CGIAR SUSTAINABLE FARMING

IRRI International Rice Research Institute

Evaluating the Adoption and Impact of Systematic Compost Production

Evidence from a Survey in Northern Bangladesh

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The Sustainable Farming science program will address key challenges in agri-food systems by fostering efficient production of nutritious foods and safeguarding the environment to create fair employment opportunities, as we simultaneously tackle climate change, soil degradation, pests, diseases, and desertification.

The program's goals include mitigating the effects of climate change and other shocks, reducing the environmental footprint of agriculture, and generating impact for five million farmers by introducing innovative solutions across two million hectares of land. Additionally, the program aims to minimize farm-related greenhouse gas (GHG) emissions by 15%.

Activities will be implemented in thirty-four focus countries Bangladesh, Benin, Burundi, Cambodia, Colombia, Côte d'Ivoire, Democratic Republic of Congo, Egypt, Ethiopia, Ghana, Guatemala, India, Kenya, Laos, Madagascar, Malawi, Mali, Mexico, Morocco, Mozambique, Nepal, Niger, Nigeria, Pakistan, Peru, Philippines, Rwanda, Senegal, Tanzania, Uganda, Uzbekistan, Vietnam, Zambia, Zimbabwe.

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Abbreviations and acronyms

FAO	Food and Agriculture Organization
CAPI	Computer-Assisted Personal Interview
BDT	Bangladeshi Taka
NGO	Non-Government Organizations
MFS	Mixed Farming Systems Initiative
WP	Work Package

Executive Summary

This study evaluates the adoption, feasibility, and socio-economic impacts of systematic composting among 100 households in Northern Bangladesh as part of a CGIAR initiative on mixed farming systems and sustainable farming. Farmers received support and training for two to three years from the projects, followed by a survey to assess the benefits and challenges of systematic compost production in their homesteads. All surveyed households were knowledgeable about compost production and had received training, primarily from IRRI (84%). In compost production, 100% of households use cow dung, followed by kitchen waste (46%), poultry manure (24%), and crop residues (12%). On average, households complete 2.87 compost cycles per year, producing around 3,000 kg annually. Compost is mainly used on vegetables and crop fields (87%), while 13% of households sell it, generating supplementary income averaging BDT 2,100 per year. Compost usage varies by season, peaking during the Rabi season, with 88% of households utilizing it for various crops such as rice, potatoes, mustard, vegetables, and maize. Farmers report clear benefits: improved soil fertility (97%) and higher crop yields (86%), with 86% considering compost more effective than chemical fertilizers. Compost also reduces dependence on chemical inputs, contributing to sustainable farming practices. Farmers demonstrate strong commitment to compost production, with 66% planning to continue current levels and 34% intending to expand. Key support needs include training and technical advice (100%), financial assistance (36%), and market linkages (16%), emphasizing the importance of capacity-building to sustain and scale compost production. Overall, the results highlight compost as a vital component of crop productivity, soil health, and potential income diversification, reinforcing its role in promoting sustainable agriculture in the study area.

1. Introduction

Compost is a kind of organic manure. Earthworms and different types of microorganisms (bacteria, fungi, worms, and actinomycetes) decompose organic matter to humus, which stores nutrients for plant intake (FAO 2008). Compost makes the soil softer and more porous, improving tillage and helping roots grow easily. It also enriches the soil with essential nutrients. Compost stimulates both the formation and expansion of helpful soil microbes, which play a crucial role in maintaining long-term soil fertility.

Compost production at the household level has emerged as an effective, low-cost practice for improving soil health and supporting sustainable crop production in Bangladesh. With the increasing pressure on agricultural land, declining soil organic matter, and rising costs of chemical fertilizers, farmers and rural households are seeking alternative nutrient sources that are both affordable and environmentally friendly.

Compost, produced from everyday kitchen scraps, crop residues, and other biodegradable wastes, offers a practical solution that transforms household waste into a valuable soil amendment.

In rural and peri-urban areas across Bangladesh, composting not only reduces waste disposal problems but also enriches the soil with organic matter, enhances microbial activity, improves physical structure, and increases the availability of plant nutrients (Ahmed et al. 2024). Farmers applying compost in crop fields often observe better soil moisture retention, improved root development, and enhanced crop resilience. As a result, household composting contributes to higher productivity in homestead gardens and field crops, while reducing dependence on synthetic fertilizers.

Research in Bangladesh has shown that integrating compost or vermicompost into crop systems (e.g., tomatoes, rice) significantly improves soil fertility and boosts yield. For example, a field trial in Netrokona found that combining organic matter and vermicompost nearly doubled soil organic matter and increased tomato yield by 66% (Shamsuzzoha et al., 2025).

Beyond just adding nutrients, compost enhances the soil's physical properties, improving structure, porosity, and moisture retention, which supports root growth and makes cultivation easier. Its biological contributions are also noteworthy: compost stimulates beneficial microbial activity that helps sustain long-term soil fertility. This is especially important in Bangladesh, where overreliance on synthetic fertilizers has put pressure on soil health (Sultana et al., 2020).

Given its multiple environmental, economic, and agronomic benefits, household-level compost production is increasingly recognized as a key component of sustainable agriculture in Bangladesh. This report explores the adoption, feasibility, and socio-economic impacts of systematic compost production, alongside challenges and recommendations for scaling up the practice nationwide.

2. Background

Bangladesh's agricultural soils have experienced a continuous decline in organic matter due to intensive cultivation, low biomass return, and heavy reliance on chemical fertilizers. Many regions report critical levels of soil organic matter below 1%, leading to poor soil structure, reduced water-holding capacity, and lower crop productivity. Household organic waste, often discarded improperly, represents a large untapped resource for producing compost that can restore soil health.

