

ENHANCING SUSTAINABLE AGRICULTURE AND LIVELIHOODS THROUGH INTEGRATED ORGANIC FARMING SYSTEMS (IOFS) IN NORTHEAST INDIA

Abstract

The North East region of India stands out with its significant potential for organic farming due to indigenous knowledge and a tradition of sustainable agricultural practices. The adoption of IOFS, which merges diverse farming components, offers a holistic and comprehensive strategy to improve livelihoods and ecological well-being. The cluster approach to introducing IOFS in Meghalaya demonstrates the importance of community involvement and local adaptation. Farmers are educated through training sessions and workshops, enhancing their understanding of integrated organic farming techniques, soil health management, and livestock care. The core principles of IOFS emphasize enhancing soil health, biodiversity, and resource use efficiency. By integrating crop and livestock systems, organic matter recycling, and agroforestry, IOFS enhances soil fertility, minimizes external input dependency, and promotes climate resilience. This approach also addresses challenges such as yield variability and labor intensity. However, its implementation requires farmers to navigate a learning curve and overcome initial investment barriers. The IOFS model's impact on the village and farming systems underscores its potential to improve agricultural sustainability, food security, and livelihoods in the North East region. In conclusion, the transition from traditional organic farming to the Integrated Organic Farming System (IOFS) in the North East region of India presents a promising avenue for sustainable agricultural development. The integration of diverse components offers a holistic approach to enhance

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productivity, resource use efficiency, and climate resilience. While challenges exist, the case study from Meghalaya demonstrates the positive outcomes of adopting IOFS, emphasizing its potential to improve livelihoods and ecological well-being in the region.

Keywords: Agriculture and Livelihoods
Organic Farming Systems

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I. INTRODUCTION

India's distinctive position is evident as it hosts 30% of the world's organic producers with an area of 2.30 million hectares. According to the FIBL Survey of 2021, India ranks 6th globally in terms of organically cultivated area. The northeastern region of India shows great potential for organic farming, with states traditionally practicing either by default or compulsion. Organic farming is a sustainability prioritizing agricultural approach that relies on natural ways to manage soil fertility, pests and diseases and promote harmony between the different components of the ecosystem. This approach ensures production without harming the environment, avoiding synthetic chemicals, pesticides, GMOs, and other harmful substances. Diverse forms of organic farming are practiced across the northeastern region (NER) of India, spanning various agro-climatic conditions, particularly in rainfed, mountainous, hilly, and tribal areas. The NER has a total of 118,084 hectares under organic certification (Yadav, 2017).

India's rural economy relies on small and marginalized farmers, constituting 85% of the farming community, including those in the northeast. Despite efforts, these farmers struggle due to limited surplus after covering expenses like seeds, fertilizers, labor, etc. Also, the prevailing cropping system followed by most of the marginal and small farmers in the NER, India is monocropped cereal-based, primarily rice-fallow. This should be replaced with legume or pulses-based systems that can sustain productivity under organic practices (Das et al., 2017b; Babu et al., 2020; Singh et al., 2021a) and to meet essential needs such as food, feed, fiber, and fuel, introduction and adoption of integrated farming systems (IFS) are crucial. Integrated Farming System (IFS) offers an alternative approach to support small-scale farming and enhance viability compared to larger farming systems. Organic farming aligns with the goal of agricultural sustainability, meeting present needs without compromising future requirements (The Brundtland Report, 1987) and promoting organic farming techniques can improve soil quality, microbial diversity, and nutrient cycling (Reeve et al., 2010).

Leveraging the traditional methods of organic farming in northeast India, Integrated Organic Farming System (IOFS) models can be developed. These models involve various crops, livestock, and nutrient recycling, especially beneficial for small and marginal farmers. IOFS diminishes the need for external inputs like chemical fertilizers and pesticides, resulting in decreased production expenses and minimizes adverse environmental consequences linked with chemical inputs. This comprehensive approach thus can be very essential to fulfill their everyday dietary and nutritional needs while also generating marketable surplus in a sustainable manner.

II. COMPONENTS OF ORGANIC FARMING

The primary elements of organic agriculture include biological nitrogen fixation, crop rotation, crop residues, organic pesticides, and biogas. The major components constituting organic agriculture are outlined below.

