry is altered by changing inter and intra-row spacing (Planting pattern). The term cropping system refers to the crops and crop sequences and the management techniques used on a particular field over a period of years.

Need of Cropping Systems

- Cropping systems has to be evolved based on climate, soil and water availability for efficient use of available natural resources.
- The increase in population has put pressure on land to increase productivity per unit area, unit time and for unit resource used.
- The cropping system should provide enough food for the family, fodder for cattle and generate sufficient cash income for domestic and cultivation expenses.
- Cropping system is the most important component of any farming system.

Basic principles of cropping systems

1. Choose crops that complement each other.
2. Choose crops and a cropping rotation which utilize available resources efficiently.
3. Choose crops and a cropping system that maintain and enhance soil fertility.
4. Choose crops which have a diversity of growth cycles.
5. Choose a diverse species of crops.
6. Strategically plan and modify your cropping system as needed.
7. Monitor the progress.

Benefits of crop intensification and cropping systems

1. Maintain and enhance soil fertility. Some crops are soil exhausting while others help restore soil fertility. However, a diversity of crops will maintain soil fertility and keep production levels high.
2. Enhance crop growth. Crops may provide mutual benefits to each other. For example, reducing lodging, improving winter survival or even acting as windbreaks to improve growth.
3. Minimize spread of disease. The more diverse the species of plants and the longer the period before the soil is reseeded with the same crop, the more likely disease problems will be avoided.
4. Control weeds. Crops planted at different times of the year have different weed species associated with them. Rotating crops helps prevent build up of any one serious weed species.

5. Inhibit pest and insect growth. Changing crops each year to unrelated species can dramatically reduce the population of pests and insects. Crop rotation frequently eliminates their food source and changes the habitat available to them.
6. Use resources more efficiently. Having a diverse group of crops helps to more efficiently use the available resources. Natural resources, such as nutrients, sunlight and water in the soil are evenly shared by plants over the growing period, minimizing the risk for nutrient deficiencies and drought. Other resources, such as labour, animal draft power and machinery are also utilized more efficiently.
7. Reduce risk for crop failure. Having a diverse group of crops helps prevent total crop failures, as climate weather in one part of the season may not affect all crops equally. It also reduces food security concerns, as well as the amount of money required to finance production.
8. Improve food and financial security. Choosing an appropriate and diverse number of crops will lead to a more regular food production throughout the year. With a lower risk for crop failure, there is a greater reliability on food production and income generation.

Types of cropping systems

Depending on the resources and technology available, different types of cropping systems are adopted on farms. Broadly three types of cropping system are followed

Sole cropping

Only a single crop or variety is grown alone in a pure stand at normal density during one farming year.

Mono cropping or Monoculture

Mono cropping or monoculture refers to growing of only one crop on same piece of land year after year.

It may be due to climatologically and socio-economic condition or due to specialization of a farmer in growing a particular crop. Under rainfed conditions, groundnut or cotton or sorghum are grown year after year due to limitation of rainfall. In canal irrigate areas, under waterlogged condition; rice crop is grown, as it is not possible to grow any other crop.

Problems of mono cropping

1. The resources like labour, fertilizers, water and machines are not utilized efficiently.
2. The soil health is not cared and nutrients are depleted.
3. There are chances of occurrence of pest and diseases infestation.
4. Natural resources are not fully utilized.

Multiple cropping

"Growing two or more crops on the same piece of land in succession within one calendar year is known as multiple cropping" e.g. Rice-Rice-G' nut or Cotton-Wheat etc.

It aims of maximum production per unit area per unit time. It offers multiple use of resource. It is the intensification of cropping in time and space dimensions i.e. more number of crops within a year & more no of crops on the same piece of land at any given period. It includes inter-cropping, mixed cropping, sequence cropping etc.

Advantages of multiple cropping

1. It is a better source of land utilization
2. It improves yield
3. Increase yield per unit of land
4. Costs of input decrease as compared to individual crop growing cost
5. Reduce pest and disease attack
6. Different type of products can be produce at a time
7. It helps to produce a balance diet for a family
8. It helps to maintain the soil fertility
9. It helps to control weed

Disadvantages of multiple cropping

The survival of pests become easy

Pests can easily shift from one crop to another crop

Problem of weed management

Implementation of new technology is difficult etc.

Different types of multiple cropping:

Inter cropping

Inter cropping is growing two or more crops simultaneously on the same piece of land with a definite row arrangement.

The main objective of inter-cropping is to utilize the space left between two rows of main crops and to produce more grain per unit area. Inter cropping was originally practiced as an insurance against crop failure under rainfed condition.

e.g.: Groundnut & Tur in 6:1 ratio or sorghum & Tur in 4:2 ratio

Intercropping is further classified as:

Additive Series: Intercrop is introduced in the base crop. It is done by adjusting or changing crop geometry. It is mostly used in India. Eg: maize + mungbean (1+1)

Replacement Series: Both the crops are component crops. It is done by sacrificing certain proportion of population. It is mostly used in western countries. e.g: wheat + mustard (9:1), maize + mungbean (1:3)

Advantages of intercropping:

- Improvement in yield
- Improvement in soil property under legume intercropping system
- Less risk against crop diseases and pests
- Additional income and higher profit
- Soil erosion is reduced
- Stability in production
- Economic sustainability is maintained

Disadvantages of intercropping:

- Fertilizer application in one crop may hamper the growth of other crop
- Improved implements cannot be used efficiently
- Harvesting is difficult
- Yield decreases if the crops differ in their competitive abilities

Management of intercropping system

Crops are grown simultaneously. Management practices should, therefore, aim to provide favorable environment to all the components, exploit favorable interactions among the component crops and minimize competition among the components. Prominent interactions in intercropping include:

Light: Intercropping can increase light inception by as much as 30-40 per cent. Proper choice of crops and varieties, adjustment of planting density and pattern are the techniques to reduce competition and increase the tight use efficiency.

Moisture and nutrients: Competition for water and nutrients results in two main types of effects on the less successful or suppressed component. First, the roots of dominated crop may grow less on the sides of aggressive component. Secondly, plants affected by competition for soil factors are likely to have increased root/shoot ratio.

Allelopathy: Some crops may be unsuitable to be grown as intercrops because they may produce and excrete toxins into the soil which are harmful to other components.

Annidation: Refers to complementary interaction which occurs both in space and time.

Varieties: Recommended principles should be followed for realizing the benefits of intercropping.

a) Varieties of component crops should be less competing with the base crop and the peak nutrient demand period should be different from the base crop.

b) Difference in duration between the components in intercropping should be a minimum period of 30 days (maize + soybean, sorghum + red gram, *toria* + *gobhi sarson).*

c) Selection of compatible genotypes of component crops increases the complementarity of intercropping system.

d) Varieties selected for intercrop should have thin leaves, tolerant to shading and less branching since these crops are, generally, shaded by the base crop.

e) If the base crop is shorter than intercrop, the intercrop should be compact with erect branching and its early growth should be slow.

f) Characteristics of base crop should be similar to the sole crop.

Nutrient Management

When legumes are associated with cereal crop in intercropping system, a portion of nitrogen requirement of cereal is supplemented by the legume. The amount may be as small as a few kg to 20 kg ha^{-1}. Cereal + legume intercropping, is therefore; mainly advantageous under low fertilizer application. Considering all the factors, it is suggested that the nitrogen dose recommended for base crop as pure crop is sufficient for intercropping system with cereals + legume or legume+legume. With regard to phosphorus and potassium, one-eighth to one-fourth of the recommended dose of intercrop is also added in addition to recommended dose of base crop to meet the extra demand. Basal dose of nitrogen is applied to rows of both components in cereals + legume intercrop system. Top dressing of nitrogen is done only to cereal rows. Phosphorus and potassium are applied as basal dose to both crops.

Water Management

Intercropping systems are, generally, recommended for rainfed crops to get stable yield. Total water used in intercropping system is almost the same as for sole crops, but yield is increased. Thus, water-use efficiency of intercropping is higher than sole crops. Component crops differ on their capacity to withstand excess or difficult moisture conditions. However, the irrigation schedule followed for sole crops is suitable even for intercropping system. Scheduling irrigation at IW/CPE ratio of 0.6 to 0.8 or irrigation at one bar soil moisture tension is suitable for most of the system. However, information on this aspect is meager.

Weed Management

Weed problem is less in intercropping system as compared to their sole crops. In certain situations, intercrops are used as biological agents to control weeds. Blackgram, greengram, cowpea in sorghum and cowpea in banana reduce weed population and one hand weeding can be avoided by this method. In some intercropping system like maize + groundnut, rice +tapioca, maize + tapioca, weed problem is similar to their sole crops. Growth habit of genotype used in intercropping has a great influence on weed growth. Weeds present in sole crops are different than those present in intercropping system. Though weed problem is less, weed control measures are necessary in intercropping system. But the labour required for weeding is less. Second weeding is not necessary because of crop coverage. Chemical weed control is difficult in intercropping system because the herbicide may be selective to one crop, but non-selective to another.

Pest and disease management

Pests and diseases are believed to be less in inter-cropping system due to crop diversity than in sole crops. Some plant combinations may enhance soil fungistasis and antibiosis through indirect effects on soil organic matter content. Spread of the disease is altered by the presence of different crops. Little leaf of brinjal is less when brinjal is sheltered by maize or sorghum. As the insect carrying virus first attacks maize or sorghum, virus infection is less on brinjal. Non-host plants in mixtures may emit chemicals or odours that affect the pests, thereby protecting host plants.

Mixed cropping: Growing two or more crops simultaneously on the same piece of land in a proportion without any row arrangement.

e.g. Wheat and Mustard seeds are mixed together in 2:1 rates and shown broadcast with no spacing maintained between the crops.