Studies in Bangladesh have demonstrated significant yield improvements when compost or vermicompost is integrated into crop production. Compost not only enhances soil physical properties but also improves nutrient availability and biological activity. Household composting, therefore, has the dual benefit of reducing waste and strengthening food production systems.

3. Problem Statement

Bangladesh's agricultural sector faces persistent challenges related to declining soil fertility, reduced organic matter content, and increasing dependence on chemical fertilizers. Continuous cropping, limited return of organic residues to the soil, and poor waste management practices have accelerated soil degradation across many regions. As a result, farmers experience declining yields, reduced soil productivity, and higher production costs. At the household level, large quantities of biodegradable waste are often discarded or improperly managed, contributing to environmental pollution and lost opportunities for nutrient recycling.

Despite the proven benefits of composting, awareness and adoption at the household level remain limited due to a lack of technical knowledge, inadequate extension support, and insufficient access to composting materials. Without practical, low-cost solutions that households can easily implement, soil health problems will continue to intensify, threatening both agricultural productivity and environmental sustainability. Addressing these issues requires promoting household-level compost production as a viable, scalable, and environmentally friendly strategy for restoring soil fertility and reducing dependence on chemical inputs.

4. Objectives

4.1 Overall Objective

To promote household-level compost production and utilization as a sustainable approach for improving soil fertility, supporting crop productivity, and reducing environmental pollution in Bangladesh.

4.2 Specific Objectives

1. **To assess the current status of household compost production** and identify the practices, materials, and techniques commonly used in rural communities.
2. **To document the agronomic benefits of applying compost in crop fields**, including effects on soil fertility, soil structure, microbial activity, and crop yield.
3. **To enhance household knowledge and capacity** on composting methods through awareness, training, and demonstration activities.
4. **To reduce reliance on chemical fertilizers** by encouraging integrated nutrient management that combines compost with appropriate levels of inorganic fertilizers.
5. **To promote environmentally responsible waste management** by converting household organic waste into valuable agricultural inputs.
6. **To identify challenges and propose practical recommendations** for scaling up household composting at the community and national levels.

5. Methodology

5.1 Selection of the Survey Sites

The household survey was conducted across three districts in Northern Bangladesh: Rangpur, Dinajpur, and Nilphamari (Figure 1). Survey respondents were selected from villages where the MFS initiative is being implemented.

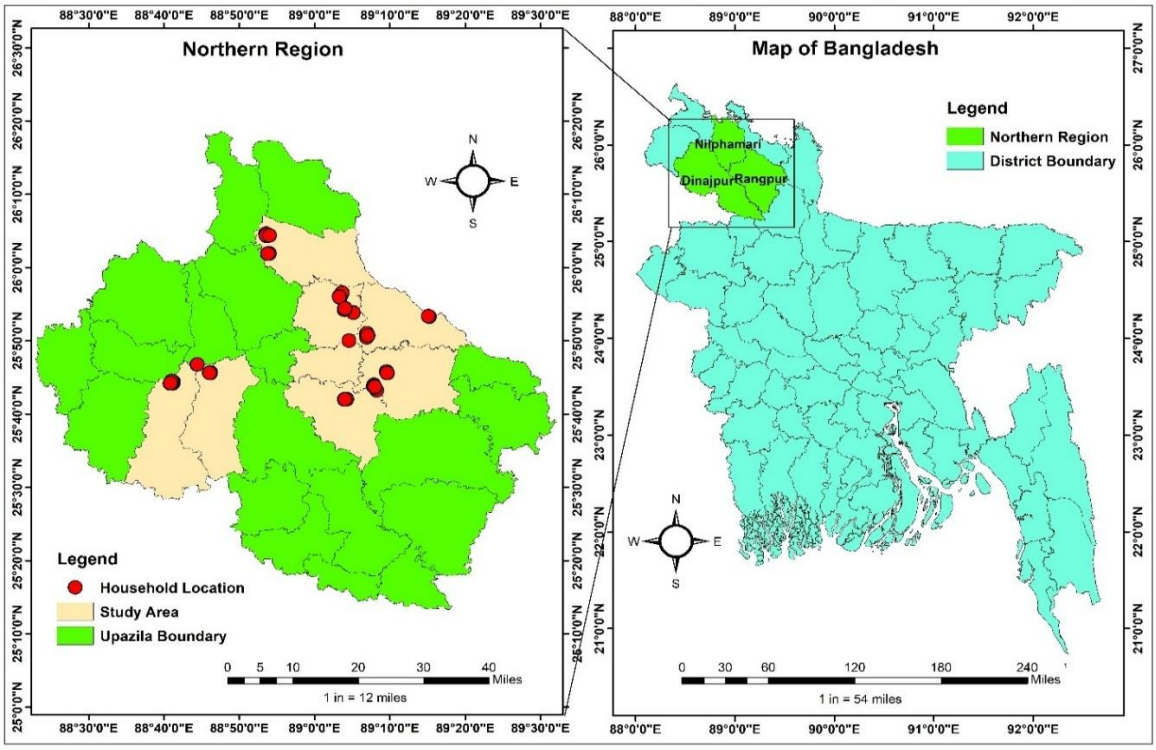

Figure 1: Maps showing the survey location and districts in the Northern region of Bangladesh.

5.2 Sampling Design

Sample households were randomly selected from comprehensive household lists within each village using a two-stage sampling method. First, the villages were purposively chosen. The second stage involves randomly selecting households from the selected villages. The proposed sample size totals 100 households. The survey employed a comprehensive questionnaire comprising nine sections.