Table 1: Building Elements of Organic Farming

Building Elements	Role and Impacts	References
Crop Rotation	(i) Control on weeds and crop diseases (ii) Fertility maintenance for soils (iii) Improve soil stability (iv) Soil environment that promotes biotic-abiotic interactions (v) Water and soil contamination are reduced	Kumar et al., 2019
Organic and Crop Residue	(i) Regulation of soil temperature (ii) Helps mineralize insoluble plant minerals (iii) Assist soil microbes in obtaining carbon	Mishra et al., 2013
Organic Manure	(i) Supply nitrogen to crops (ii) Fertility and structure of the soil can be improved (iii) Higher essential nutrients for plant growth	Bullock, 1992
Bio-fertilizers	(i) Regulate nutrient balance of soil (ii) Conversion of insoluble phosphate in soluble forms	Han et al., 2016

Source: Mukherjee et al., 2022

Table 2: Comparisons between Organic and Conventional Farming

Particulars	Organic farming	conventional farming
1. Dependency on Inputs	Aims to decrease reliance on external inputs by emphasizing self-sustaining practices such as organic matter recycling.	Often relies on purchased synthetic inputs, leaving farmers vulnerable to fluctuating costs.
2. Resource Distribution	Spreads resources across various methods like crop rotation, composting, and natural pest control, promoting a balanced ecosystem.	Concentrates on a centralized approach, using synthetic inputs for maximum yield from specific crops.
3. Relationship with Nature	Seeks harmony with nature, striving for sustainable production with minimal harm to the environment.	Prioritize immediate high output, sometimes leading to practices that harm the environment over time.
4. Land Degradation	Places emphasis on harnessing natural resources to enrich soil health. Strategies like crop rotation, cover cropping, and	Often relies on synthetic chemicals, such as artificial fertilizers and pesticides. This dependency can lead to soil deterioration over time, including diminished microbial

	composting are employed to enhance soil structure, fertility, and water retention.	activity and soil erosion.
5. Nutrient Enrichment	Often yield more nutritious and wholesome crops. The emphasis on nurturing soil health and biodiversity contributes to elevated levels of vitamins, minerals, and antioxidants in harvested produce.	Compromise nutrient quality in crops due to the heavy reliance on synthetic inputs, potentially leading to nutrient-deficient or chemically-contaminated crops.
6. Environmental Influence	Aligns with ecological equilibrium, emphasizing sustainable practices that synergize with the environment. The decreased use of chemicals and soil conservation efforts contribute to the protection of water bodies, air quality, and overall ecosystem stability. Organic farming maintains a smaller carbon footprint, nurtures soil health, revitalizes ecosystems for cleaner water and air, and avoids the presence of toxic pesticide residues.	Marked by intensive chemical use, can contribute to water and air pollution through pesticide runoff and drift, potentially disrupting local ecosystems. Conventional farming contributes to elevated greenhouse gas emissions, soil erosion, water contamination, and health hazards.
7. Health Assurance	Prioritize the well-being of all ecosystem components, including humans. Reduced reliance on synthetic chemicals leads to lower chemical residues in organic produce, potentially positively impacting human health.	Raises concerns about food safety through application of synthetic pesticides and herbicides. Chemical residues could accumulate in crops, potentially posing risks to consumer health.
8. Agricultural Practices	Often embraces a comprehensive approach, integrating diverse farming methods. Crop diversity, agroforestry, and integrated pest management collectively contribute to a resilient and sustainable agricultural system.	Often centers on maximizing crop yield, which can lead to monoculture systems vulnerable to pests, diseases, and market fluctuations.

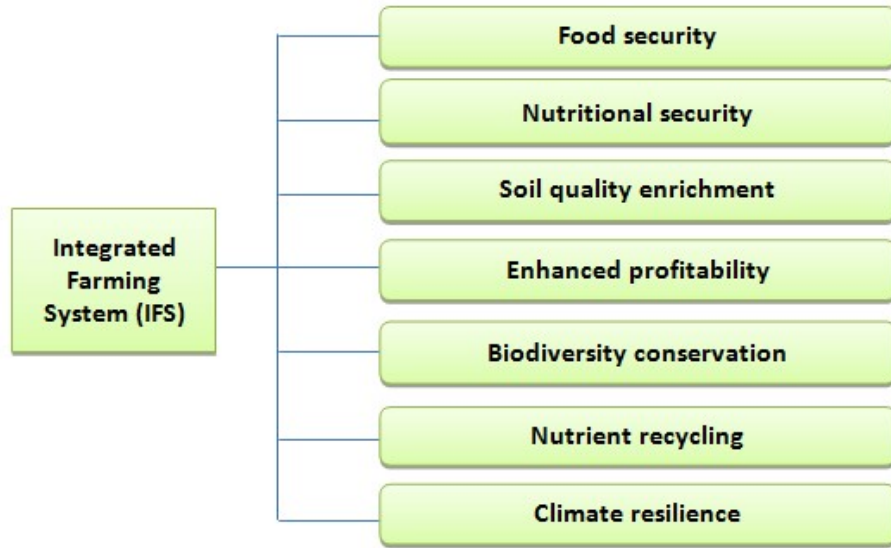
Table 3: Advantages and disadvantages of integrated organic farming systems (IOFS)

