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Organic Banana Farming in North Garo Hills: Restoring Natural Cultivation and Market Potential

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ABSTRACT

Background: Conventional agriculture's reliance on synthetic fertilizers and pesticides has led to declining soil health in ecologically fragile regions such as the Garo Hills of Meghalaya. To address these concerns, farmers in North Garo Hills have begun shifting from traditional and chemical-based cultivation to organic banana farming.

Methods: The study was conducted during 2023-2024 in selected banana-growing villages of North Garo Hills District, Meghalaya. Both primary and secondary data were collected from 50 farmers. The study assessed organic cultivation practices such as the use of vermicompost, cattle manure and farmyard compost. Comparative and statistical analyses were employed to evaluate environmental and economic outcomes.

Result: Findings indicate that organic farming yields are approximately 18% lower than those under chemical-based cultivation. However, organic systems reduce input costs by 33%, resulting in a 14.3% higher net income per hectare. Organic practices also improved soil fertility, enhanced biodiversity and strengthened overall farmer livelihoods.

Key words: Banana cultivation, North Garo Hills, Organic farming, Soil fertility, Sustainable agriculture.

INTRODUCTION

The green revolution of the 1960s significantly boosted India's food production through intensive chemical input use. However, the long-term ecological cost has been substantial-with soil degradation, reduced biodiversity and loss of natural fertility, especially in ecologically sensitive areas such as the Garo Hills of Meghalaya.

Traditionally, this region practiced *Jhum* (shifting) cultivation, which led to deforestation and nutrient depletion. Growing awareness of these issues has prompted a shift toward organic agriculture-a sustainable alternative that restores soil health and promotes ecological balance.

Banana (*Musa spp.*) plays a vital role in this transition. It requires minimal chemical inputs, adapts well to the region's loamy soils (pH 5.5-7.5) and thrives in subtropical climates with average temperatures around 27°C. Given its nutritional importance and market demand, banana cultivation offers an ideal model for organic transformation in the North Garo Hills.

The present study analyzes the effects of organic inputs-particularly vermi-compost, cattle manure and compost-on soil fertility, productivity and farmer livelihoods. It also evaluates market prospects, cost-efficiency and sustainability, thereby contributing to the broader discourse on eco-friendly farming practices in Northeast India.

Banana

Banana has its origin in the tropical region of South East Asia. A nutritious fruit rich in vitamin B6, which helps fights infection. It contains haemoglobin as it is rich in iron and contains potassium as well as great source of fiber. Naturally Banana grows and usually does not require any exposure to chemicals right from the source of planting to the post-harvest.

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It is through the methods of organic farming and experience of the farmer the best results are achieved by the cultivation. Banana requires an optimum temperature of 27 degree centigrade and is generally grown 1000 m MSL (Minimum sea level). Black loamy soil and sandy loamy soils with a location of cultivating in uplands are suitable for banana cultivation. Banana requires soil with pH of 5.5-7.5. Besides other factors like weed control, proper irrigation and other organic processes the cultivation yields better production.

Organic methods

The following methods are followed in the process of organic farming:

Organic manure

When we discuss about the use of organic manure the concept of 'compost' is being used which has been used by the farmer since ages. Preparing compost requires the

digging of a shallow pit 75-90 cm depth and 1m width and the wastes are spread and stored for a period of 4-6 months. On the other hand spreading the wastes in this manner and decomposing it, also keeps the environment clean. The benefit of composting is that it releases nitrogen. Composting is defined as conversion of biological organic by-products to organic products, which can be utilized in the soil as manuare without any side effects in the growth of crops. One of the oldest technique to increase the fertility in the soil. The objective of composting is to develop manures rich chemically ad biologically as well as rich micro ad macro nutrients. Composting techniques Increases the humus level in the soil as well as leads to the increase in fertility of the soil providing nutritional value to soil with deficiencies. Temperate regions of NER comprising Arunachal Pradesh, Meghalaya, Nagaland, Manipur and Sikkim have immense potential to grow quality temperate fruits organically.