No spacing is maintained between the crops it is a common practice in areas where climatic hazards such as flood, drought, frost etc. are frequent and common.

Under such circumstances the farmers always fear that their crops will fail. Under mixed cropping, the time of sowing of all the crops is almost the same, however they may

Sequential cropping: Growing of crops in sequence

e.g. Double cropping: Growing of 2 crops in a year e.g.: Rice-wheat

Triple cropping: Growing of 3 crops in a year e.g.: Rice-wheat-maize

Quadruple cropping: Growing of 4 crops in a year e.g.: Rice-early potato-Wheat- mung

Multistoried cropping: Cultivation of crops of different heights in the same field at the same time.

e.g. Sugarcane + Indian bean or potato or onion, Sorghum+ mung

Ratoon cropping: Raising a crop with re-growth coming out of roots or stalks after harvest of the crop.

e.g. sugarcane, brinjal, chilli, fodder maize etc.

This minimizes the cost of production of next crop in terms of land preparation and cost of seed, also the next crop i.e. ratoon crop gets already established root system.

Relay cropping: In this, second crop is sown before the harvest of previous crop in same field.

e.g. 1st crop-tomato 2nd crop-French bean.

This is done mainly to utilize the conserve moisture in the field after kharif season. It also saves the time and keeps the land under vegetation.

Alley cropping: Growing food crops within the rows of tree or plantation crops

e.g. Green gram in alley of glyricidia or subabul.

Strip intercropping: Growing alternate rows of erosion resisting and permitting crops along the slope

e.g. Strips of soybean and alfalfa, cowpea and sorghum

Chapter- 9

Research & Development in Natural Farming and Validation of Bio-inputs

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Introduction

Natural Farming comprising of set of agro-ecological practices such as minimum disturbance to soil, application of locally prepared concoctions (beejamrit, jeevamrit, ghanjeevamrit) from livestock, mulching (soil mulch, cover crops, crop residues), muti-variate cropping during fallow, intercropping, prophylactic application of botanical preparations such as agniaster, brahmaster, neemaster, dashparni arketc, trap crops, border crops and other eco-friendly pest control practices are emerging as alternate production system. It aims to reduce the land degradation by recycling of crop and animal residues and reduce the paid-out costs. Indian Council of Agricultural Research through All India Network Programme on Organic Farming (AI-NPOF) with 20 co-operating centres in 16 statesinitiatedmulti-location study on Natural farming in different agro-ecologies from kharif 2020.

Performance of Natural farming in different cropping systems

Soybean + maize- vegetable pea + coriander (green leaf) recorded system yield (Soybean equivalent) of 7307 kg/ha/year at Bajaura (Himachal Pradesh), Almora (Uttarakhand) and Gangtok (Sikkim) under complete natural farming.Soybean + maize-wheat + mustard recorded system yield (soybean equivalent) of 4020 kg/ha/year at Bhopal and Jabalpur (Madhya Pradesh) and Raipur (Chhattisgarh) under complete natural farming. Cowpea + maize – Fennel + cauliflower/cabbage recorded system yield (Cowpea equivalent) of 9473 kg/ha/year at SK Nagar (Gujarat), Ajmer & Udaipur (Rajasthan) under complete natural farming. Cassava + vegetable cowpea-greengram recorded system yield (Cassava equivalent) of 45050 kg/ha/year at Thiruvananthapuram (Kerala) under complete natural farming. Yield under natural farming was found to be on par with that of organic and integrated crop management during the first year of study. Rice + dhaincha – sorghum/maize + cowpea recorded system yield (rice equivalent) of 5449 kg/ha/year at Karjat (Maharashtra) and Ranchi (Jharkhand) under complete natural farming. Cotton +greengram-sorghum+ chickpea cropping system evaluated at Coimbatore (Tamil Nadu) and Dharwad (Karnataka) recorded system yield (cotton equivalent) of 1692 kg/ha/year under complete natural farming.Maize + cowpea – wheat + chickpea evaluated at Modipuram (Uttar Pradesh) and Ludhiana (Punjab) recorded system yield (maize equivalent) of 4710 kg/ha/year respectively under complete natural farming involving practices such as intercropping, mulching and application of concoctions of natural farming. Turmeric + cowpea -greengram recorded system yield (turmeric equivalent) of 12227 kg/ha/year at Umiam (Meghalaya) under complete natural farming. Multi-location results of 2 years (2020-21 and 2021-22) in terms of productivity of the selected cropping systems in different agroecology are given in Table 1. Aulakhet al., (2013), Ravisankar et al., (2020), Karan Bhadhu et al., (2021) and Swarnam et al., (2021) also studied the productivity of crops with natural farming concoctions and found significant variation in yield due to different agroecological conditions.

Table 1. System productivity of best performing cropping systems under natural farming at selected locations in various agro-ecology

Cropping systems	Farming situation (Agroecology)	Test location (State)	Productivity (kg/ha)
Soybean + maize - vegetable pea + coriander (green leaf)	Hilly, irrigated	Bajaura (Himachal Pradesh), Almora (Uttarakhand) and Gangtok (Sikkim)	7307 (Soybean equivalent)
Soybean + maize-wheat + mustard	Plains, partially irrigated	Bhopal and Jabalpur (Madhya Pradesh) and Raipur (Chhattisgarh)	4020 (Soybean equivalent)
Cowpea + maize – Fennel + cauliflower/cabbage	Plains, Irrigated	SK Nagar (Gujarat), Ajmer & Udaipur (Rajasthan)	9473 (Cowpea equivalent)

Other advantages observed under natural farming in the above systems are significant reduction in cost of cultivation under Natural farming compared to organic farming or integrated crop management which contributed for net return gain. Soil organic carbon increased from 0.90 % (initial) to 1.04 % under natural farming in the soybean + maize-vegetable pea + coriander (green leaf) cropping system. Similarly, the soybean + maize-wheat + mustard also recorded reduction in cost of cultivation and improvement in soil organic carbon from 0.57 % (initial) to 0.65 %.Cowpea + maize – Fennel + cauliflower/cabbage under natural farming resulted in improvement of soil organic carbon from 0.38 % (initial) to 0.40 % under Natural farming. Due to the reduction in cost of cultivation, net return gain of 6 % over integrated crop management was observed in cassava+ vegetable cowpea-greengram system.

Significance of the Natural Farming Practices Including Bio-inputs

Concoctions: Natural Farming is expected to contribute for significant changes in the production system. Addition of concoctions such as Jeevamrit, Ghanjeevamrit significantly increases the biological activity in the soil. Characterizing changes in the microbial population during culturing of liquid jeevamrit showed significantly higher increase in microbes (bacteria, fungi, actinomycetes and rhizobium). If these microorganisms survive and then proliferate once applied to soil, the rate of decomposition of organic materials added in the form of crop residues and organic manures under natural farming could be greatly increased thereby increasing the native nutrient supplying capacity of the soil.

Mulching: Mulching practices such as soil mulch, crop residue mulch and live crop mulching recommended under natural farming are predicted to substantially increase soil organic carbon. Globally the production of residues associated with agricultural crops has been estimated at

2802 m tonnes/year for cereal crops, 3107 m tonnes/year for 17 cereals and legumes, and 3758 m tonnes/year for 27 food crops. Similarly, the amount of crop residue produced in India was estimated at 634 m tonnes/year. Mulching with dried biomass could increase soil carbon depending on the specific conditions at the site by 292 ±11 kg carbon/ha/year. This can contribute for better soil health. Soil organic carbon (SOC) sequestration is seen as a major target to mitigate climate change through the compensation of anthropogenic emissions. In agriculture, crop residues are a principal component of the carbon cycle, and their removal for uses other than maintaining or enhancing soil quality contributes to the depletion of SOC pools. The estimates on the potential for carbon sequestration differ depending on the specific conditions at the site used to study. Still, it is more likely that mulching with crop residues as proposed in Natural Farming systems is likely to increase the organic matter content of the soil, rather than mining it.

Crop rotation and Intercropping

Natural farming advocates intercropping, border cropping, bund cropping, trap cropping as mandatory practice which can result in crop diversification and also enhance biological nitrogen fixation. Analysis of the data on production costs under natural farming from 7 States collected by the ICAR constituted committee for food and commercial crops, millets, oilseeds and pulses consistently revealed lower costs of production under natural farming over conventional farming. Overall, on an average, production costs for crops raised under natural farming system were 16, 28.5, 17.4 % lower than conventional farming for rice, millets and pulses & oilseeds respectively.

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Chapter - 10

Introduction to PGS-India Organic Certification System

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Certification

A system of assuring quality of products produced by the farmers that he has followed standards which is verified by inspector's/peer reviewers, and is documented and demonstrated in the form of logo or a statement.

Need of Certification

To build Trust of consumers, Identity of organic product, to assure Quality, to guarantee organic products, to make it unique in the market, to provide Ownership to organic producers, to build organic Brand and to make consumer acceptance of certified products.

Organic Certification

National Programme on Organic Production NPOP certification / Third party certification is mainly oriented for export purposes implemented since from **2004** from APEDA/Ministry of Commerce. CBs are implementing certification programme.

Participatory Guarantee System (PGS)-INDIA organic certification system meant for domestic purpose was launched in **2011** by Department of Agriculture and Farmers welfare, Ministry of Agriculture & Farmers welfare, Government of India and is an alternative to third party certification. Regional Councils are authorized for implementing certification programme.