S.No.	Advantages	Disadvantages
1	Enhanced Soil Health: IOFS enriches soil by adding organic matter, reducing tillage, and employing cover cropping, which enhances nutrient availability, soil structure, and microbial activity.	Complexity: Managing interactions among crops, livestock, and ecology can be complex, demanding ecological knowledge and system fine-tuning.
2	Biodiversity and Pest Management: Diverse crops and livestock foster a balanced ecosystem, promoting natural pest control and reducing the need for chemical pesticides.	Labor-Intensive: IOFS practices can be labor-intensive, potentially increasing costs and posing challenges in labor-short or high-cost regions.
3	Reduced Chemical Inputs: By minimizing chemical usage, IOFS improves food safety, human health, and reduces environmental impacts.	Yield Variability: IOFS relies on natural processes and fewer external inputs, resulting in yield variability due to weather, diseases, and pests.
4	Sustainability: IOFS minimizes waste, optimizes resources, and creates a closed-loop system, promoting long-term farming sustainability.	Learning Curve: Farmers transitioning to IOFS require knowledge of organic management, ecology, and innovative techniques, affecting initial productivity.
5	Resilience to Climate Change: IOFS practices like agroforestry and conservation tillage enhance climate resilience.	Market Challenges: IOFS may face market restrictions, costly certification, and uncertain price premiums, impacting farmers' competitiveness.

III. FARMING SYSTEM AND INTEGRATED FARMING SYSTEM (IFS)

A farming system refers to a complex interplay of various agricultural activities, practices, and components within a specific ecological, socio-economic, and cultural context. It involves the integration of crops, livestock, forestry, and other agricultural enterprises to achieve sustainable production, enhance livelihoods, and optimize resource utilization (Norman, 2002). Farming systems approach takes into account the interactions between different components of the farming system and aims to create a holistic and efficient agricultural production system (Garrity et al., 2010).

Integrated farming systems (IFS) entail a holistic approach to farming aimed at meeting the multiple demands (impart farm resilience, farmer livelihoods, food security, ecosystem services, and making farms adaptive and resilient, etc.). IFS are characterized by temporal and spatial mixing of crops, livestock, fishery, and allied activities in a single farm (Paramesh et al., 2022).



IV. INTEGRATED ORGANIC FARMING SYSTEM (IOFS)

Integrated Organic Farming System (IOFS) is a holistic and sustainable agricultural approach that combines various farming components to optimize resource utilization, enhance farm productivity, and promote environmental stability (Layek et al., 2023). IOFS typically involves integrating crops, livestock, agroforestry, and other components to create a self-sustaining and diverse farming system. The concept of IOFS is built upon the foundations of organic farming and integrated farming systems.



- 1. A Shift from Organic Farming System to Integrated Organic Farming System (IOFS):** The origin of Integrated Organic Farming System (IOFS) can be traced back to the broader evolution of organic farming practices and the recognition of the need for integrated and holistic approaches to agricultural production. While there might not be a single point of origin for IOFS, its development is influenced by the evolution of organic farming practices and the recognition of the benefits of integrated approaches (ICAR-National Institute of Agricultural Economics and Policy Research, 2018). IOFS combines various organic farming practices to create a synergistic system that enhances sustainability, productivity, and environmental conservation. The shift from organic farming systems to integrated organic farming systems (IOFS) in the present represents a transition towards a more holistic and comprehensive approach to agricultural production. Integrated organic farming systems go beyond the boundaries of traditional organic farming by incorporating various agricultural components, such as crops, livestock, agroforestry, and more, in a synergistic manner (Panwar et al., 2018). This shift is driven by the need to enhance sustainability, productivity, and resource efficiency while maintaining the core principles of organic agriculture.