Table 1: Distribution of sampled households by administrative units.

District	Upazila	No. of households
Rangpur		**34**
	Badarganj	5
	Gangachara	3
	Rangpur Sadar	26
Dinajpur		**19**
	Chirirbandar	9
	Dinajpur Sadar	10
Nilphamari		**47**
	Jaldhaka	21
	Kishoreganj	26
Total		**100**

5.3 Data Collection Method

A semi-structured questionnaire was developed in KoboToolbox to support data collection for the household surveys. KoboToolbox, an open-source computer-assisted personal interview (CAPI) software, offers a reliable platform for designing, managing, and conducting surveys with digital data collection features.
A comprehensive two-day training program was conducted for the interviewers. This training encompassed several key aspects, such as providing an in-depth understanding of the household compost production and use, clarifying the survey objectives and scope, emphasizing survey ethics (including guidelines and protocols), and providing comprehensive training on the survey tool. Practical exercises involving mock interviews were integrated into the training to familiarize interviewers with the actual survey implementation process.

6. Results

6.1 Demographic and Social Attributes

The average age of household heads was approximately 39.6 years, indicating that most were in their productive working age (Table 2). Household size averaged 5.15 members, reflecting moderately large rural family structures. Most of the respondents were female (72%), with males constituting 28%, suggesting that women played a significant role in providing household information. Crop production emerged as the dominant source of income for most households (88%), highlighting a strong reliance on agriculture. A smaller share of households depended on agricultural labor (3%) and non-agricultural labor (5%), while only a few engaged in business or trade (2%) or other income-generating activities (2%). These findings collectively illustrate that the community is predominantly agrarian with limited diversification of income sources.

According to the survey findings, the average annual household income was BDT 235,350, with a range from BDT 22,000 to BDT 700,000, reflecting the overall economic status of the households surveyed. This income level suggests that most families earn a modest livelihood, consistent with the predominantly agriculture-based occupations reported earlier. The figure also highlights households' reliance on seasonal farming and limited income diversification, which may contribute to year-round income variability. Overall, the average income level provides important context for understanding the economic capacity and livelihood resilience of the respondent households.

Table 2: Summary of household demographic characteristics

Household Characteristic	**%**	**mean**	**std**	**min**	**max**
Basic Demography					
Average age of household head (years)	-	39.6	9.5	22	65
Average household size (actual)	-	5.2	1.8	2	10
Gender of respondent					
Male (%)	28	-	-	-	-
Female (%)	72	-	-	-	-
Main source of household income					
Crop production	88	-	-	-	-
Agricultural labor	3	-	-	-	-
Non-Agricultural labor	5	-	-	-	-
Business/trade	2	-	-	-	-
Other	2	-	-	-	-
Annual total household income (BDT)	-	235,350	110,554	22,000	700,000

The educational status of the respondents shows a wide distribution across different schooling levels (Figure 2). According to the table, 11.1% of respondents had no formal

education, indicating a significant segment with limited literacy. Primary-level attainment was common, with the highest proportion completing Class 5 (14.14%), followed by Class 8 (10.1%), Class 4 (9.09%), and Class 3 (8.08%).

A moderate share reached lower secondary levels, including Class 9 (8.08%). Completion of major academic milestones was comparatively low, with 12.12% having passed SSC or an equivalent level and 8.08% completing HSC. Higher education was rare in the surveyed population, with only 2.02% holding a graduate degree and 3.03% possessing a postgraduate qualification. Additionally, 1.01% reported other forms of education. Overall, Figure 2 indicates that the majority of respondents attained primary to lower-secondary education, while relatively few advanced to higher academic levels.