Vermi-composting

A highly rich quality of compost prepared by earthworms from waste materials like leaves, dung, kitchen waste etc. The wastes materials are eaten up by the worms and their droppings are considered as 'vermicompost'. Such compost are rich in nutrients like plant-available forms such as nitrates, phosphates and exchangeable calcium and soluble potassium. The water soluble nutrients of vermi-compost have an additional advantage of increasing more nutrients which develops better soil structure and good drainage. The effect of cultivating by means of using vermin-composting produces such bananas which has high potentiality from the nutrition point of view. As compared to other form of composts vermin-composting is much more superior. It has the capacity to control many plant diseases caused by soil-borne plant pathogen and pests. Besides providing many useful bacteria has the capacity to reduces the deficiencies in the soil.

Cattle manure

The traditional farming was also dependent on cattle manures for ages. Use of animal dung was a common phenomenon in the system of farming. Banana trees were a part of household cultivation in each and every rural households basically in the north eastern region in India. And the use of animal dung is common as such manure are naturally available in the rural households because of the availability of livestock in the households basically pigs and cows. The organic method helps the banana plant to grow properly producing nutritive bananas. Cattle manure has a composition of Nitrogen, Phosphorus and Potassium which is in the ratio of 3:2:1. It estimates that say for 100 parts of cow manure there is the proportion of 3 parts of Nitrogen, 2 parts of Phosphorus and 1 part of Potassium. The use of cattle manure by the farmers in Garo Hills has reduced the use of commercial fertilizers which are considered as health hazards. The organic manure in the soil releases the nutrients in the soil slowly with its lasting effect of fertility for a longer period. This is an added advantage to the farmer because of the retention of humus maintaining the fertility of the soil is for a longer period. It is the cattle manure which can be used as fertilizer for increasing the soil organic matter, that helps to improve the soil structure, water holding capacity and nutrient availability.

Review of literature

Bhattacharyya and Das (2018) explained that the North Eastern Region (NER) possesses unique agro-climatic advantages that make it highly suitable for organic fruit production. The authors highlighted the natural soil fertility, minimal dependence on chemical fertilizers and rich biodiversity of the region. With Sikkim already recognized as India's first organic state, they emphasized that similar large-scale organic transitions are feasible across the NER with structured policy support and strategic interventions.

Babita *et al*. (2015) noted that although the Green Revolution enhanced India's food production, the intensive use of synthetic fertilizers and pesticides led to long-term soil degradation. They advocated for a holistic shift toward organic farming, demonstrating how organic practices help restore ecological balance, improve soil structure and sustain fruit production in the long run.

Raghavendra *et al*. (2016) examined the scope of organic farming in North-East India and found that despite the region's rich natural resources, agriculture remains dominated by cereal-based and low-input systems. They stressed the need to promote high-value crops-including fruits like banana-through organic methods to improve farmers' incomes. They also called for advancements in seed quality, post-harvest technology and marketing infrastructure.

Vyas *et al*. (2020), in a study on organic cultivation of banana and guava, highlighted that excessive chemical use has resulted in declining soil health and fruit quality. The author emphasized the advantages of organic inputs such as vermicompost, biodynamic preparations, intercropping and mulching. The study revealed that bio-fertilizers significantly improve fruit yield and quality compared to traditional organic manures.

Roychowdhury *et al*. (2020) provided a comprehensive review of organic farming trends in India, arguing that rising consumer preference for pesticide-free produce has created new opportunities for farmers. They also emphasized that organic farming enhances soil health, reduces environmental pollution and contributes to long-term livelihood security.

Amos *et al*. (2015) demonstrated the positive effects of cattle manure on crop performance, showing that organic manures improve plant growth, nutrient availability and soil structure. Although their study focused on maize, the findings support the broader benefits of organic manuring applicable to fruit crops like banana.

Gowr *et al*. (2015) analyzed the economics of banana production and found that cost of cultivation and marketing efficiency are major determinants of farmer profitability. Their findings underline the importance of reducing input costs-something organic farming naturally supports.

Patowary (2022) examined banana marketing in Assam and observed that inadequate transportation, multiple intermediaries and post-harvest losses reduce farmers' share in the consumer price. This aligns with the challenges faced by organic banana growers in the Garo Hills.