2. Scope of Integrated Organic Farming System (IOFS) in India

- **Sustainable Agriculture:** IOFS promotes sustainable agricultural practices by reducing the reliance on synthetic inputs, improving soil health, and enhancing biodiversity. It aims to minimize negative environmental impacts while increasing productivity.
- **Improved Soil Health:** Organic farming practices like composting, green manuring, and crop rotation enhance soil fertility, structure, and microbial diversity, leading to improved soil health and long-term productivity (Kaur and Choudhary, 2019)
- **Diversification of Income:** Integrated organic farming systems include multiple components like crop cultivation, animal husbandry, and agroforestry, providing farmers with diversified income sources and reducing risks associated with single-crop dependence.
- **Resource Use Efficiency:** The integration of livestock and crop components in IOFS leads to efficient recycling of nutrients and organic matter, reducing the need for external inputs and minimizing waste (Das et al., 2019)
- **Climate Resilience:** Organic farming practices adopted in IOFS, such as cover cropping and reduced tillage, contribute to climate resilience by improving water retention, reducing erosion, and enhancing carbon sequestration in soils.
- **Market Demand for Organic Produce:** The increasing demand for organic produce in both domestic and international markets provides economic incentives for farmers to adopt integrated organic farming practices.

V. PRESENT SCENARIO OF INTEGRATED ORGANIC FARMING

Organic farming has witnessed significant growth in terms of cultivated area and the number of certified organic producers across the world. Organic farming is implemented across 187 nations, and a total of 72.3 million hectares of agricultural land are cultivated using organic methods, involving no less than 3.1 million farmers in 2019 (Source: FAO, 2021). The demand for organic products has risen due to consumer preferences for healthier and more environmentally friendly options. This has led to the expansion of the organic market and trade both within countries and internationally. In the year 2021, approximately 2.66 million hectares of agricultural land in India were dedicated to organic cultivation. According to the provided data, India secured the 6th spot in the global ranking for organic agricultural land and achieved the top position for the total count of producers as of 2021 (Source: FIBL, 2023).

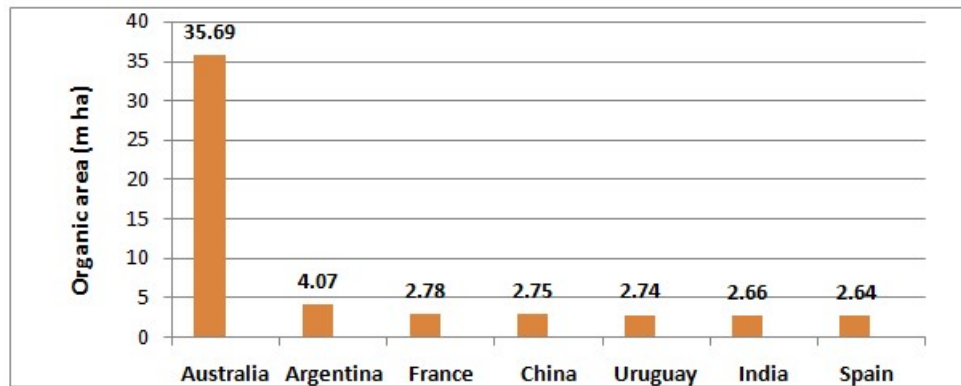


Figure 1: World countries with largest organic agricultural area, 2021

The potential for organic farming production in the North-East region of India is tremendous. Additionally, this area accounts for the highest number of organic producers characterized by their small land holdings that have been practicing organic agriculture traditionally either by default or compulsion. Traditional organic farming methods in Northeast India draw from indigenous knowledge and practices that have been passed down through generations. These methods emphasize sustainable and ecologically balanced agricultural practices. A few examples of such practices in Northeast India include jhum cultivation/ shifting cultivation or slash-and-burn farming, fish-rice Integration, use of indigenous seeds, community forest management etc.

1. Package of Practices Followed in IOFS

- Selection of Cropping System:** To ensure sustained productivity in organic farming, shifting from a cereal-based cropping system to one that incorporates legumes is imperative one (Das et al., 2017b; Babu et al., 2020b, Singh et al., 2021a). The choice of a suitable cropping system in organic agriculture hinges on factors like climate, soil quality, crop rotation, and market demand. To make informed decisions, consider the local climate and soil conditions, select crops well-suited to your region's climate and soil, implement crop rotation for soil health and pest control, explore companion planting, seek guidance from local experts and experienced farmers, prioritize crops with stable market demand, adhere to sustainable organic farming practices, and stay updated on research for region-specific crop varieties and practices (NCAT, 2020).
- Selection of Cultivars:** Crop selection should be based on regional demand, focusing on organic production of crops like Joha rice, medicinal rice, pineapple, passion fruit, ginger, large cardamom, and medicinal plants with prioritizing location-specific varieties and certified organic seeds. More emphasis should be given upon natural pest-resistant varieties, sustainable practices like crop rotation, green manuring, and mulching. Use of high-quality seeds from reliable sources with organic seed treatments like cow dung and neem seed powder are essential, and must strictly avoid genetically engineered materials (Munda et al., 2014).