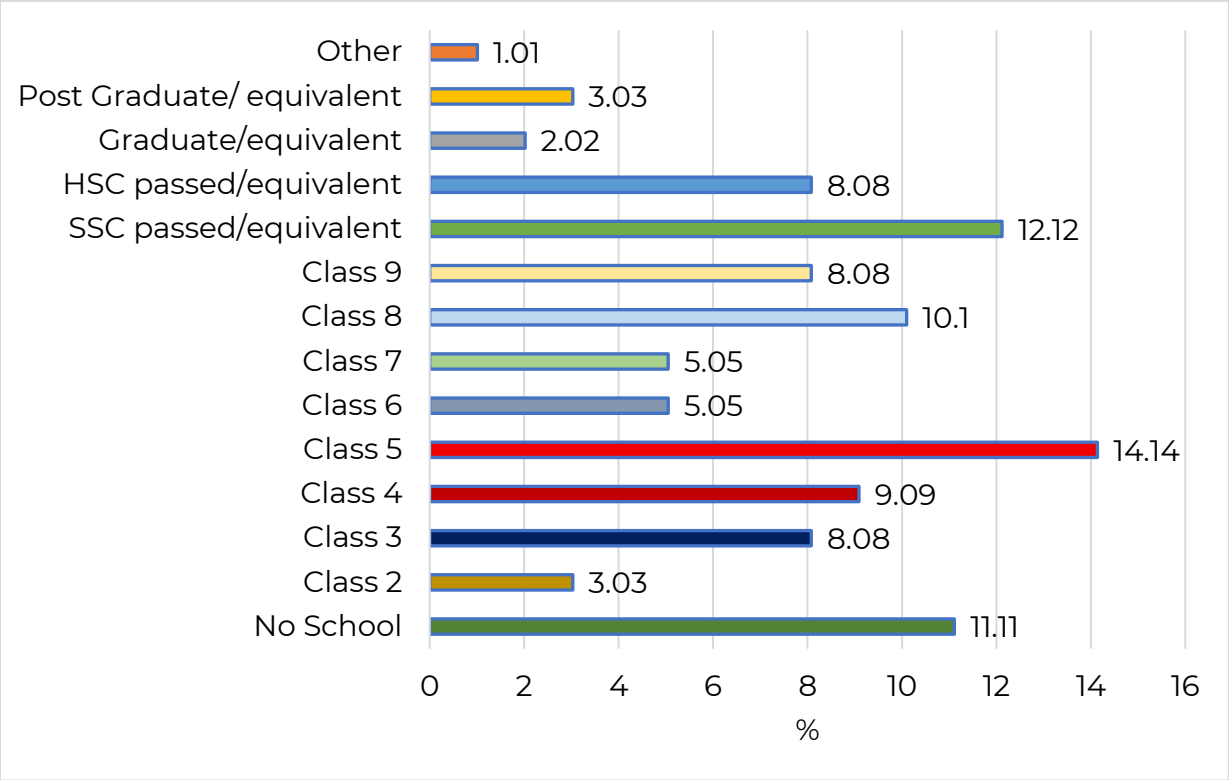

Figure 2: Educational level of the participants.

6.2 Household Farmland and Crop Production

The survey results, presented in Table 3, show a notable variation in household landholdings. Among 82 households with cultivable land, the average size was 0.37 ha. Rented or leased land, reported by 54 households, averaged 0.37 ha, with a broader range of 0.04 to 4.05 ha. All households had homestead areas averaging 0.05 ha, while 41 households owned fishponds averaging 0.04 ha. Overall, the

findings indicate diverse land access and ownership patterns across the surveyed households.

Table 3: Distribution of household farmland.

Household farmland (ha)	Mean	Min.	Max.
Own cultivable land (N=82)	0.37	0.03	2.02
Rented/leased land (N=54)	0.37	0.04	4.05
Homestead area (N=100)	0.05	0.01	0.24
Fishpond (N=41)	0.04	0.01	0.22

The results in Figure 3 indicate that rice is the most widely cultivated crop, with 95.96% of households growing it in the last 12 months, highlighting its central role in the local farming system. Potato is also commonly cultivated, reported by 66.67% of households, while maize is grown by 53.54%, showing moderate adoption of these non-rice staple crops. Mustard (21.21%), chili (11.11%), brinjal (8.08%), and pumpkin (5.05%) are grown by a smaller proportion of households, suggesting they are more specialized or supplementary crops. Wheat cultivation is minimal, with only 5.05% of households engaged, indicating its limited importance in the area. Overall, the findings reflect a farming system heavily reliant on rice, supplemented by select high-demand vegetables and tubers.

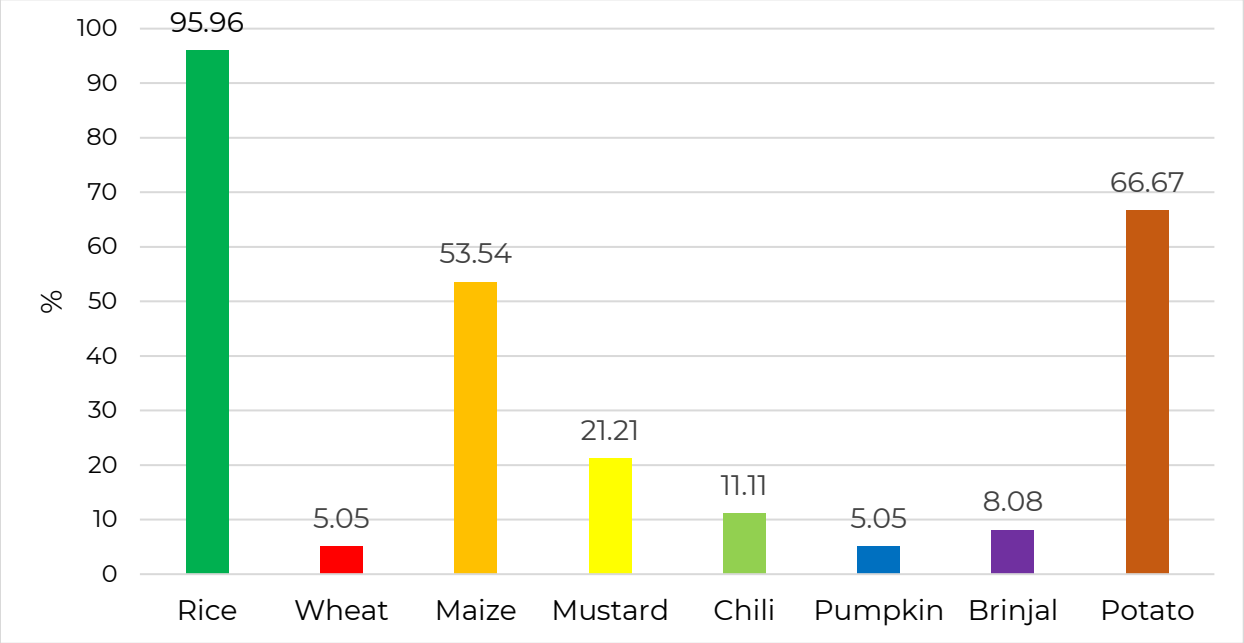

Figure 3: Percentage of households cultivating different crops in the last 12 months.