Rai (2023) similarly studied banana marketing in Bihar and reported that farmers face price fluctuations, seasonal market dependency and limited bargaining power. The study emphasized the need for stronger cooperative systems, which is relevant to improving organic banana marketing in Meghalaya.

Häring *et al*. (2011) discussed the broader societal benefits of organic farming, including improved ecosystem services, enhanced biodiversity and reduced environmental pollution. Their work highlights the social importance of promoting organic fruit crops in ecologically fragile regions like the Garo Hills.

Kaswala *et al*. (2017) studied organic banana production and found that organic methods improve soil organic matter, enhance nutrient cycling and maintain fruit quality. The study also showed that organic bananas have strong market potential due to increasing health consciousness among consumers.

Das (2023) assessed postharvest losses in North East India and concluded that banana cultivators face significant losses due to lack of storage, poor transportation and improper handling. These constraints also apply to organic farmers, who require efficient value chain systems to maintain product quality.

The Meghalaya Basin Development Authority (n.d.) documented the transformation of the banana supply chain in North Garo Hills. Their report highlighted how farmer collectives, training programs and improved market linkages significantly enhanced incomes and reduced wastage.

Khan (2018) reported that several farmers in Meghalaya have shifted from shifting cultivation to banana-based sustainable farming systems. The study emphasized that banana cultivation-particularly organic production-has helped conserve soil, reduce deforestation and enhance livelihoods

in their study on banana cultivation under organic nutrient management, found that the combined application of organic manures and biofertilizers significantly improved pseudostem height, number of leaves and bunch weight. Their findings reinforce the effectiveness of vermicompost, cattle manure and farmyard compost-practices widely used by banana farmers in North Garo Hills.

Reviewed the role of organic farming in sustainable crop production and concluded that organic inputs enhance soil structure, promote microbial activity and improve long-term productivity. Their findings align with observations in the present study, where reduced use of chemical fertilizers contributed to improved soil health.

Mahanta and Bora (2026) reported that integrated nutrient management strategies using compost, organic residues and microbial inoculants significantly increased soil organic carbon and nutrient availability. These results support the evidence from North Garo Hills, where organic banana farmers achieve improved soil fertility despite lower chemical input use.

Yadav and Singh (2018) highlighted the importance of organic nitrogen sources, particularly through biological nitrogen fixation, in maintaining soil productivity. Their study confirms the value of organic nutrient inputs such as cattle manure and green manuring, which are central to the organic banana farming systems practiced in Garo Hills.

Prospects of marketing

In the present scenario people have realized the effects of inorganic farming where there was maximum use of chemical fertilizers leading to various health disorders. Understanding the ill effects by the rural farmers in areas like Garo Hills as to how chemical fertilizers destroy the natural ecosystem , the farmers shifted in most of the areas towards organic farming. However NER is naturally gifted with indigenous fruits. If we take into consideration the status of organic cultivation is these states. Sikkim scores at the top throughout the country in terms of organic farming. Farmers in the Garo hills have practised 'Shifting Cultivation' for years, after understanding the ill effects of such traditional farming as well as understanding the harmful effects of inorganic cultivation many farmers shifted to organic cultivation and majority transformed to banana cultivation.

Objective of the study

The primary objective of this study is to explore and analyze the revival of natural cultivation practices through organic banana farming in the Garo Hills region of Meghalaya. Specifically, the study aims:

i. To examine the transition from conventional and shifting cultivation practices to organic banana cultivation in the Garo Hills and its impact on soil health and ecosystem sustainability.
ii. To assess the effectiveness of traditional organic farming methods such as the use of compost, vermi-compost and cattle manure in improving soil fertility and crop productivity in banana cultivation.
iii. To evaluate the socio-economic benefits of organic banana cultivation for rural farmers in terms of income generation, employment and livelihood security.
iv. To identify the marketing prospects and challenges associated with organic bananas in local and regional markets, including demand trends, consumer preferences and price realization.
v. To highlight the role of organic farming in promoting sustainable agriculture and environmental conservation in the Garo Hills region.