PGS India Certification

Participatory Guarantee System of India (PGS-India) is a quality assurance initiative that is locally relevant, emphasizing the participation of stakeholders, including producers and consumers and operates outside the frame of third-party certification. As per IFOAM (2008) definition "Participatory Guarantee Systems are locally focused quality assurance systems. They certify producers based on active participation of stakeholders and are built on a foundation of trust, social networks and knowledge exchange". In the case of organic agriculture, PGS is a process in which people in similar situations (in this case producers) assess, inspect and verify the production practices of each other and collectively declare the entire holding of the group as organic. Although PGS-India is basically a farmer group centric organic guarantee system but to integrate all sections of producers, processors, handlers and traders, to complete the value chain from farm to fork and keep the PGS-India programme as central guiding force to the entire organic agriculture movement, it also provides for an access to individual producers, individual processing and handling facilities under PGS groups, organized processing, warehousing, handling and packaging and trading entities away from producer groups. To ensure end-to-end traceability (as per the requirements of regulatory framework under FSS [Organic Foods] Regulation2017), PGS-India programme also provides uninterrupted chain of custody, starting from producer groups till the products are processed and finally packed into retail packs. To integrate traditionally organic areas in to mainstream organic and harvest the benefits of traditionally organic practices for safe and healthy certified organic food for consumers, PGS-India programme also provides for a mechanism to certify large contiguous areas, involving village councils and Gram Panchayats by adopting village-wise conformity assessment on annual basis.

Principles of PGS India Certification

Participation: Participation is an essential and dynamic part of PGS. Key stakeholders (producers, consumers, retailers, traders and others such as NGOs) are engaged in the initial design, and then in the operation of the PGS and decision making.

Shared Vision: Collective responsibility for implementation and decision making is driven by common shared vision. All the key stakeholders (producers, facilitating agencies, NGOs, social organizations and even the State Governments) support the guiding principles and goals, PGS is striving to achieve. This can be achieved initially through their participation and support in the design and then by joining it. This may include commitment in writing through signing an application/ document that includes the vision.

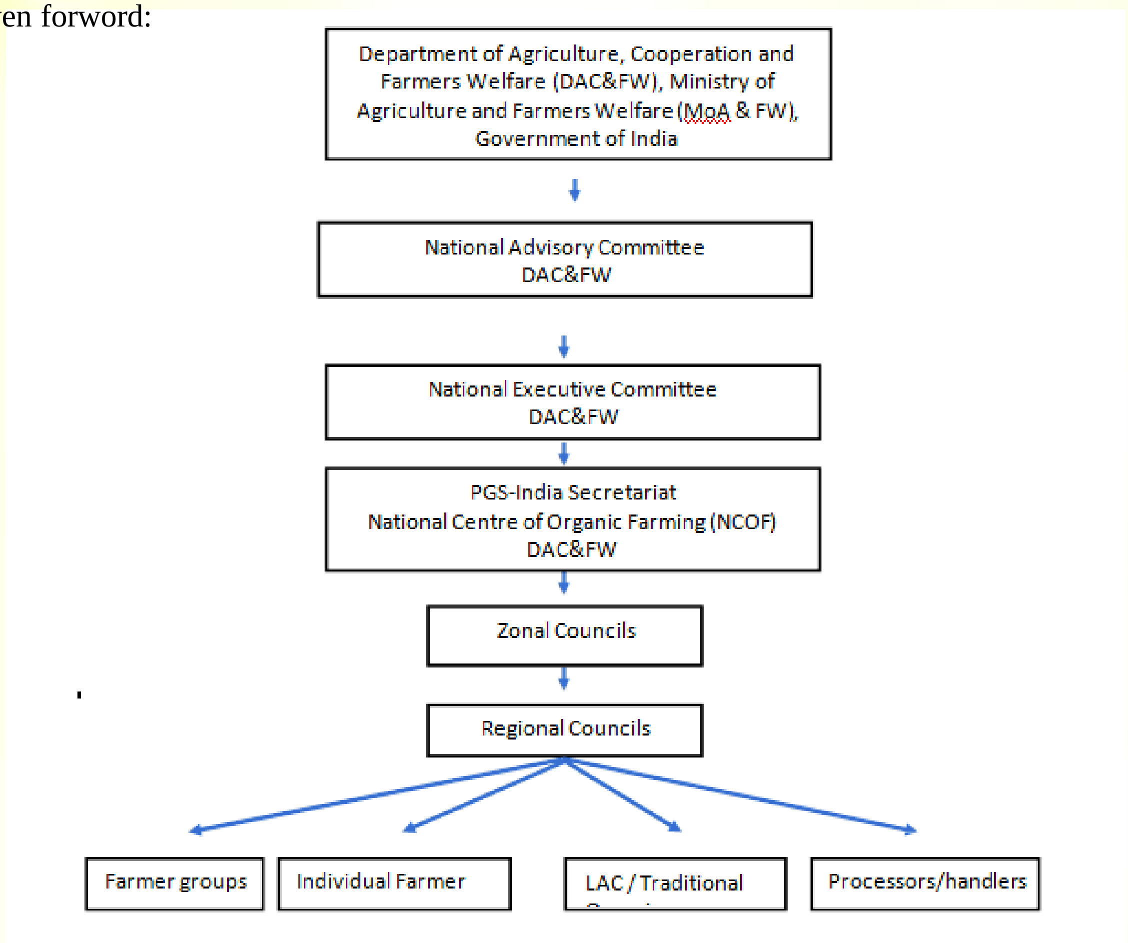
Transparency: Transparency is created by having all stakeholders, including producers and consumers, aware of exactly how the guarantee system works to include the standards, the organic guarantee process (norms) with clearly defined and documented systems and how decisions are made. At the grass roots level transparency is maintained through the active participation of the producers in the organic guarantee process which can include

Trust: The foundation of this trust is built from the idea that the key stakeholders collectively develop their shared vision and then collectively continue to shape and reinforce their vision through the PGS. The ways this trust is reflected may depend entirely on factors that are culturally / socially specific to the PGS group. Mechanism for expressing trustworthiness includes:. Declaration (a producer pledge) via a witnessed signing of a pledge document. Written collective undertaking by the group to abide by the norms, principles, standards of PGS-India and uphold trust for their peers.

Horizontality: PGS India is intended to be non-hierarchical at group level. This will reflect in the overall democratic structure and through the collective responsibility of the PGS group with sharing and rotating responsibility, by engaging producers directly in the peer review of each other'sf arms; and by transparency in decision making process.

PGS-India Certification–Operational Structure

The PGS-India programme is operated under the overall direction and guidance of the Department of Agriculture and Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India with Secretary, Agriculture, Dept. of Agri. & Farmers Welfare as the apex decision making and appellate authority. Schematic operational structure of the PGS India is given forword:



PGS India Certification-Operational Structure, Roles and Responsibilities

ThePGS-India programme shall be operated under the overall guidance, directions and authority of the Department of Agriculture and Farmers Welfare (DA&FW), Government of India. The Secretary,DA&FW shall be the overall controlling authority.

National Advisory Committee (PGS-NAC)-Secretary DA&FW shall constitute an apex policy formulation and programme steering and supervision committee(shall meet at least once a year or as and when required)

Structure:

Head-Additional Secretary, DA and FW; Members–, Department of Agriculture & Farmers Welfare, Department of Animal Husbandry and Dairying, Food safety and Standards Authority of India, Department of Commerce, ICAR, PGS Secretariat Other Government or private organizations Member Secretary–NEC.

Main Role and Responsibilities

- Defining operational and policy guidelines and PGS India Standards.
- Make changes, improvements and amendments to the programme and national coordination structure as a whole.
- Constitution of National Executive Committee
- Steering and supervision of implementation of PGS-India programme at national level.
- Delegation of authority and responsibilities to NEC and PGS-India secretariat
- Policy coordination, convergence and coherence with other certification systems and regulatory

National Executive Committee (PGS-NEC) shall be the programme implementation, monitoring, evaluation and decision making body for PGS India Programme

Structure: Joint Secretary (INM), DA&FW- Chairman; Executive Secretary-Director, NCONF, Members- Additional Commissioner (INM) Head, Zonal Council (RCONFs- 2Nos), Joint Secretary (Horticulture) Joint Secretary, DAHD Representative APEDA Representative FSSAI , Head Zonal Council (Non-Govt). PGS-NEC will meet atleast twice a year the implementation process and progress of PGS programme implementation and its monitoring and for authorization of new Regional councils.

Main Role and Responsibilities

PGS-NEC being apex implementation, monitoring and evaluation and decision-making body shall be responsible for:

- Overall monitoring and supervision of programme implementation
- Drafting policies, suggest modifications & amendments to PGS-India operational structure, standards for approval of NAC.
- Coordinate and monitor national level capacity building, education, outreach and supervision activities.
- Delegation of authority and duties to PGS- India Secretariat
- Selection and Authorization of Zonal and Regional Councils
- Supervision and monitoring on the functioning of ZCs & RCs
- Sanction/ withdrawal of authorization to ZCs/RCs on being found not functioning according to the guidelines.
- Constitute technical & evaluation / surveillance committees and assign responsibilities bodies.

PGS Secretariat: PGS-India National Secretariat NCONF and MoA& FW Director NCONF (Executive Authority)

Main Role and Responsibilities

- All executive and secretarial responsibilities related to execution of the programme, NAC and NEC meetings, implementation of the decisions of NAC and NEC, matters to be put up to NEC and coordination with NEC members

- Coordinate and facilitate evaluation and surveillance visits of duly constituted evaluation and surveillance committees, assessment of reports and submission of reports/ recommendations to NEC for necessary action
- Capacity building, education, training outreach activities and Monitoring & supervision of Zonal and Regional councils.
- Receipt and processing of applications for Zonal Councils and Regional Councils for authorization by NEC
- Coordinate and liaise with different State Governments for promotion and popularization of PGS programme.
- Supervision of PGS products through residue testing including collection of PGS samples, getting those samples tested for residue analysis.
- Appellate authority for local groups against the actions and decisions of Zonal Councils and for Regional Councils against the action of Zonal Council.