The survey results show that *Aman* rice is grown by the vast majority of households, with 97.89% reporting its cultivation, indicating its dominance and widespread adoption in the area (Figure 4). *Boro* rice is also an important crop, cultivated by 64.21% of households, reflecting significant engagement in dry-season irrigated rice production. In contrast, *Aus* rice is grown by only 24.21% of households, suggesting

that it is a less common choice, possibly due to lower productivity, limited rainfall during the early season, and alternative options of profitable crops.

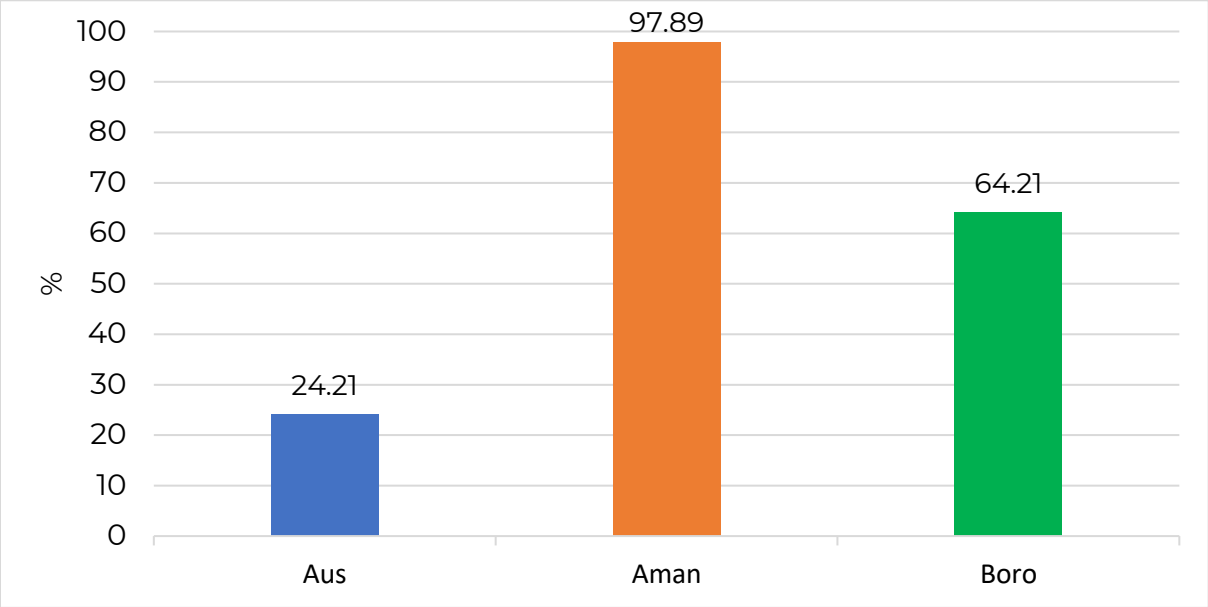

Figure 4: Percentage of households cultivating different rice seasons (Aus, Aman, and Boro) in the study area.

6.3 Livestock Ownership

The results in Figure 5 indicate that livestock rearing is a common practice among households, with cows being the most widely kept, reported by 96% of households, highlighting their importance for milk production, draft power, and income. Chickens are also commonly reared, with 58% of households keeping them, followed by goats at 55%, reflecting their role as a supplementary source of income and nutrition. Ducks are kept by 25% of households, suggesting moderate adoption, while sheep are rare, with only 2% of households rearing them, indicating limited importance in the area.

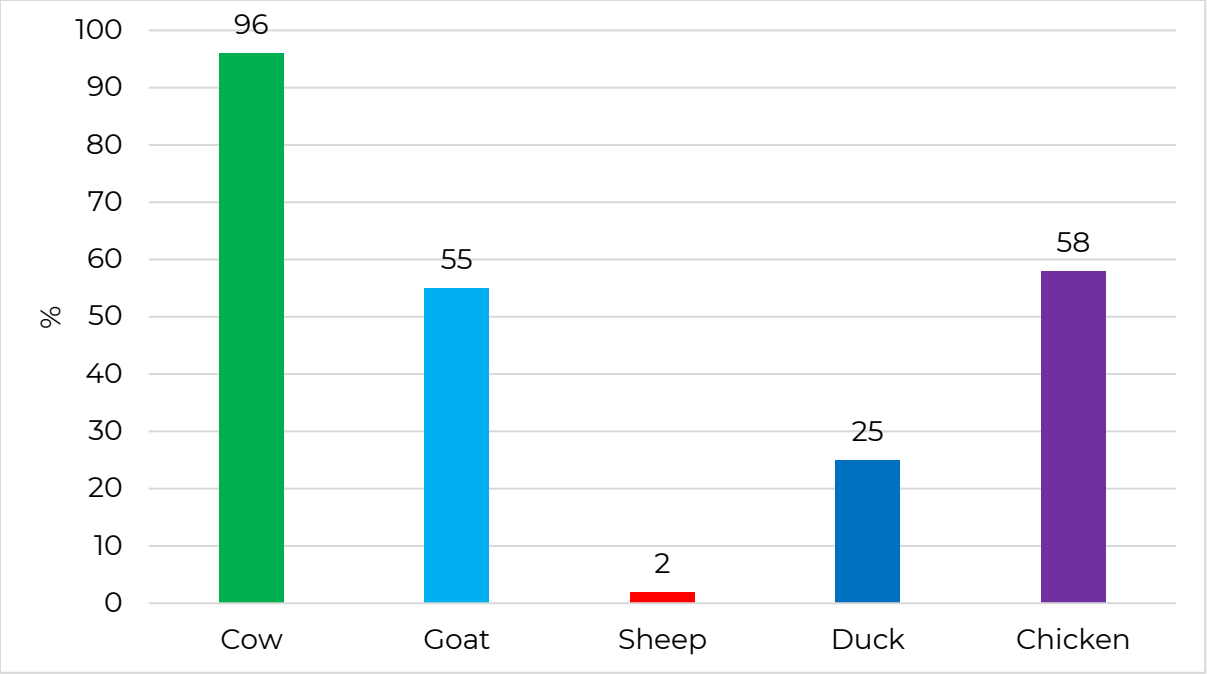

Figure 5: Percentage of households rearing different types of livestock in the study area.