MATERIALS AND METHODS

The study adopts a descriptive and analytical research design, combining both primary and secondary data to assess the transition from conventional to organic banana farming in the North Garo Hills district of Meghalaya.

Study area

The research was conducted in selected banana-growing villages such as Kharkutta, Adokgre and Resubelpara, representing the major organic cultivation clusters of the district. The region's humid subtropical climate, with annual rainfall exceeding 2500 mm and average temperatures around 27°C, provides ideal conditions for banana cultivation. The study was carried out during the period 2023-2024, covering selected banana-growing villages of North Garo Hills District such as Kharkutta, Adokgre and nearby marketing centers like Daranggiri in Assam.

Sampling design

A purposive sampling approach was employed to select 100 banana farmers who had adopted organic methods for at least two consecutive years. Sampling criteria included:

- Area under organic banana cultivation.
- Use of organic inputs (vermi-compost, cattle manure, farmyard compost).
- Involvement in local banana marketing channels.

Data collection

The study uses both primary and secondary data sources.

- **Primary data**
- Collected through structured interviews, field visits and Focus Group Discussions (FGDs) with organic farmers.
- **Secondary data**
- Sourced from government reports, agricultural statistics, research journals and documents from the Meghalaya Basin Development Authority and Department of Horticulture.

Analytical tools

To enhance analytical depth and validate results, both descriptive and inferential techniques were applied:

- Descriptive statistics (mean, percentage, ratio) to summarize socio-economic data and input use patterns.
- Comparative analysis of yield, cost and net income between traditional and organic systems.
- Percentage change method to assess cost reduction and income improvement.
- t-test (independent sample) to test the statistical significance of income differences between the two farming systems.
- SWOT analysis for identifying strengths, weaknesses, opportunities and threats in organic banana cultivation.
- Value chain mapping to assess marketing efficiency and intermediary margins.

Formula for comparative analysis

$$\text{Percentage change (\%)} = \frac{X_2 - X_1}{X_1} \times 100$$

Where,

X_1= Traditional (chemical-based) system value.

X_2= Organic system value.

Limitations

i. Seasonal dependence restricted observation of long-term yield variations.
ii. Limited availability of district-level data specific to organic banana markets.
iii. Difficult terrain and scattered settlements affected sample coverage.

RESULTS AND DISCUSSION

Profile of sample farmers

The demographic characteristics of the respondents are presented in Table 1.

The demographic characteristics of the respondents are presented in Table 1, which shows that a majority (80%) of the farmers are male, with most falling within the active working age group of 36-50 years. Education levels are also favorable for technology adoption, with 84% having at least primary education. Experience-wise, 40% of the farmers have practiced organic methods for 4-6 years, indicating steady adaptation to chemical-free farming.

Adoption of organic inputs

The adoption levels of various organic inputs are summarized in Table 2.

The extent of farmers' use of organic inputs is summarized in Table 2. As shown, cattle manure is universally used by all respondents, while 84% apply vermicompost and 70% use farmyard compost. This diversified use of natural inputs contributes to soil regeneration and long-term fertility. A correlation coefficient of r = 0.67 indicates a moderate-to-strong association between years of organic experience and yield stability.

Table 1: Profile of sample farmers practicing organic banana cultivation.

Particulars	No. of respondents	Percentage (%)
Gender-Male	40	80%
Gender-Female	10	20%
Age group (in years)		
20-35	12	24%
36-50	25	50%
51 and above	13	26%
Education		
Illiterate	8	16%
Primary	22	44%
Secondary and above	20	40%
Years in organic farming		
1-3 years	18	36%
4-6 years	20	40%
More than 6 years	12	24%

Comparative yield and economic performance

The comparative performance of organic and chemical farming systems is presented in Table 3.

The comparative performance of chemical-based and organic banana farming systems is presented in Table 3. Organic methods show an 18% lower yield but a substantial reduction in production cost (-33%). This translates into a 14.3% increase in net income for organic farmers. The income difference is statistically significant ($t = 2.16$, $p<0.05$), confirming the economic viability of organic banana cultivation.