Zonal Council (ZCs)

Five Regional Centre for Organic & Natural Farming (RCONFs) under National Centre for Organic & Natural Farming shall act as Zonal Councils.

Main Role and Responsibilities

- Monitoring on the functioning of Regional Councils.
- Capacity building, training and outreach activities for Regional Councils/LGs
- Complaint redressal of farmers and local groups against the functioning and actions of Regional councils
- Appellate authority on complaints of certificate denial by RC or sanctions imposed by RC on local groups
- Appellate authority on complaints of traders/ retailers/ consumers on the quality/ organic integrity of PGS products of particular group and action taken by RC or in action of RC and submission of quarterly report to PGS secretariat.
- Monitoring of PGS products through residue testing.

Regional Council (RCs)

Legally registered agency under relevant acts (Societies act, the companies act, cooperatives act, trust act or any other state or central Government act in force from time to time). Government Departments/agencies shall be deemed legal entities. Applicant Regional Councils and its personals shall have no conflict of interest which can hinder or affect the organic guarantee programme and/ or its credibility.

Main Role and Responsibilities

- Provide copy of standards, operational documents and literature etc to LGs and to members of public on demand in local language
- Grant registration to local groups on-line on submission of documents.

- Capacity building of local groups in data uploading on PGS website. If local groups do not have access to a computer and internet or do not know the English language, RCs can help in data uploading. But such services to be agreed upon between LG and RC.
- Training and support to existing and new local groups in procedures and documentation.
- Approval of the local groups
- On-line monitoring on the functioning of Local Groups.
- Physical inspection/ evaluation of the local groups registered with it within next one year. Each group shall be subject to at least one physical inspection/ evaluation in two years subsequently and at least 50% of the Local groups shall be physically evaluated every year.
- Assessment of summary peer appraisal summary sheets of LGs/ inspection report uploaded by the operators on PGS website, grant necessary approval and issue scope certificates from PGS-India portal based on assessment and inspection if required.
- In case of individual producers (not linked with any PGS-India group) and stand-alone processing and handling units, RCs shall undertake annual inspection /supervision and issue scope certificate only after physical inspection is done and no non-compliances are pending.
- To address complaints, comments or feedback it receives from the public about functioning of the LGs and also respond to communication from statutory bodies such as FSSAI regarding any consumer complaints.

Scopes for certification under PGS-INDIA organic of PGS-INDIA system

To ensure entry of individual farm/Group/large area producers and PGS-India certified organic farm produce into organized processing and retail sales, PGS-India provides a system of continued verification of organic integrity for farms, on-farm and off-farm processing and handling and online marketing and traceability system. There are three types of module developed at present as given below

1. Crop Production Module
2. Processing and Handling Module
3. Live Stock Module and others

1. Crop Production module: The complete certification operation under PGS-INDIA web portal has been made functional at present. Under crop production modules and there are three categories for which certificates will be issued by RC and the details as fallows;

Large Area Certification (LAC)

Individual Group certification

Local Group certification:

General Requirement

Local group is the main functional and decision-making body under Participatory Guarantee System. It is a local group of farmers that live in the same village or close by villages and interact regularly with each other. Participation of consumers or representatives of traders or retailers in the group and its functioning should be encouraged as it strengthens the integrity and trust.

Any food processing, handling and storage of organic products, on-farm and/oroff-farm or under hired facilities away from the farm can be certified under PGS, provided the entire operation is carried out under the supervision of PGS Local Group and the items /materials to be processed are the direct produce of the PGS group. If required many PGS groups can make their federation and get their federation registered with RC for collective processing, handling and storage. Necessary guidelines for making federation and handling of products from different groups will be laid down by the concerned RC.

Requirement and Eligibility Criteria for Local Groups

1. A local group should comprise of minimum 5 members belonging to the same village or close by villages with continuous territory. Regional Councils can decide on maximum number of farmers per group keeping local situations in mind.
2. Adequate participation of women farmers shall be ensured.
3. Atleast a few (25%) members of the group shall be well versed with the PGS organic guarantee systems or certification system and National Standards of Organic Production (NPOP) or have undergone training on PGS guarantee system organized by Regional Councils, Zonal Council or PGS Secretariat or have been part of the core team of other functional PGS group.
4. All the members in the group have signed the PGS pledge and group agreement to adhere to the group’s specific vision, participatory approach and collective responsibility.
5. Although, there is no restriction on the size of holding of any individual farmer but in any case, the holding of one single member should not exceed 50% of the total land under the group.
6. Under PGS organic guarantee system normally parallel production and part conversion is not allowed, therefore it is necessary that all group members need to bring their entire farm with livestock under organic management as per the PGS standards. However, Regional Councils in some cases may give exception and may also allow conversion in phases.
7. Have access to PGS documents and preferably have access to computer and internet (optional).
8. Registered with the concerned Regional Council and have obtained necessary user ID and password to upload data on PGS website.
9. In case if farmer group is unable to operate on-line system of data uploading then the services can be availed from Regional Council or of any other facilitating agency or local NGO or service providers etc.
10. In case an individual farmer or a group of farmers with less than 5 members is/are proposed to join existing LG, as advised by the RC, then to accept those farmers as members of the LG.
11. LG need to register only once, till the LG keeps on doing certification activities, uploading peer appraisal summary sheets on season-to-season basis on PGS-India website. Non-submission of Peer Appraisal summary sheet continuously for two seasons or12 months shall result in suspension of the group. Revival of certification process for such groups will restart from the date of submission of fresh peer appraisal and fresh certification process will start with PGS-Green-1 status.

Role and Responsibility of Local Group

1. Organize farmers in the group and each member individually sign PGS organic pledge and group agreement.
2. Provide copies of PGS standards, operational manual and appraisal forms to all the members in the local language. If farmers are illiterate, then they need to be explained details and standards orally and through pictorial representations.
3. Prepare necessary field documents with farm history. Each group shall maintain such documents in a group file comprising of application form, signed pledge, signed agreement, farm maps showing locations with GPS coordinates in respect of each member and last one year history on input usage and management practices.
4. Elect Group leader and core team of peer reviewers (minimum 3 in 5 members group). There is no upper limit. It will be an optimal situation if all members of the group can participate in peer reviews, as this contributes to capacity building and information exchange between farmers, and reduces conflicts of interests.
5. Participate in the activities of any other registered PGS group to understand the functioning of the PGS Group.
6. Implement standard requirements on the farms of all the group members and obtain endorsement from the other registered group. This endorsement is needed only once at the time of registration.
7. Register group on PGS-India website and obtain registration approval from the Regional Council.
8. Contact nearby PGS group for endorsement
9. In case no PGS registered group is there in the vicinity for endorsement then State Agencies (State Agriculture Department District Officer) may be requested to verify the requirement and submit necessary verification report to RC. Else request RC to do verification and grant registration approval. RCONF scan also be requested for verification and endorsements of Local Groups for their recognition by Regional Council. RCs can endorse the groups only after physical verification / inspection.
10. In case of Groups constituted under some Government Programme (such as PKVY) endorsement of the group shall be done by the authorized District officer/scheme in-charge of the implementing state Government Department.
11. Organize time to time meetings and maintain attendance register. Participation of members in these meetings is a mandatory activity and is an indication of dedication of the member to the cause of group's guarantee scheme. There should be at least 2-4 times a year (2 for perennial crop group and 4 times a year for annual crop group) compulsory meetings at key Times of the year depending on the season, the crops, etc. One / two for peer appraisal planning and one/two for decision making.
12. Every member needs to attend at least 50% of the meetings in a year and sign in attendance register.
13. Advise each other and share information to improve the capacity of the group as a whole.
14. Organize regular training courses by inviting practicing organic farmers from other groups, RC members or experts of other State Govt and Non-Govt agencies.

15. Chalk out peer appraisal strategy and ensure timely appraisal of each farm at least twice a year. Peer reviewers will ensure to complete Peer review appraisal form, sign and submit to the group leader. Each farmer is to be appraised by at least a two-member team. Inclusion of consumer's representative increases the credibility and trust.
16. Inspection of peer reviewer's farms to be done by another peer reviewer group. To increase credibility and trust the group may have any number of peer reviewers.
17. All peer appraisal sheets in respect of each group member needs to be maintained in hard copy or digitally by the local group for future supervision activity. These are to be made available in the public domain and provided to RC or statutory authority upon demand during physical supervision.
18. At appropriate times the group decides which farmers are to be certified. Separate out farmers which are yet to comply with the certification requirements. List out defaulters and impose sanctions.
19. Organize final decision meeting, explain the peer appraisal results to all the members. Collectively declare the group as conforming to PGS standards (in case of small groups, upto 10 members). If the group is large then elect a sub-group or certification committee, comprising of 5 or more members, which may review the results and decide upon the certification. Approval of majority group members is required only in the cases of negative decision (denial of certification or decertification). Full member body can also serve as an appeal body against the decision of the certification committee.
20. At appropriate time prepare peer appraisal summary sheet with list of farmers declared certified with details of crops and expected quantity of produce.
21. Upload peer appraisal summary sheet for the entire group on the PGS-India website along with necessary group decision and send signed hardcopy to RC through post.
22. On being approved by RC on-line, RC shall issue the certificate.

Individual Farmers Certification

1. In cases where an individual farmer (or a group of farmers less than 5) is
2. interested in PGS-India certification and there is no group in the vicinity
3. and no additional community members are ready to form a group, the individual
4. producers can directly apply to the Regional Council for registration.
5. Make an application to available Regional Council with signed application form, pledge and a signed declaration stating their current inability to form a local group
6. Invite other PGS-India group members to end or se the application after physical visit to farm. In case if no PGS-India group is accessible then request the Regional Council to physically verify the farm
7. Obtain PGS-India operational guidelines and standards from nearby group or from RC
8. Request the RC to approve the registration and obtain user ID and password for PGS-India website.
9. Request the Peer appraisers of nearby group to physically inspect the farm and fill peer appraisal form. Filled peer appraisal farm to be submitted to Regional Council. In case if no group is close by then request RC to do physical inspection and grant certification.