Households keep varying numbers of livestock (Table 4). On average, cows are kept in small herds (2.5 per household, 1–8), goats moderately (3.3, 1–22), and sheep (6, 4–8) and ducks (6.2, 1–17) in moderate flocks. Chickens are the most numerous, averaging 8.9 per household, with some households keeping up to 90. This indicates a system focused on poultry and small ruminants, with smaller herds of larger animals.

Table 4: Average number of livestock per household, with minimum and maximum values.

Livestock	Mean	Min.	Max.
Cow	2.5	1	8
Goat	3.3	1	22
Sheep	6	4	8
Duck	6.2	1	17
Chicken	8.9	1	90

6.4 Knowledge of Compost Production

All surveyed households (100%) know compost production and have received training on it (Table 5). Most households (84%) received training solely from IRRI, while the remaining 16% received training from both IRRI and the government extension office, indicating strong outreach by IRRI to promote composting practices.

Table 5: Household knowledge and training on compost production, including training sources.

Characteristics	N=100
Knowledge about compost production (%)	100
Received training on compost production (%)	100
Trained from (%)	
Only IRRI	84
IRRI and Govt. extension office	16

6.5 Household Compost Production

All the households produced compost, and they produced pit composting.
All households produced compost, primarily using pit composting methods. The results in Figure 6 indicate that cow dung is the primary raw material for compost production, used by all households (100%), highlighting its central role in organic fertilizer production. Kitchen waste is the second most common material, utilized by 46% of households, reflecting the use of readily available household residues. Poultry manure is used by 24% of households, while crop residues contribute to compost in 12% of households. Other materials are rarely used (2%), suggesting limited experimentation with alternative inputs.

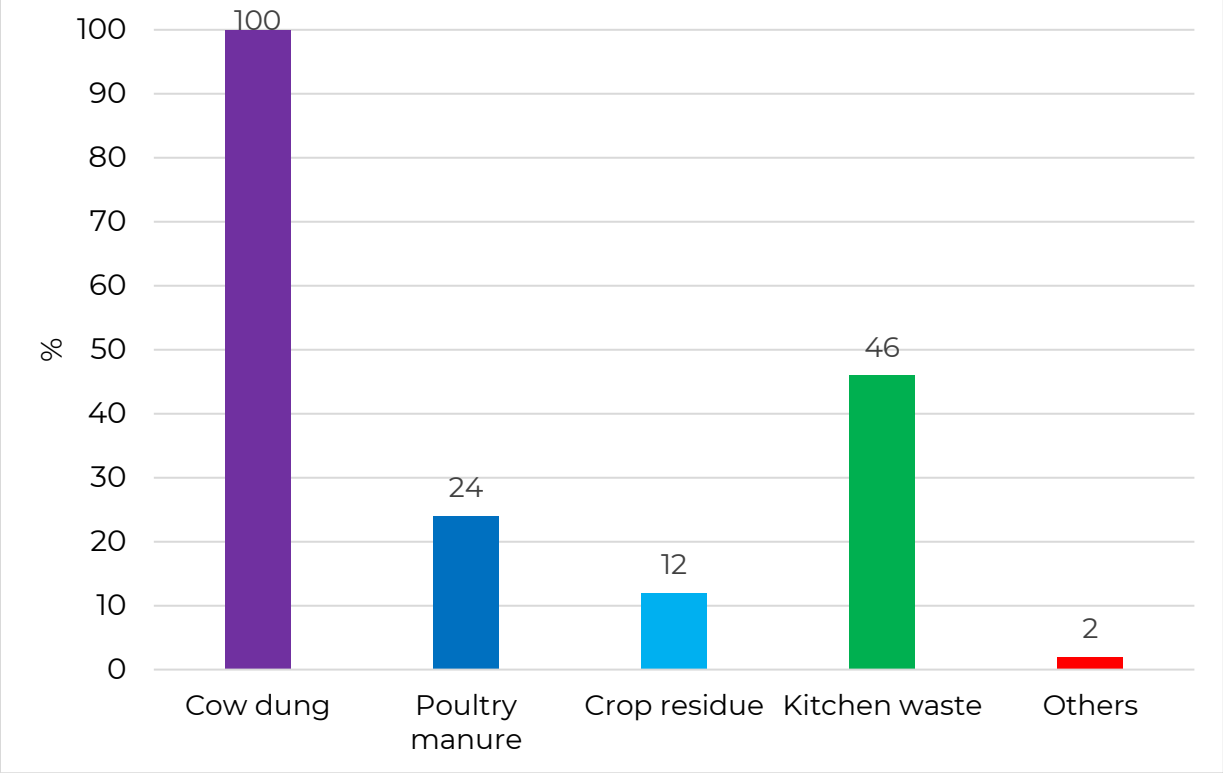

Figure 6: Raw materials used by households for compost production and their adoption percentages.