- Field Preparation:** The field is plowed to achieve optimal soil texture, referred to as "tilth." During field preparation, it is essential to mix thoroughly decomposed organic materials into the soil. This can involve incorporating farmyard manure (FYM) at a rate of 10 to 15 tons per hectare or vermicompost at a rate of 2.5 to 5 tons per hectare. This practice is crucial for enhancing soil fertility and promoting sustainable farming practices (Magdoff and Van 2000).
- Nutrient Management:** Integrated Organic Nutrient Management (IONM) combines organic sources to sustainably meet nutrient needs, vital for soil structure, microbial activity, and nutrient availability. This approach fosters crop, livestock health, and economic agricultural yields (Watson et al., 2002). Organic amendments such as untreated wood sawdust, calcified seaweed, limestone, and rock phosphate address nutrient deficiencies and soil acidity. Biofertilizers like Rhizobium, Azotobacter, Azospirillum and Azolla, phosphate-solubilizing bacteria and fungi, as well as Vesicular/Arbuscular Mycorrhiza (VAM/AMF) aid nutrient management. Green manuring with crops like sunhemp (*Crotalaria juncea*), dhaincha (*Sesbania bispinosa*), barseem (*Trifolium alexandrinum*), cowpea, and others (Rana et al., 2014) enriches soil fertility. botanical extracts stimulate growth and act as biopesticides. Composting practices, including vermicomposting and the use of animal manures, recycle organic materials. Sprays like beejamrut and panchagavya boost crop health during growth. These organic methods promote sustainable farming while nurturing soil and plant vitality.

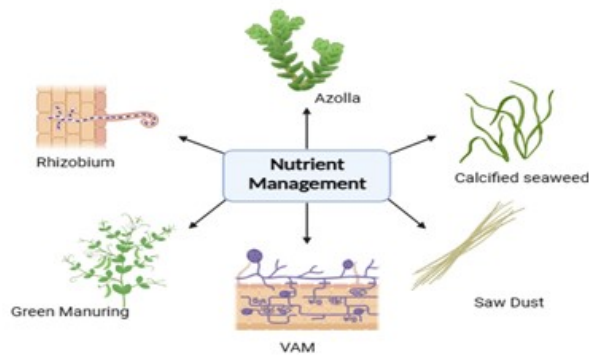


Figure 3: an Approach to Integrated Organic Nutrient Management

- Weed Management:** Weed management is a significant challenge in high-rainfall regions of North East India (NER) under organic farming systems (Singh et al., 2016). Effective weed control in organic agriculture relies on various natural and sustainable approaches:

2. Cultural Practices

- Crop Rotation:** Rotating crops disrupts weed life cycles and reduces weed pressure (Magdoff and Van 2000).

- **Cover Cropping:** Planting cover crops between cash crops suppresses weeds and improves soil health (Creamer 2002).
- **Mulching:** Using organic mulches like straw or wood chips smothers weeds and hinders their growth (Worthington and Reberg-Horton 2013).

3. Mechanical Weed Control

- **Hoeing and Tilling:** Hand or mechanical hoeing and tilling physically remove weeds (Ghaley and Edwards 2004).
- **Bioherbicides:** Eco-friendly weed control methods derived from natural sources, such as microorganisms and plant extracts, offer sustainable alternatives to synthetic herbicides (Duke et al., 2000).
- **Hand Weeding:** Although labor-intensive, manually removing weeds from the field is effective.

VI. INTEGRATED WEED MANAGEMENT (IWM):

IWM integrates cultural practices like crop rotation, mulching, and cover cropping with mechanical techniques like hoeing and tilling. It also incorporates biological control using natural predators and selective organic or chemical herbicide application when necessary. This holistic approach efficiently reduces weed pressure while promoting sustainable weed control in an environmentally conscious manner (Smith et al., 2017).

1. **Pest and Disease Management:** Managing pests and diseases in organic farming requires a holistic and integrated approach that relies on natural and sustainable methods.

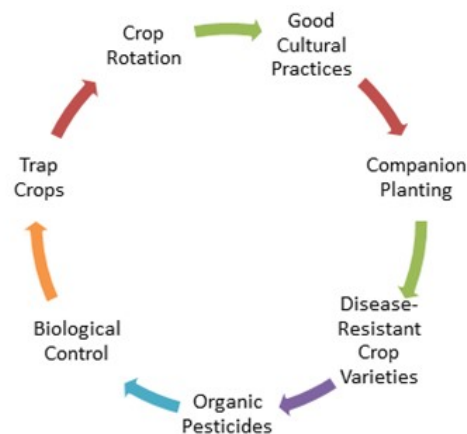


Figure 4: Pest and Disease Management under Organic IOFS

- **Crop Rotation:** Crop rotation disrupts pest and disease life cycles by changing the crop grown in a specific area each season. This practice can reduce pest and disease pressure (Magdoff and Van 2000).