Individual producer registration is an interim arrangement and the producer must initiate efforts to bring in other members from the village community to form the group in due course (maximum 2 years) and transform individual status to group status. In case if an individual farmer is unable to form a group even after 2years, then Regional Council will attach the farmers with the nearest group.

Large Area Certification

In India there are large and contiguous areas that are traditionally/ default organic with no history of prohibited input usage. Due to geographic isolation or lack of connectivity such areas remained away from conventional agriculture. This dis- advantage now can be taken as advantage by transforming such areas to certified organic under PGS-India to harvest the growing demand for safe and healthy organic food. States, concerned State Departments and/ or Zonal Council will have to ensure following responsibilities:

a) Verify that there is no history of synthetic input and GMO use at least during the last 3 years
b) Administrative ban on use, sale and supply of GMO seeds, synthetic agro- inputs in the defined area
c) Documentation of the entire area, including geo-tagged maps with defined boundaries with villages and landmarks. Documentation will be done village-wise with details of farming practices. To maintain uniformity, it should be ensured that all farmers follow similar farming practices. In case if few farmers are adopting different practices then they need to be documented separately. This will be a one-time activity.
d) One village comprising of all the farmers will be treated as one group. To qualify for large area certification all the farming members of the village and the large area must comply to PGS-India organic standards.
e) Gram Panchayat/ Village council will ensure that all the growers undertake PGS pledge and sign the pledge.
f) Once all the farmers sign the pledge, it need to be endorsed by the Gram Panchayat and Gram Panchayat may pass a resolution for adopting and allowing only organic farming within their geographical limits.
g) Register the area with individual village wise documents to authorized RC. RCs authorized for large area certification shall be authorized to register such area and undertake certification process.
h) Create peer appraisal committees from among the farmers from the village. At least one peer appraisal committee will be constituted in each village for annual peer appraisals. Complete first peer appraisal and submit peer appraisal summary sheet to RC.
i) Facilitating PGS-NEC appointed verification committee visit for ensuring that the defined area is organic since last 3 years.
j) ZC/RC on verification of documents, peer appraisal submitted by village peer appraisers and report of verification committee on reduction of conversion period can recommend declaration of the area as organic to PGS-NEC.

k) PGS-NEC after thorough assessment can declare the entire area as organic. In all such cases the decision on declaration of entire / large contiguous area as certified rests with PGS- NEC and ZC/RCs are only the recommending agencies. On such approval RC shall issue village-wise certificates giving full list of farmers, area and crops. In large area certification certificates and TCs shall be issued to the entire village group and not to individual farmers.

l) For continuation of organic status each and every village in the region needs to undertake atleast one peer appraisal annually. The annual peer appraisal report will be submitted to the concerned ZC/Regional Council for extension/renewal of certification.

m) Under this certification programme all the farmers and their farming operations (including livestock) must be complying to PGS-India organic standards. Even a single default by one farmer can result in to cancellation of organic status of the entire village. Repeated defaults in a village or in many villages may result in cancellation of certification of the entire geographic boundary (such as whole block).

n) Individual farmers and processing and handling units under group or stand alone units away from the groups shall not be eligible for certification under this category, eventhough they may be located within the same geographical area.

Processors /Handlers Certification

In cases where an individual farmer (or a group of farmers less than 5) is interested in PGS-India certification and there is no group in the vicinity and no additional community members are ready to form a group, the individual producers can directly apply to the Regional Council for registration.

a) Make an application to available Regional Council with signed application form, pledge and assigned declaration stating their current inability to form a local group

b) Invite other PGS-India group members to endorse the application after physical visit to farm. In case if no PGS-India group is accessible then request the Regional Council to physically verify the farm

c) Obtain PGS-India operational guidelines and standards from nearby group or from RC

d) Request the RC to approve the registration and obtain user ID and password for PGS-India website.

e) Request the Peer appraisers of nearby group to physically inspect the farm and fill peer appraisal form. Filled peer appraisal farm to be submitted to Regional Council. In case if no group is close by then request RC to do physical inspection and grant certification.

f) Individual producer registration is an interim arrangement and the producer must initiate efforts to bringin other members from the village community to form the group in due course (maximum 2 years) and transform individual status to group status. In case if an individual farmer is unable to form a group even after 2 years, then Regional Council will attach the farmers with the nearest group.

Grant of Logo and Labelling: Grant of Logo and Labelling

Grant of Logo and unique certificate ID code

On getting approved from Regional Council, Local Group can use scope certificate for publicity, trade enquiry or for putting into trade literature and also can use the granted PGS logo. Scope certificate will have a unique number, identifying the RC and Local Group along with the farmers. Each certificate will also list out the area, crops and products certified during the year as Annexure. The packets or containers of PGS certified products along can be printed with PGS logo with UID code.

Logo on the product is required to be printed with the unique ID code. Consumers can access the authenticity of the certificate and name and address of the last end handler by entering the UID code in consumer verification window on PGS-India website. For traceability of the entire value chain consumers need to contact Regional Council along with UID code.

The right of use of Logo rests with the registered group, farmer, processing and handling operator. This right is not transferable unless the last point of value chain before the consumer is covered as part of the process of traceability and approved by the PGS-NEC along the structure of PGS-India.

Validity of Scope Certificate

The validity of scope certificate shall be12 months from the date of decision approval by the RC. Scope certificate shall be issued as per seasons (kharif, rabi and Zaid) subject to submission of timely peer appraisal summary sheets and other requirements such as group meetings and trainings.

Separate logo for PGS organic and PGS under conversion status

Two separate logos shall be granted for PGS organic and PGS under conversion as follows:

Conditions for use of logo

1. PGS certified products can be labeled with PGS logo, only when they are packed under the supervision of registered PGS operator (farmer group, certified farmers and off-farm processor.
2. Logois tobe used onlyon quantitycertified as per the detailsprovided in the scope certificate and yield/ production duly approved by the RC.
3. Use of logo without unique ID code is not allowed
4. Separate logos need to be used for organic and in-conversion products

Labelling

1. Single ingredient products may be labelled as "PGS-India Organic" when all standard requirements have been and certified.
2. Multi ingredient products where 100% of all ingredients are of organic origin, products may be labelled as “Organic” when all standard requirements have been met in respect of all ingredients and certified.

3. Multi ingredient products where not all ingredients, including additives, are of organic origin may be labeled in the following way:

- Where a minimum of 95% by weight of its ingredients of agricultural origin are organic including allowed additives, processing aids and preservatives (as allowed under Appendix 5 of NPOP), products may be labelled as"organic".

b. Where less than 95% but not less than 70% by weight of its ingredients of agricultural origin are organic, products may not be called "organic" and can only be labelled as "made with organic ingredients".

4. Labelling shall convey clear and accurate information on the organic status of the product.

5. Products granted with PGS-Organic certification shall use PGS-India organic logo.

6. Products under in-conversion to organic and granted with PGS-Green certification shall use PGS-Green logo. Such products shall not be claimed as organic and only the indication “Under Conversion to Organic” can be used.

7. The name and address of the company legally responsible for processing and packing shall be mentioned on the label.

8. Logo of the Government programme (such as PKVY of MOVCDNER etc.) may also be indicated on the label.

9. In addition, labeling shall comply all general and product specific requirements as prescribed under Food Safety and Standards (Packaging and Labelling) Regulation 2011 and Food Safety and Standard (Organic Produce) Regulation2017.

10. AllPGS-India certified products need to comply the general requirements of the FSSAIAct 2006 as notified from time to time by FSSAI.

Organic Food & FSSAI

“Organic food” means food products that have been produced in accordance with specified standards for organic food production. Food Safety and Standards Authority of India (FSSAI) is the food regulator in the country and is also responsible for regulating organic food in the domestic market and imports. According to FSSAI,’ organic agriculture’ is a system of farm design and management to create an ecosystem of agriculture production without the use of synthetic external inputs such as chemical fertilizers, pesticides and synthetic hormones or genetically modified organisms.

Existing Certification Systems

FSSAI had notified the existing certification system through Food Safety and Standards (Organic Foods) Regulations in 2017.

1) Participatory Guarantee System for India (PGS)
2) Third Party Certification-National Programme for Organic Production (NPOP)

Labelling Requirements for Domestic Trade

All products labelled as organic shall be required to be certified either under NPOP or PGS-India and shall bear logo of Jaivik Bharat (FSSAI organic food logo) alongwith the concerned certification programme logo as follows:

a) Products certified under PGS India

b) Products certified under NPOP India

Labelling on the package of organic food shall convey full and accurate information on the organic status of the product. Such product may carry a certification or quality assurance mark of one of the systems mentioned in regulation 4 in addition to the Food Safety and Standard Authority of India's organic logo. All organic foods shall comply with the packaging and labelling requirements specified under the Food Safety and Standards (Packaging and labelling) regulations, 2011 in addition to the labeling requirements under one of the applicable systems mentioned in regulations.

Chapter - 11

Value Chain Management: The COWBERRY Way

Kaushik Sonani
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Agriculture is adapted from the Middle English Latin word; agricultural (Ager 'Field' & Cultura 'Growing'). Usually, agriculture refers to the human activities. It is the most important key player in the Indian Economy as 60% of the population depends on agriculture directly or indirectly.

Role of Agriculture in the Indian Economy

The Indian economy is often referred to as an agro-economy. While there is a continuous decline in the agriculture sector, the service sector is improving. However, the majority of the population still depends on agriculture for their livelihood, playing a vital role in the Indian economy.