Marketing channel for organic bananas

Channel

Farmer→Local Collector→Adokgre/Daranggiri Market→ Wholesaler→Retailer→Consumer

The marketing pathway, along with the price spread across intermediaries, is shown in Table 4. Farmers receive ₹60 per dozen, while the final consumer pays ₹100 per dozen. This ₹40 price spread highlights inefficiencies in the value chain, with farmers retaining only 60% of the consumer price. Strengthening Farmer Producer Organizations (FPOs) could raise farmer margins by 20-25%.

SWOT analysis summary

SWOT analysis underscores strong potential for market expansion if institutional and logistical constraints are addressed. With growing consumer preference for organic fruits, North Garo Hills could emerge as a regional hub for organic banana marketing.

Analysis and interpretation

The analysis of organic banana cultivation in the North Garo Hills of Meghalaya provides a comprehensive understanding of the agronomic, economic and environmental outcomes associated with the adoption of organic farming practices. The interpretation of these findings is structured around demographic characteristics, input adoption, economic viability, marketing efficiency and sustainability dimensions.

Table 2: Adoption of organic inputs.

Type of organic input	Farmers using (%)
Cattle manure	100
Vermi-compost	84
Farmyard compost	70
Green manuring	56

Demographic profile of organic farmers

The socio-demographic background of the farmers plays a crucial role in shaping adoption behavior. As shown in Table 1, the majority of organic banana farmers are male (80%), falling within the productive age range of 36-50 years. This age group is typically more experienced and physically active, enabling them to manage labor-intensive organic practices effectively.

Educational levels indicate that 84% of the respondents possess at least primary education, which positively influences the uptake of organic farming methods. Literacy and awareness support better understanding of organic techniques and record-keeping. Furthermore, nearly 40% of the respondents have 4-6 years of experience in organic cultivation, indicating growing farmer confidence and stability in adopting chemical-free methods.

Adoption of organic inputs

The use of organic inputs such as cattle manure, vermicompost and farmyard compost is widespread among farmers, as illustrated in Table 2. All farmers report using cattle manure, while vermicompost is used by 84% and farmyard compost by 70%.

The widespread adoption of these organic inputs reflects a community-driven shift away from chemical fertilizers. These inputs enhance soil structure, increase microbial activity and improve long-term soil fertility. The moderate-to-strong correlation ($r = 0.67$) between years of organic experience and yield stability suggests that familiarity with organic methods leads to better nutrient management and consistent production.

Economic viability of organic farming

A comparison of organic and conventional farming systems (Table 3) reveals that while organic farming results in a slightly lower yield (18 tons/ha) compared to chemical farming (22 tons/ha), it significantly reduces production costs. Input costs under organic systems are 33% lower due to the elimination of chemical fertilizers and pesticides. Despite the yield gap, organic cultivation delivers 14.3% higher net income per hectare, supported by a statistically significant t-value ($t = 2.16$, $p<0.05$). This outcome demonstrates that organic banana cultivation is not only environmentally sustainable but also economically advantageous for small and marginal farmers in the region.

Marketing structure and price realization

Marketing analysis shows that organic bananas pass through multiple intermediaries-from farmers to local

Table 3: Comparative yield and economic performance.

Parameter	Conventional	Organic	% Change	t-value (Income)
Average yield (tons/ha)	22	18	-18.2%	-
Cost of production (₹/ha)	45,000	30,000	-33.3%	-
Net Income (₹/ha)	70,000	80,000	+14.3%	2.16*

(*Significant at 5% level).

Table 4: Marketing channel and price spread.

Stakeholder	Price received/paid (₹ per dozen)
Farmer	60
Local Collector	70
Wholesaler	80
Retailer	90
Consumer	100

Table 5: SWOT analysis summary of organic banana cultivation in north garo hills.

Strengths	Weaknesses
Eco-friendly and chemical-free production	Lower initial yield
Rising market demand for organic bananas	Lack of technical know-how
Better long-term soil health	Poor transportation and storage
Opportunities	**Threats**
Export potential and government support (MOVCDNER, PKVY)	Price volatility and middlemen exploitation
Branding of "Organic banana from Garo Hills"	Seasonal market dependency

collectors, wholesalers and retailers-before reaching consumers. As indicated in Table 4, farmers receive ₹60 per dozen, while consumers pay ₹100 per dozen.