- **Companion Planting:** Planting certain crops together can deter pests or attract beneficial insects. For example, marigolds can deter nematodes, and planting basil near tomatoes can deter aphids (Alteri 1999).
- **Organic Pesticides:** Organic-approved pesticides derived from natural sources, such as neem oil or diatomaceous earth, can be used when other methods are insufficient (Isman 2006).
- **Disease-Resistant Crop Varieties:** Planting disease-resistant crop varieties can reduce the risk of disease outbreaks (Mundt 2002).
- **Good Cultural Practices:** Practices like proper spacing, irrigation management, and maintaining soil health can reduce disease incidence (Belanger et al., 2002).
- **Biological Control:** Introducing natural predators, parasites, or pathogens of pests can help control their populations. For example, releasing ladybugs to control aphids (Gurr et al., 2004).
- **Trap Crops:** Planting specific crops that pests prefer as sacrificial crops can divert pests away from the main crop (Shelton et al 2003).

VII. IOFS PRACTICED IN NORTH EAST INDIA: SUCCESS STORIES

The Integrated Organic Farming System (IOFS) practices in North East India integrate various agricultural components to establish a sustainable and regionally suitable approach. Traditionally, Jhum farmers in the area have relied on natural soil fertility enriched by organic matter decomposition and microbial activity. While these practices have deep historical roots, they've yielded limited productivity and income. States like Meghalaya, Assam, Nagaland, and Mizoram are actively advancing organic agriculture.

The North East is becoming a hub for organic farming, with states like Sikkim and Arunachal Pradesh making significant strides. Sikkim achieved certification of all its agricultural production as organic, setting international standards, and others are following suit. The region's uneven development, once viewed as a drawback, now works to its advantage. The North East resisted the green revolution's use of chemicals and hybrid seeds, maintaining traditional farming practices, essentially making it "organic by default." This shift towards organic farming is gaining popularity in the North East, with multiple states actively endorsing and adopting these practices (Singh et al., 2021). The tables below detail the extent of land dedicated to organic farming and the resulting organic yield in the region.

Table 3: Area under Organic Certification Process in North-Eastern Region Of India (2022-2023)

State	Organic area (ha)	In conversion area (ha)	Total farm area (ha)
Arunachal	3109	9773.68	12882.68

Pradesh			
Assam	15593.93	7473.49	23067.42
Manipur	7682	3003.50	10685.50
Meghalaya	21652.71	2356.33	24009.04
Mizoram	4796.84	15264.10	20060.94
Nagaland	7550.61	5002.56	12553.17
Sikkim	75453.18	22.096	75475.28
Tripura	2490.13	17124.31	19614.44
Total	138328.4	60020.066	198348.466

Source: <https://apeda.gov.in/apedawebsite/organic/data.htm>

Table 4: Organic Production in North-Eastern Region of India (2022-2023)

State	Organic production (MT)	Conversion production (MT)	Total production (MT)
Arunachal Pradesh	793.00	0.00	793.00
Assam	14497.86	0.00	14497.86
Manipur	11.00	0.00	11.00
Meghalaya	9919.69	0.00	9919.69
Mizoram	334.00	0.00	334.00
Nagaland	-	-	-
Sikkim	51.90	0.00	51.90
Tripura	332.78	216.04	548.81
Total	25940.23	216.04	26156.26

The North East India region possesses a wealth of ancestral wisdom pertaining to enduring agricultural techniques. The indigenous organic farming methodologies in this area are intricately intertwined with the customary wisdom, methodologies, and ecological discernment of its varied indigenous communities. These agricultural systems have progressively developed through generations, attuning to the exceptional climatic, geographical, and cultural attributes of the region (Das et al., 2012). Given the diverse

ecological panorama, the local traditional knowledge, and the distinct challenges, a range of typical Integrated Organic Farming System (IOFS) practices have been put into action in North East India.