Households completed an average of 2.87 composting cycles in the last 12 months, with the number of cycles ranging from 2 to 5, indicating consistent engagement in compost production throughout the year. The average duration of one composting cycle was 4.21 months, varying between 2 and 6 months depending on management practices and environmental conditions. Total compost production showed wide variation, with households producing an average of 3,179.5 kg annually, ranging from 400 kg to as high as 24,000 kg, reflecting differences in livestock holdings, raw material availability, and household capacity.

Table 6: Compost production cycles, duration, and total quantity produced by households in the last 12 months.

Characteristics	Mean	Min.	Max.
Compost cycles in the last 12 months (no.)	2.87	2	5
Time for one cycle of composting (months)	4.21	2	6
Total quantity produced in the last 12 months (kg)	3179.5	400	24000

Table 7 shows that most households in the study area produce compost mainly for their personal use, with 87% of households indicating this purpose. Only a small proportion, 13%, produce compost both for personal use and for selling. Regarding challenges in compost production, most households did not experience difficulties, as 92% reported no issues, while only 8% of households indicated facing some challenges in producing compost. This suggests that compost production is generally manageable for most households and is largely oriented toward meeting their own agricultural needs rather than commercial purposes.

Table 7: Purpose and Difficulties of Compost Production among Households (%)

Characteristics	% of households
Purpose of compost production	
Own use only	87.0
Own use + Selling	13.0
Difficulties in compost production	
Yes	8.0
No	92.0

6.6 Household Compost Use Scenario

Household compost use shows clear seasonal and crop-based variation (Figure 7). In *Kharif-I*, only 22% of households applied compost, and exclusively on rice fields.

Compost use increases sharply in *Kharif-II*, with 73% of households applying compost to rice, brinjal, and pumpkin, indicating greater nutrient demand during the monsoon cropping cycle.

The highest adoption occurs in the *Rabi* season, where 88% of households applied compost on a diverse set of crops: rice, potato, mustard, vegetables, and maize,

covering 20.55 hectares. This reflects farmers' reliance on compost to improve soil fertility and moisture retention during the dry season and support intensive winter cropping.

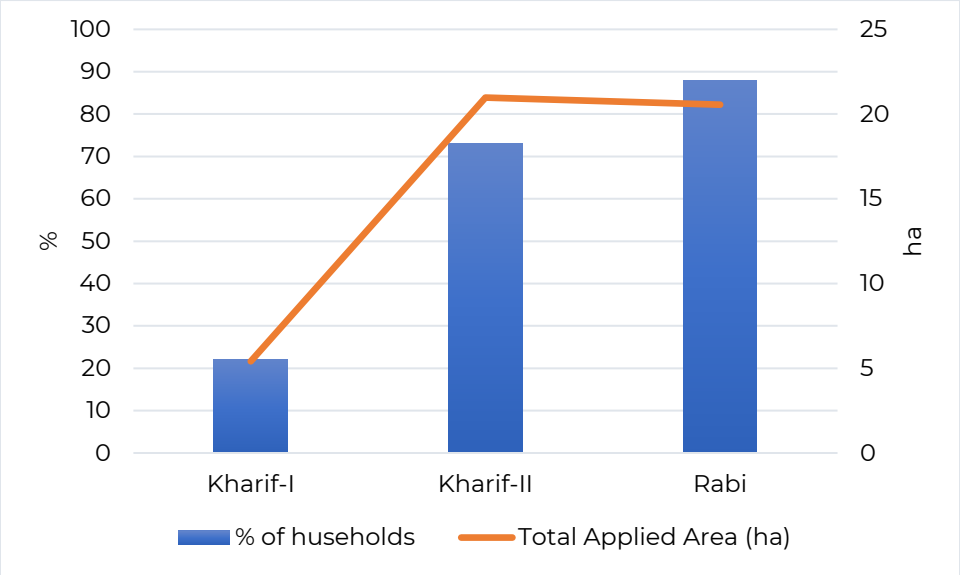

Figure 7: Household compost application scenario in different seasons.

6.7 Perceived Benefits

From Figure 8, farmers overwhelmingly perceive compost as beneficial for crop production, with 96.97% noting improved soil fertility and 85.86% reporting higher crop yields. Around 39.39% observed reduced costs of chemical fertilizers, while fewer recognized improved soil moisture retention (7.07%) or reduced pest and disease incidence (3.03%). These results indicate that compost is primarily valued for enhancing soil health and crop productivity, whereas its economic and pest-related benefits are less widely acknowledged.