Here are some key points mentioning the role of agriculture:-

• **Contribution to India's GDP-** The agriculture sector is one of the main contributors to the country's GDP. It contributes about 29% to the Gross Domestic Product.

• **Increasing Employment Sector** - India's 54.6% of the total population is engaged in the agriculture sector in comparison with other developed nations.

• **Supply of essential food** - The agriculture sector in India provides essential goods to 121 crore people. These vital goods include wheat, rice, pulses, oil, and other staples necessary for daily life.

• **Supplier of raw materials to industries** - Most of the industries in India directly collect the raw material from the agriculture sector. In India, the industrial sector is highly dependent on the agriculture sector as 50% of their income is generated from agriculture-based industries.

Therefore, the Indian economy heavily relies on the agriculture sector. Besides supporting the economy, agriculture also aids the industrial sector and plays a crucial role in international trade, including imports and exports.

Challenges Faced by Farmers

Today, farmers face many challenges that affect their lives directly and indirectly. From post-harvest activities to getting inputs and marketing their products, farmers encounter numerous issues that often go unnoticed.

Some of the challenges which are faced by farmers:-

- Lack of access to credit
- Lack of infrastructure
- Lack of insurance
- Uncertain water rights and supply

- Lack of remunerative income
- Lack of knowledge
- Market price issues
- Marketing challenges
- Labor shortages

At COWBERRY, we help farmers overcome their challenges. Supply Chain Management and Value Chain Management will make farming easier and more efficient. By addressing the issues farmers face, COWBERRY ensures they can focus on farming without any worries.

What is Supply Chain Management?

The supply chain can be complex due to fragmented networks. Typically, it involves three main steps: moving goods from farmers to storage silos, from silos to processing plants, and from processing plants to customers. Each step involves several decisions. In simple terms, supply chain management focuses on organizing and managing the process of getting products from suppliers to consumers efficiently.

What is Value Chain Management?

Value chain management in agriculture involves overseeing every step needed to produce and deliver farm products. This means coordinating and improving each stage, from getting raw materials and seeds to growing, harvesting, marketing, and selling the products. By managing the value chain well, farms can become more efficient, cut costs, and make customers happier. In a more detailed view, value chain management looks at each farm individually, covering everything from planning and designing to acquiring supplies, producing the goods, marketing them, distributing them, and offering after-sale support.

Comparing Supply Chain and Value Chain

The Value Chain and Supply Chain are two important concepts in agriculture.
The value chain refers to the process where companies receive raw materials and add value to them through production, manufacturing, and other necessary steps to create a finished product. This finished product is then sold to consumers. In contrast, the supply chain encompasses all the steps required to get a product or service to the customer, often involving Original Equipment Manufacturers (OEM) and secondary markets. While the supply chain includes all parties involved in fulfilling customer requests and ensuring customer satisfaction, the value chain is a set of interrelated activities that a company uses to gain a competitive advantage.

Key Points on Value Chain

- Focuses on enhancing raw materials through production and other processes to create products for consumers, giving companies a competitive edge.
- Involves all necessary steps to deliver the product to the customer, ensuring overall satisfaction.
- The value chain boosts a company's competitiveness, the supply chain ensures the product reaches customers efficiently and meets their needs.

Benefits of Value Chain Management

Value chain management helps companies optimize every step of their manufacturing process. This approach can increase profits, improve efficiency, and enhance quality control. For farmers, using value chain management means better production and higher incomes. By carefully managing each part of the process, from sourcing raw materials to delivering finished products, farmers can grow more crops, raise healthier livestock, and reduce costs. This leads to increased productivity and allows farmers to earn more money from their efforts.

Here are some of the key benefits:

Improved Crop Productivity: By optimizing the production process, farmers can grow healthier and more abundant crops.

Enhanced Livestock Productivity: Better management practices lead to healthier animals and higher yields.

Increased Cropping Intensity: Farmers can grow more crops in a given period, maximizing land use.

Shift to High-Value Crops: Diversifying towards crops that bring higher profits can significantly boost farmers' income.

Higher Prices for Farmers: Efficient value chain management helps farmers get better prices for their produce compared to before.

Cost Savings: Streamlining operations reduces the cost of production.

Overall, these improvements not only enhance productivity but also have positive ripple effects on the larger agricultural ecosystem.

How COWBERRY Fits in and helps Farmers in this Value Chain Management

COWBERRY plays a crucial role in helping farmers optimize their value chain management, leading to increased productivity and higher incomes. We provide farmers with advanced techniques and tools to streamline their production processes, resulting in healthier and more abundant crops. Hereby we also ensure farmers have access to high-quality seeds, fertilizers, and other inputs. Additionally, COWBERRY also offers training and resources for better livestock management, leading to healthier animals and higher yields.

We motivate farmers to bend towards high-value crops which eventually bring them higher profits than before. This will eventually boost farmer's income and their financial stability. Similarly, COWBERRY'S efficient value chain management helps farmers get better prices for their produce grown with unmatchable hard work. It aims to bridge the gap between consumers and the source of their food, while securing livelihood for farmers through alternative markets and revenue models. Overall, we help farmers work more efficiently, improve the quality of their products, and increase their profits. This support leads to a more sustainable and productive agricultural system.

Conclusion

COWBERRY exemplifies how VCM can be effectively implemented in agriculture. By offering advanced tools, quality inputs, and expert guidance, COWBERY supports farmers in enhancing their efficiency and achieving better financial outcomes. This approach not only improves the quality and value of agricultural products but also contributes to a more sustainable and productive agricultural system. In essence, effective value chain management through initiatives like Cowberry's ensures that farmers can maximize their potential, resulting in a more robust and thriving agricultural industry.

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Chapter - 12

Schemes and Programs in India for Promotion of Natural Farming

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Abstract

India's natural farming schemes are vital for sustainable agriculture. By shifting from chemical-intensive practices to eco-friendly methods, these programs address critical issues like soil degradation and water scarcity. They empower farmers with knowledge and resources to adopt organic and regenerative approaches, boosting their incomes and resilience. These initiatives restore soil health, enhance biodiversity, and mitigate climate change impacts. Through infrastructure development and market support, they create a conducive environment for scaling up natural farming. Ultimately, these schemes contribute to a healthier, more sustainable food system. They offer farmers essential support, including training, financial assistance, and technical resources, which facilitate a smoother transition to sustainable practices. These schemes are vital for establishing a more sustainable agricultural system in India, ensuring the long-term health of farming communities, and safeguarding natural resources for future generations. Their comprehensive approach addresses both environmental and economic aspects, making them essential to the future of Indian agriculture.

Keywords: *Natural Farming, Natural Farming Schemes, PKVY, BPKP, NPOF*

Introduction

Schemes related to natural farming in India are crucial for addressing the challenges of conventional agriculture and promoting sustainable agricultural practices. As traditional farming methods face issues like soil degradation, water scarcity, and over-reliance on chemical inputs, these schemes offer essential support for transitioning to more sustainable practices. The need for such programs is underscored by the declining health of soils, increasing costs of chemical inputs, and the adverse environmental impacts of conventional farming. By promoting natural farming techniques, these schemes aim to restore soil fertility, reduce the ecological footprint, and enhance water conservation. They also provide farmers with the necessary training, financial support, and technical resources to adopt natural farming practices, ensuring a smoother transition from conventional methods. Furthermore, these programs contribute to the overall sustainability of agriculture by encouraging organic practices that reduce chemical residues in food, improve biodiversity, and mitigate climate change effects. The importance of these schemes is also evident in their role in enhancing farmer incomes by reducing input costs and creating opportunities for organic market access. Additionally, they support the development of local value chains, infrastructure, and certification processes, which are critical for the success and scalability of natural farming. Overall, these schemes are vital for fostering an agricultural system that is environmentally friendly, economically viable, and resilient, ultimately contributing to the long-term health of India's farming communities and ecosystems. India has initiated several schemes and programs to promote natural farming as part of its broader goal of sustainable agriculture. Natural farming, often synonymous with organic farming in this context, emphasizes minimal use of chemical inputs, relying instead on natural processes and traditional knowledge. Here is a comprehensive, detailed account of the key schemes and programs for promoting natural farming in India:

Paramparagat Krishi Vikas Yojana (PKVY)

Overview

Launched in 2015, PKVY aims to promote organic farming across India through the adoption of traditional practices. The scheme encourages farmers to form clusters and Organic Farming Producer Companies (OFPCs) to facilitate the adoption of organic farming techniques. By organizing farmers into clusters, providing financial and technical support, and emphasizing training, certification, and marketing, PKVY aims to transform traditional farming practices into profitable and environmentally sustainable ventures. The scheme has the potential to improve soil health, reduce dependency on chemical inputs, enhance farmer incomes, and promote overall agricultural sustainability.

Objective: The primary objective of PKVY is to promote organic farming practices and ensure the sustainability of agriculture. The program aims to increase soil fertility and productivity while reducing dependency on chemical fertilizers and pesticides.

Features:

Cluster Approach: The scheme emphasizes a cluster-based approach, where groups of farmers (minimum of 50 acres) are encouraged to adopt organic farming collectively. This helps in creating a contiguous belt of organic farms, making it easier to manage and market organic products.

Financial Assistance: Farmers receive financial assistance of INR 50,000 per hectare over three years. This assistance covers various expenses, including the cost of organic inputs, certification, and capacity building.

Training and Capacity Building: The scheme includes comprehensive training programs to educate farmers about organic farming techniques, certification processes, and marketing strategies.

Certification and Marketing Support: PKVY provides support for obtaining organic certification and helps in establishing market linkages to ensure farmers get a fair price for their produce.