Table 5: Prominent Traditional Agricultural Systems within North East India and Their Distinctive Attributes

Farming systems	States	Resource conservation methods followed	Crop productivity (t ha⁻¹)
Panikheti system of rice cultivation	Nagaland, Sikkim and Manipur	Creating terraces, channeling water from hills to these terraces, utilizing green leaf manure, and managing on-site crop residues	Rice- 2.5 - 3.0
Apatani method of rice cultivation	Apatani plateau of Arunachal Pradesh	Integration of rice, fish, and red algae; strategies for conserving soil and water; management of crop residues on-site	Rice- 4.0 - 4.5
Zabo farming	Phek district of Nagaland	Arrangement of a forest area in the higher hills, positioning of animal shelters on mid hill slopes, establishment of a water harvesting tank near the livestock area, and finally, the cultivation of rice or crops. Incorporation of alder leaf litter for green leaf manure. Utilization of paddy husks to seal embankments for minimizing seepage losses. Application of sediment from the tank to enhance crop fields	Rice- 3.0 - 3.5
Alder based farming system	Nagaland	The alder tree, a nitrogen-fixing tree that is not of the leguminous family, is pruned to maintain a height of approximately 2 meters. The leaves and biomass are employed to regulate soil fertility	Rice- 2.0 - 2.5
Alder + Large cardamom system	High altitude of Sikkim	A combination of alder and large cardamom is cultivated concurrently. The nitrogen-fixing capability of alder sustains soil fertility	Large cardamom- 0.2 – 0.24

Bun method (Raised beds)	Meghalaya	Utilization of dried vegetation/biomass for manure and cultivation of legumes as companion crops	Potato - 18 - 20
Bamboo drip irrigation	Jaintia hills of Meghalaya	Drip irrigation employing pseudo stems banana or bamboo plants	Good harvest of arecanut
Cattle shed rotation in upland	Sikkim	A transient cow shelter is constructed within the field to collect on-site urine, cow dung, and organic debris.	Organic production of ginger and cole crops
Pond based farming systems	Plains of Tripura, Assam and Manipur	Proximity to a homestead farm pond; integration of fish, livestock, arecanut trees, kitchen garden, vegetables, and rice cultivation; utilization of farmyard manure; irrigation through collected pond water.	Rice- 3.5 - 4.0

Source: Das et al. (2012)

Conserving and rejuvenating the native organic farming systems can play a role in safeguarding regional biodiversity, promoting enduring livelihoods, and enhancing resilience to climate impacts (Layak et al., 2019). Initiatives aimed at endorsing and fostering these systems should include a respectful partnership with indigenous communities, acknowledging their wisdom and stewardship of the land. The integration of contemporary organic methods with age-old wisdom has the potential to yield distinctive and efficient farming systems (Sahoo et al., 2023)

VIII. DEVELOPMENT OF IOFS MODEL IN NE INDIA

The Integrated Organic Farming System (IOFS) model in North East India integrates diverse agricultural practices for a sustainable and harmonized farming approach, tailored to the region's unique agro-climatic conditions and indigenous wisdom (Das et al., 2018). Its goal is economically viable, resource-efficient farming that meets farm households' needs while preserving the environment (Layek et al., 2023). By carefully selecting and implementing IOFS components, it eliminates the need for external inputs, reducing costs and improving produce quality and quantity through organic waste recycling (Sayara et al., 2020). To establish an Integrated Organic Farming System (IOFS) in North East India, a stepwise approach is imperative. It begins with an Agroecological Zone Assessment to understand soil composition, climate patterns, and available resources, the selection of crops, livestock, and methods. Community involvement is crucial, engaging local farmers and indigenous communities for their wisdom. Skill enhancement through training and workshops educates farmers on organic techniques, soil health, pest management, and sustainable resource

utilization. Crop-livestock integration is encouraged, utilizing livestock waste for organic fertilizer and crop remnants for animal fodder. Agroforestry is employed in the hilly landscape to enhance biodiversity and prevent soil erosion. Soil health is improved using organic methods like composting and covers cropping, while advocating for crop diversity, including indigenous varieties, to enhance resilience against climate fluctuations and pests.

Table 6: Regional Implementation of Integrated Organic Farming System (IOFS) Models within the All India Network Programme on Organic Farming (AI-NPOF)

Regional centre	Area under IOFS (ha)	Components		Net income (Rs.) / year	Remarks
ICAR Research Complex for NEH Region, Umiam, Meghalaya	0.43	Crops	rice – lentil, rice – pea, maize + soybean - french bean, Vegetables (tomato, cabbage, cauliflower, broccoli, brinjal, chilli, spinach, carrot, pumpkin, bitter gourd etc.), fruits (Assam lemon, papaya, peach, guava) and fodder crops	73,903/-	The model is also capable of producing 80% of the necessary seeds and planting materials, as well as required nutrients, internally within the system.
		Livestock	1 milch cow & 1 calf		
		Fisheries	Composite (0.046 ha)		
ICAR-Research Complex for North Eastern Region, Gangtok, Sikkim.	0.5	Crops	rice – vegetable pea, rice – potato – dhaincha, rice – toria – dhaincha, rice – cabbage– dhaincha, maize– soybean– buckwheat, coriander– radish– broccoli–	1, 37,000/-	

			fenugreek and cauliflower– pea– beetroot– spinach)		
		Livestock	2 cows and 50 poultry birds		