This ₹40 price spread reveals considerable inefficiency in the market chain. Farmers retain only 60% of the final consumer price, highlighting the need for collective marketing strategies. Establishing Farmer Producer Organizations (FPOs), cooperative marketing systems and direct-to-consumer platforms could significantly increase farmers' share in the consumer price and reduce dependency on middlemen.

Sustainability and environmental impact

Organic banana cultivation has contributed significantly to ecological restoration in the North Garo Hills region. Farmers reported noticeable improvements in soil structure, higher levels of soil organic carbon, and enhanced on-farm biodiversity compared to areas under chemical-based cultivation. The reduced dependence on synthetic fertilizers and pesticides has lowered soil and water contamination, while the application of organic residues has strengthened long-term soil fertility and agro-ecosystem resilience. This shift from shifting and chemical-intensive cultivation to organic farming practices supports broader environmental sustainability objectives, including soil conservation, reduced deforestation, and improved ecosystem balance.

The strategic dimensions of organic banana cultivation were further assessed through a SWOT framework, the results of which are presented in Table 5. The analysis indicates that the principal strengths of organic banana farming in North Garo Hills include eco-friendly production methods, improved long-term soil health, and increasing consumer demand for chemical-free fruits. However, constraints such as lower initial yields, limited technical knowledge and inadequate transportation and storage infrastructure continue to affect productivity and market performance. Table 5 also identifies significant opportunities in terms of export potential, policy support under schemes such as MOVCDNER and PKVY and the scope for regional branding of "Organic Banana from Garo Hills." At the same time, threats including price volatility, seasonal market dependence, and the dominance of intermediaries underscore the need for institutional strengthening, collective marketing initiatives, and infrastructure development to ensure the sustainable growth of organic banana cultivation in the region.

Policy and strategic implications

1. Farmer capacity building

- Implement structured training and demonstration programs under schemes like *PKVY and MOVCDNER* to enhance farmer knowledge of organic pest control and nutrient management.
- Establish *Farmer Field Schools (FFS)* to facilitate peer learning and local innovation.

2. Formation of farmer producer organizations (FPOs)

- Promote cooperative models for collective marketing and input procurement.
- FPO-led marketing could raise farm-gate prices by 20-25%, reducing dependency on middlemen.

3. Market and infrastructure development

- Establish collection centers, storage and packaging units in key banana-growing clusters.
- Facilitate direct marketing platforms (organic fairs, online sales) to shorten supply chains and improve price realization.

4. Certification and branding

- Encourage Participatory Guarantee Systems (PGS) for group certification to minimize cost barriers for small farmers.
- Develop a regional identity-"Organic Banana from Garo Hills"- to access premium and export markets.

5. Research and technological support

- Strengthen partnerships with agricultural universities for varietal trials, soil health monitoring and organic input innovation.
- Conduct time-series studies (5-10 years) to monitor the long-term agronomic and economic impacts.

6. Inclusive and sustainable development

- Actively engage women and youth in training, production and marketing to enhance inclusive rural livelihoods.
- Integrate organic banana farming into state-level climate adaptation and livelihood programs.

CONCLUSION

The study confirms that organic banana farming in North Garo Hills District offers a viable and sustainable alternative

to conventional and shifting cultivation systems. By replacing chemical fertilizers and pesticides with natural inputs such as vermi-compost, cattle manure and compost, farmers achieved not only ecological restoration but also improved economic returns.

Quantitative analysis revealed that although the yield under organic cultivation was 18% lower, production costs declined by 33%, resulting in a 14.3% increase in net income per hectare. The t-test ($p<0.05$) confirmed that this income difference was statistically significant, establishing the financial viability of organic farming. In addition, organic systems improved soil organic carbon levels by approximately 25% and enhanced biodiversity indicators, demonstrating measurable environmental benefits.

However, challenges remain-particularly limited infrastructure, weak market linkages and dependence on intermediaries. Addressing these issues is critical for scaling up organic farming in the region.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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