Implementation:

- Farmers are organized into clusters, and a detailed project report is prepared for each cluster.
- The funds are disbursed in installments, with specific guidelines on how the money should be utilized.

Regular monitoring is conducted to ensure the effective implementation of the scheme. The progress of each cluster is evaluated periodically.

2. Bhartiya Prakritik Krishi Paddhati (BPKP)

Overview

The Bhartiya Prakritik Krishi Paddhati (BPKP) is a sub-scheme under the Paramparagat Krishi Vikas Yojana (PKVY) aimed at promoting traditional indigenous practices of natural farming, including Zero Budget Natural Farming (ZBNF). BPKP focuses on minimizing the use of chemical inputs and enhancing soil health through natural processes, thus ensuring sustainable and eco-friendly agricultural practices.

Objective: BPKP aims to promote traditional and indigenous agricultural practices that utilize natural inputs. The primary focus is on Zero Budget Natural Farming (ZBNF), which emphasizes minimizing the cost of production by using on-farm resources.

Features:

Zero Budget Natural Farming (ZBNF): ZBNF involves the use of locally available natural resources like cow dung, cow urine, jaggery, pulse flour, and other plant-based formulations. This reduces the dependency on external inputs and enhances soil health.

Capacity Building: The scheme provides extensive training and capacity building for farmers to adopt natural farming techniques. Workshops, field demonstrations, and exposure visits are organized regularly.

Financial Assistance: Financial support is provided for creating necessary infrastructure, procuring inputs, and capacity building.

Sustainable Practices: Emphasis is placed on sustainable practices like mulching, crop rotation, and intercropping, which improve soil fertility and biodiversity.

Implementation:

- Extensive training programs are conducted to educate farmers about ZBNF practices.
- Financial assistance is provided for setting up necessary infrastructure, including composting units, seed banks, and nurseries.
- Efforts are made to establish market linkages to ensure farmers can sell their produce at a premium price.

Bhartiya Prakritik Krishi Paddhati (BPKP) is a forward-thinking initiative aimed at promoting natural and traditional farming practices across India. By emphasizing the use of indigenous knowledge, natural inputs, and community-based approaches, BPKP seeks to transform Indian agriculture into a more sustainable and eco-friendly system.

3. National Mission on Sustainable Agriculture (NMSA)

Overview

The National Mission on Sustainable Agriculture (NMSA) is one of the eight missions outlined under the National Action Plan on Climate Change (NAPCC) by the Government of India.

Launched in 2014-15, NMSA aims to promote sustainable agriculture practices that enhance agricultural productivity, ensure food security, and mitigate the effects of climate change. The mission focuses on resource conservation, sustainable use of water and soil, and the promotion of agricultural practices that are resilient to climatic variability.

Objective: NMSA aims to promote sustainable agricultural practices that are climate-resilient. The mission focuses on enhancing soil health, water use efficiency, and overall productivity.

Features:

Agroforestry: NMSA promotes the integration of trees and shrubs into farming systems. Agroforestry helps in improving soil fertility, reducing erosion, and providing additional income to farmers through timber, fruits, and other tree-based products.

Soil Health Management: The mission emphasizes the use of organic and bio-fertilizers, green manuring, and vermicomposting to enhance soil health.

Water Management: Efficient water management practices like micro-irrigation, rainwater harvesting, and watershed development are promoted to ensure sustainable water use.

Integrated Farming Systems (IFS): IFS involves the combination of crops, livestock, and other enterprises to increase farm productivity and sustainability. This approach helps in diversifying income sources and reducing risk.

Implementation:

- NMSA is implemented through various sub-missions and schemes at the state level.
- Regular training programs and workshops are conducted for farmers on sustainable agricultural practices.
- Financial assistance is provided for adopting sustainable practices, creating infrastructure, and capacity building.

The National Mission on Sustainable Agriculture (NMSA) is a comprehensive initiative aimed at transforming Indian agriculture into a more sustainable, climate-resilient, and resource-efficient sector. By promoting practices like integrated farming, water management, soil health management, agroforestry, and organic farming, NMSA seeks to enhance agricultural productivity, ensure food security, and mitigate the impacts of climate change. While challenges exist, the mission's multi-faceted approach and focus on capacity building and technology adoption hold the potential to significantly contribute to the sustainable development of India's agricultural sector.

4. Rashtriya Krishi Vikas Yojana (RKVY)

Overview

Rashtriya Krishi Vikas Yojana (RKVY), also known as the National Agriculture Development Programme, was launched in August 2007 by the Government of India. The scheme aims to incentivize states to increase public investment in agriculture and allied sectors, ensuring comprehensive development and growth of these sectors. RKVY provides states with flexibility and autonomy in planning and executing agricultural projects based on their regional priorities.

Objective: RKVY aims to promote the overall development of agriculture and allied sectors by providing financial support to state governments for implementing innovative projects.

Features:

State-Specific Projects: RKVY allows states the flexibility to design and implement projects based on their local needs and priorities.

Promotion of Natural Farming: States can use RKVY funds to promote natural and organic farming practices, including the adoption of sustainable agricultural techniques.

Innovation and Technology: The scheme encourages the adoption of innovative technologies and practices to enhance agricultural productivity and sustainability.

Marketing Support: Support is provided for establishing market linkages and value addition to ensure farmers get a fair price for their produce.

Implementation:

- States submit detailed project reports, which are reviewed and approved by a central committee.
- Funds are allocated to states based on their agricultural growth rate and performance.
- Regular monitoring and evaluation are conducted to ensure the effective implementation of projects.

Rashtriya Krishi Vikas Yojana (RKVY) is a comprehensive and flexible scheme designed to drive agricultural growth and development across India. By providing states with the autonomy to plan and execute projects tailored to their specific needs, RKVY has been instrumental in increasing public investment in agriculture, enhancing productivity, and promoting innovation and entrepreneurship.

5. National Project on Organic Farming (NPOF)

Overview

The National Project on Organic Farming (NPOF) is an initiative by the Government of India aimed at promoting organic farming practices, ensuring the production of quality organic inputs, and fostering sustainable agriculture. Launched in 2004-05, NPOF is implemented by the National Centre of Organic Farming (NCOF) under the Ministry of Agriculture and Farmers Welfare. The project focuses on training, certification, research, and the production and promotion of organic inputs.

Objective: NPOF aims to promote the production and use of organic inputs to enhance soil health and agricultural productivity.

Features:

Bio-Fertilizer and Organic Fertilizer Production Units: The scheme supports the establishment of bio-fertilizer and organic fertilizer production units to ensure the availability of quality inputs for organic farming.

Organic Certification: NPOF supports the development of organic farming certification systems to ensure the credibility and marketability of organic produce.

Training and Awareness Programs: Extensive training and awareness programs are conducted for farmers, extension workers, and other stakeholders to promote organic farming practices.

Research and Development: The scheme supports research and development activities to improve organic farming techniques and develop new organic inputs.

Implementation:

- Financial support is provided for setting up production units and conducting training programs.
- Regular capacity-building programs are conducted to educate farmers about organic farming techniques.
- Efforts are made to establish market linkages to ensure farmers can sell their organic produce at a premium price.

The National Project on Organic Farming (NPOF) is a comprehensive initiative aimed at promoting organic farming practices and ensuring the availability of quality organic inputs in India. By focusing on capacity building, certification, research, and market development, NPOF seeks to enhance the sustainability of Indian agriculture and improve the livelihoods of farmers. Despite the challenges, the project's holistic approach and emphasis on organic farming hold significant potential for driving sustainable agricultural development in India.

6. Mission Organic Value Chain Development for North Eastern Region (MOVCDNER)

Overview

The Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) is a dedicated initiative by the Government of India aimed at promoting organic farming and creating a robust value chain for organic products in the North Eastern states. Launched in 2015, MOVCDNER focuses on developing organic farming practices, improving value addition, and enhancing market linkages for organic produce in the North Eastern region, which has significant potential for organic agriculture due to its favorable climatic conditions.

Objective: MOVCDNER aims to develop certified organic production in the North Eastern Region and create market linkages for organic produce.

Features:

Value Chain Approach: The scheme supports the entire value chain, from production to marketing, to ensure the sustainability of organic farming.

Farmer Producer Organizations (FPOs): Emphasis is placed on forming FPOs to collectively manage production, certification, and marketing of organic produce.

Capacity Building: Extensive training and capacity-building programs are conducted for farmers and FPOs on organic farming techniques and certification processes.

Market Linkages: Efforts are made to establish market linkages to ensure farmers get a fair price for their organic produce.

Implementation:

- Farmers are organized into clusters, and a detailed project report is prepared for each cluster.
- Financial assistance is provided for capacity building, certification, and marketing.
- Regular monitoring is conducted to ensure the effective implementation of the scheme.

The Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) is a focused initiative aimed at promoting organic farming and creating a robust value chain for organic products in the North Eastern states of India. By emphasizing production, processing, and marketing, along with infrastructure development and capacity building, MOVCDNER seeks to enhance the sustainability and profitability of agriculture in the region. Despite challenges, the mission's comprehensive approach and focus on organic agriculture have the potential to drive significant growth and development in the North Eastern region's agricultural sector.

7. Punjabrao Deshmukh Organic Farming Mission

The Punjabrao Deshmukh Organic Farming Mission (PDOFM) is a significant state-driven initiative by the Government of Maharashtra, aimed at fostering the adoption and promotion of organic farming practices. Named in honor of Punjabrao Deshmukh, a prominent agricultural leader and reformer, the mission focuses on transforming Maharashtra’s agricultural landscape by encouraging sustainable, chemical-free farming. The mission seeks to improve soil health, boost farmer incomes, and develop a robust organic farming sector.

Objectives

Promote Organic Farming: PDOFM aims to increase the adoption of organic farming techniques among Maharashtra’s farmers. The goal is to reduce reliance on chemical inputs and enhance soil health through sustainable agricultural practices.