Creating the Integrated Organic Farming System (IOFS) model in the village of Meghalaya involved a series of steps. The initial phase included considering the local circumstances, as well as the crop and livestock preferences of the farmers. The gradual development of the IOFS model within the farmers' fields is outlined below (Layek et al., 2023):

- Villages are chosen using a clustered approach to disseminate the IFS model.
- Identification of suitable land near households for implementing the IOFS.
- Construction of 'Jalkund' rainwater harvesting structures with vertical cropping.
- Establishment of compost or vermicompost units for recycling agricultural residues.
- Creation of organic kitchen gardens and year-round vegetable cultivation.
- Planting cash crops and fruits at field corners, and growing fodder on degraded land.
- Introducing improved livestock breeds to enhance income.
- Obtaining organic certification and marketing of the produce.

Farmers in Meghalaya, North East India, have a favorable environment for adopting the Integrated Organic Farming System (IOFS) due to their existing organic farming traditions, minimal reliance on chemicals, and a growing interest in eco-friendly practices. Through training and exposure to innovative techniques, including field visits to ICAR Research Complex farms, farmers are gaining confidence in implementing organic methods (Layek et al., 2023). The introduction of IOFS in Meghalaya holds promise for boosting productivity, profitability, and employment opportunities, promoting crop diversification, ensuring food security, and enhancing sustainable resource management. The cluster approach and model village concept are effectively spreading organic farming and sustainable practices throughout the North East, benefiting hill farming communities (Singh et al., 2021).

The Integrated Organic Farming System (IOFS) has exhibited a favorable impact on the productivity and economic viability of the village's farming systems. It has yielded increased system productivity and net returns by synergizing diverse farming ventures such as livestock, cereals, pulses, and vegetables, coupled with on-site compost or vermicompost production. Embracing the IOFS approach has translated to amplified crop yields, expanded employment prospects, and enhanced soil health. The incorporation of leguminous crops and adept resource recycling has also significantly contributed to the triumph of the IOFS model. In sum, the IOFS has emerged as a sustainable and economically advantageous strategy for the village farmers.

Table 7: Economic Gains of Farmers in Meghalaya through the Adoption of the IOFS Model

Sl. No.	Farmer's name	Farming components	Water source	Area (ha)	Net return/year from model without premium price (Rs)	Net return/year from model with 20% premium price (Rs)
1.	JrilMakhroh	Maize + vegetables + ginger + dairy + poultry + pisciculture + mushroom	Jalkund	0.27	46,695	56,034
2.	LahunLapang	Fruit trees (pineapple, Assam lemon, pomelo) + vegetables + piggery + poultry	Jalkund	0.20	24,500	29,400
3.	Judy Wahlang	Rice + vegetables + poultry + pisciculture + bamboo	Pond	0.32	29,500	35,400
4.	Pynsanlang Rynghang	Maize + vegetables + ginger + + poultry + apiculture	Jalkund	0.18	18,750	22,500
5.	Lamphrang Rympei	Rice + vegetables + turmeric + piggery+ poultry + pisciculture	Pond	0.29	35,670	42,804
6.	BanWar	Fruit trees	Jalkund	0.35	41,590	49,908

		(pineapple, Assam lemon, banana) + piggery +vegetables				
7.	SkolaKurbah	Maize + soybean + vegetables + turmeric+ piggery + poultry + apiculture	Jalkund	0.21	31,102	37,322
8.	Hynniew Rynghang	Sweet potato + vegetables + piggery + poultry + dairy+ turmeric	Jalkund	0.26	33,500	33,500

Source: Layek et al., 2023

IX. CONCLUSION

The North East region of India, with its traditional farming practices, indigenous knowledge, and unique agro-climatic conditions, is ideally suited for IOFS adoption. States like Sikkim, Meghalaya, Assam, Nagaland, and Mizoram are making significant strides towards embracing organic farming, aligning with their "organic by default" ethos. This transition combines ancestral wisdom with modern techniques, revitalizing indigenous farming systems and promoting biodiversity, livelihoods, and climate resilience. IOFS, tailored to the region's specific needs, offers a promising path to economic prosperity and environmental harmony. By integrating various agricultural practices within the IOFS framework, the North East region can effectively address its diverse agro-climatic landscape and cultural heritage, fostering self-reliance and paving the way for a sustainable and prosperous agricultural future.

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