Support Farmers: The mission provides comprehensive support to farmers transitioning to organic farming, including financial assistance, technical guidance, and infrastructure development.

Develop Market Linkages: It seeks to create effective marketing channels for organic products, ensuring better market access and increased profitability for farmers.

Enhance Soil Health and Productivity: By encouraging the use of organic inputs and methods, the mission aims to improve soil fertility and overall crop productivity.

Key Components

1. Training and Capacity Building

Farmer Education: PDOFM organizes extensive training programs and workshops to educate farmers on organic farming techniques. These sessions cover various aspects such as soil management, pest control, crop nutrition, and the use of organic inputs.

Extension Services: The mission provides ongoing technical support and extension services to assist farmers in implementing and maintaining organic practices. This includes field demonstrations and advisory services tailored to local conditions.

Financial Assistance

Subsidies for Organic Inputs: The mission offers financial support for purchasing organic inputs, including bio-fertilizers, compost, and bio-pesticides. This assistance helps offset the costs associated with transitioning to organic farming.

Certification Support: Financial aid is provided for organic certification under the National Program for Organic Production (NPOP) and Participatory Guarantee System (PGS). Certification is crucial for accessing organic markets and ensuring product quality.

Infrastructure Grants: PDOFM supports the development of infrastructure related to organic farming, such as processing units, storage facilities, and transportation networks. This infrastructure is essential for maintaining the quality of organic produce and facilitating market access.

Organic Input Production

Production Units: The mission supports the establishment of units for producing organic inputs like vermicompost and bio-fertilizers. These units help ensure a steady supply of quality inputs for farmers.

Input Supply: PDOFM facilitates the availability of organic inputs through subsidies and support programs, making it easier for farmers to access the resources needed for organic farming.

Certification and Compliance

Certification Assistance: The mission aids farmers in navigating the certification process, ensuring that their farms meet organic standards. This support includes guidance on documentation and compliance requirements.

Awareness Programs: PDOFM conducts awareness programs to educate farmers about the benefits of certification and the steps involved in obtaining and maintaining it.

Market Development

Market Access: The mission helps develop marketing channels for organic products, including organic farmers' markets and direct-to-consumer sales. These channels provide farmers with better market access and higher prices for their produce.

Branding and Promotion: PDOFM supports the branding and promotion of organic products to increase their visibility and appeal to consumers. Effective branding helps differentiate organic products in the marketplace and boosts consumer confidence.

Research and Development

Research Projects: The mission funds research on organic farming practices, crop varieties, and pest management strategies suited to Maharashtra's diverse agricultural conditions.

Innovation: PDOFM encourages the adoption of innovative technologies and practices in organic farming, helping farmers stay ahead of emerging trends and challenges.

Infrastructure Development

Processing Facilities: Support is provided for establishing agro-processing units that add value to organic products. These facilities help in processing, packaging, and marketing organic produce.

Storage and Transportation: PDOFM aids in the development of infrastructure for the storage and transportation of organic products, ensuring that they reach the market in optimal condition.

Implementation

- The mission is coordinated by the Maharashtra State Agriculture Department, with collaboration from local agricultural universities, research institutions, and non-governmental organizations (NGOs). These stakeholders play a crucial role in implementing the mission's activities, providing technical support, and facilitating farmer engagement.
- The Punjabrao Deshmukh Organic Farming Mission is a pivotal initiative in Maharashtra's agricultural development, promoting sustainable and organic farming practices. By offering comprehensive support through training, financial assistance, certification, and market development, the mission aims to transform Maharashtra's agricultural sector. Despite challenges, the mission's holistic approach and focus on organic farming provide a strong foundation for enhancing agricultural sustainability and improving the livelihoods of farmers.

8. Jaivik Kheti Portal

Overview

The Jaivik Kheti Portal is an initiative by the Government of India aimed at promoting and supporting organic farming practices across the country. Launched as part of the National Project on Organic Farming (NPOF), the portal serves as a comprehensive digital platform to facilitate various aspects of organic farming, including knowledge dissemination, certification, and market access. The portal is designed to provide farmers, stakeholders, and consumers with valuable information and resources related to organic agriculture.

Objectives:

- To provide a centralized platform for information and resources on organic farming.
- To facilitate the organic certification process and ensure compliance with organic standards.
- To promote the use of organic inputs and practices among farmers.
- To enhance market access and visibility for organic products.
- To support research, innovation, and capacity building in organic farming.

Features:

E-Commerce Platform: The portal acts as an e-commerce platform for organic products, facilitating direct marketing between farmers and consumers.

Information Dissemination: The portal provides information on organic farming practices, certification processes, and market trends.

Market Linkages: Efforts are made to establish market linkages to ensure farmers can sell their organic produce at a premium price.

Implementation:

- The portal is managed by the Ministry of Agriculture and Farmers' Welfare, integrating various stakeholders in the organic farming value chain.
- Regular training programs are conducted to educate farmers about using the portal and marketing their produce.

The Jaivik Kheti Portal is a crucial initiative aimed at supporting the growth and development of organic farming in India. By providing a centralized platform for information, certification, market access, and capacity building, the portal seeks to enhance the adoption of organic practices and improve the livelihoods of farmers.

Organic Certification

Organic certification in India ensures that agricultural products adhere to specific organic standards, allowing consumers to trust that what they are buying is truly organic. Here's a detailed look at the major organic certification schemes in India:

1. National Program for Organic Production (NPOP)

Overview: The National Program for Organic Production (NPOP) is the primary certification scheme for organic agriculture in India. Established by the Ministry of Commerce and Industry, it provides a comprehensive framework for organic farming, processing, and trading.

Key Features:

Standards: NPOP outlines detailed standards for organic farming, including soil management, pest control, crop production, and prohibited substances. It covers both crop and livestock production, as well as organic processing and labeling.

Certification Bodies: NPOP includes a list of accredited certification bodies that are authorized to certify farms and processing units according to its standards. These bodies conduct inspections, audits, and provide certification services.

Certification Process: The process involves:

- **Application:** Farmers or producers apply for certification through accredited bodies.
- **Documentation Review:** Certification bodies review records related to production practices, inputs, and handling procedures.
- **Inspection:** An on-site inspection is conducted to verify compliance with organic standards.

- **Certification Decision:** Based on the inspection and documentation, a certification decision is made.
- **Renewal:** Certification is valid for a specified period, usually one year, after which renewal is required.

Benefits:

International Recognition: NPOP certification is recognized internationally, facilitating exports to global markets.

Consumer Trust: Ensures that products meet rigorous organic standards, enhancing consumer confidence.

2. Participatory Guarantee System (PGS)

Overview: The Participatory Guarantee System (PGS) is a community-based certification system managed by the Ministry of Agriculture and Farmers Welfare. It provides an alternative to the NPOP system, focusing on local and small-scale farmers.

Key Features:

Community-Based: PGS relies on peer reviews and inspections conducted by farmer groups and local communities rather than formal certification bodies.

Certification Process: Involves:

Self-Assessment: Farmers conduct a self-assessment of their practices.

Peer Reviews: Other members of the PGS group review and verify practices.

Group Inspections: Regular inspections are conducted by the group to ensure compliance.

Standards: PGS standards are aligned with NPOP but adapted to be more accessible and feasible for small-scale farmers.

Benefits:

Cost-Effective: Lower costs and simplified procedures compared to NPOP certification.

Local Focus: Strengthens local organic farming communities and promotes local markets.

Conclusion

The promotion of natural farming practices in India is supported by a range of schemes and programs aimed at ensuring environmental sustainability, economic viability, and social acceptability. These initiatives focus on reducing the cost of production, enhancing soil health, and providing better market opportunities for farmers. By adopting natural farming practices, farmers can achieve sustainable agricultural development while protecting the environment and ensuring food security for future generations.

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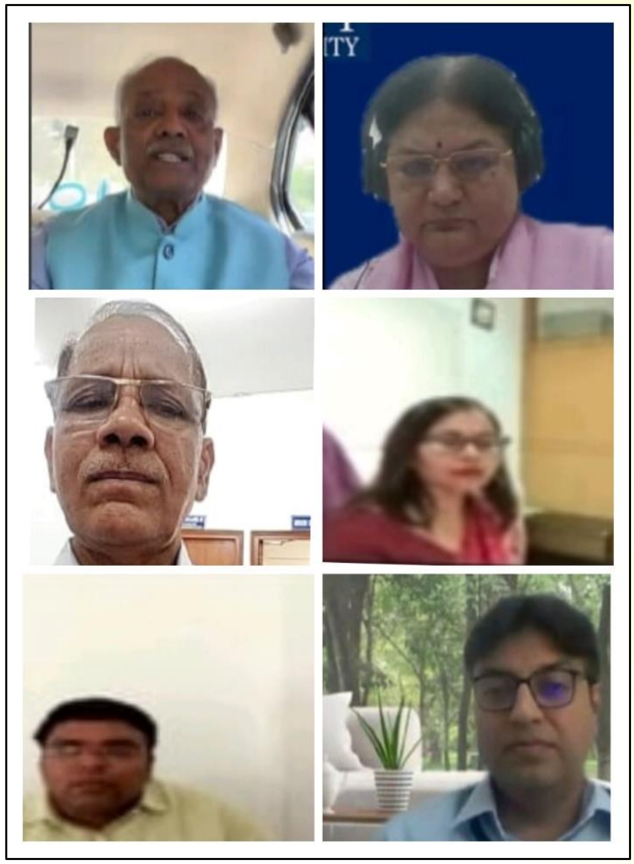
Photographs of dignitaries and speakers during training programme on

"Natural Farming for One Health"



Natural Farming for One Health

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