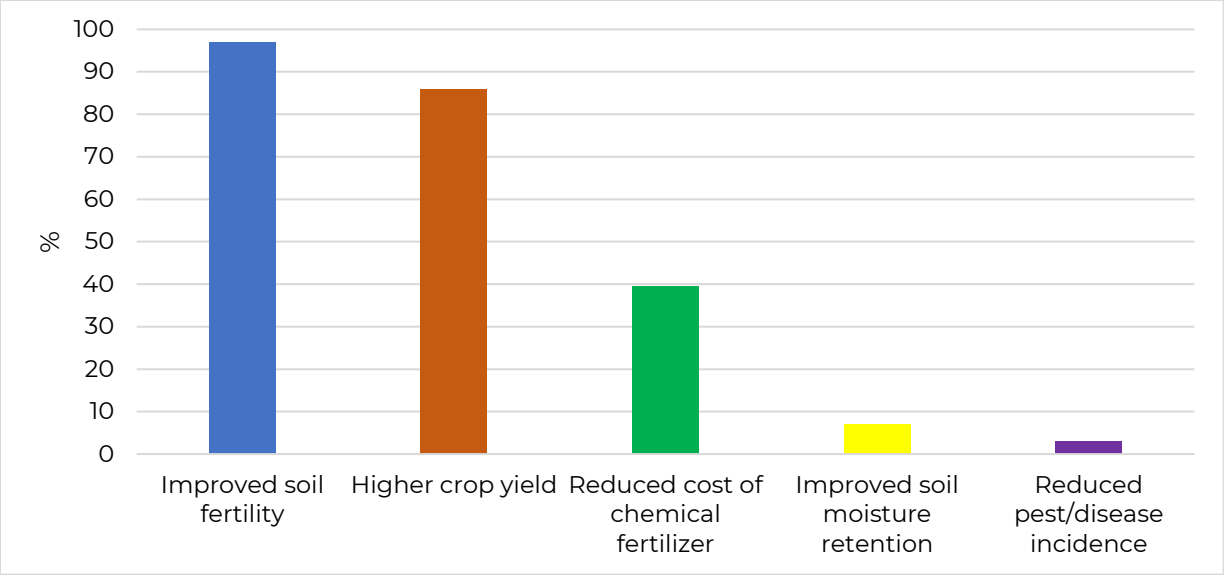

Figure 8: Perceived benefits of using compost on crop fields (% of respondents).

From Figure 9, the majority of farmers consider compost more effective than chemical fertilizers, with 86% indicating superior performance. Another 13% believe compost is equally effective, while only 1% remain uncertain. These findings reflect a strong preference for compost based on perceived effectiveness, reinforcing its potential as a sustainable alternative to chemical fertilizers.

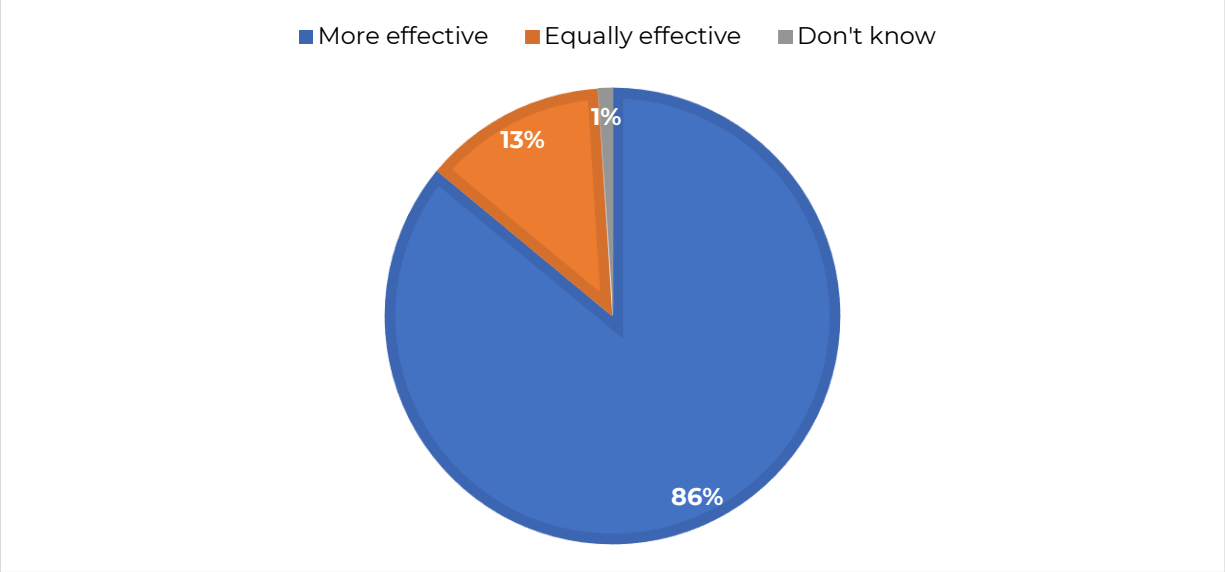

Figure 9: Farmers' perceptions of compost effectiveness compared to chemical fertilizers (% of respondents)

6.8 Household Income from Compost Selling

As shown in Table 8, only a small proportion of farmers (14%) reported selling compost, indicating that compost production is primarily for their own use rather than commercial purposes. Among those who sold compost, the average sales over the last 12 months were 1,940 kg, ranging from 500 to 4,800 kg, reflecting considerable variation in selling quantities. The average price received was 1.2 BDT/kg, resulting in an average income of 2,175 BDT.

Overall, while compost selling is limited to a few farmers, it provides supplementary income and shows potential for further commercial development if market linkages are strengthened.

Table 8: Characteristics of farmers selling compost, including sales quantity, price, income, and market linkages.

Characteristics	%	Mean	Min.	Max.
Sell compost	14.00	-	-	-
Average sales in the last 12 months (kg)	-	1,940	500	4,800
Average price (BDT/kg)	-	1.2	0.5	2
Income from last 12 months (BDT)	-	2,175	500	7,200
Having regular buyers	71.43	-	-	-

6.9 Sustainability

All farmers in the survey reported that compost reduces the need for chemical fertilizers, and 52% respondents recommended that other farmers adopt compost production.

As shown in Figure 10, farmers indicated a strong interest in support to continue or improve compost production. All respondents (100%) expressed a need for training and technical advice, highlighting the importance of capacity-building and knowledge sharing. A smaller proportion (36%) reported a need for financial or credit support, suggesting that funding is helpful but not the primary constraint. Only 16% emphasized the need for market linkages, indicating that while access to buyers is useful, most farmers prioritize improving their production skills and knowledge.

Overall, the results show that enhancing farmers' technical capacity is the most critical support required for expanding compost production.

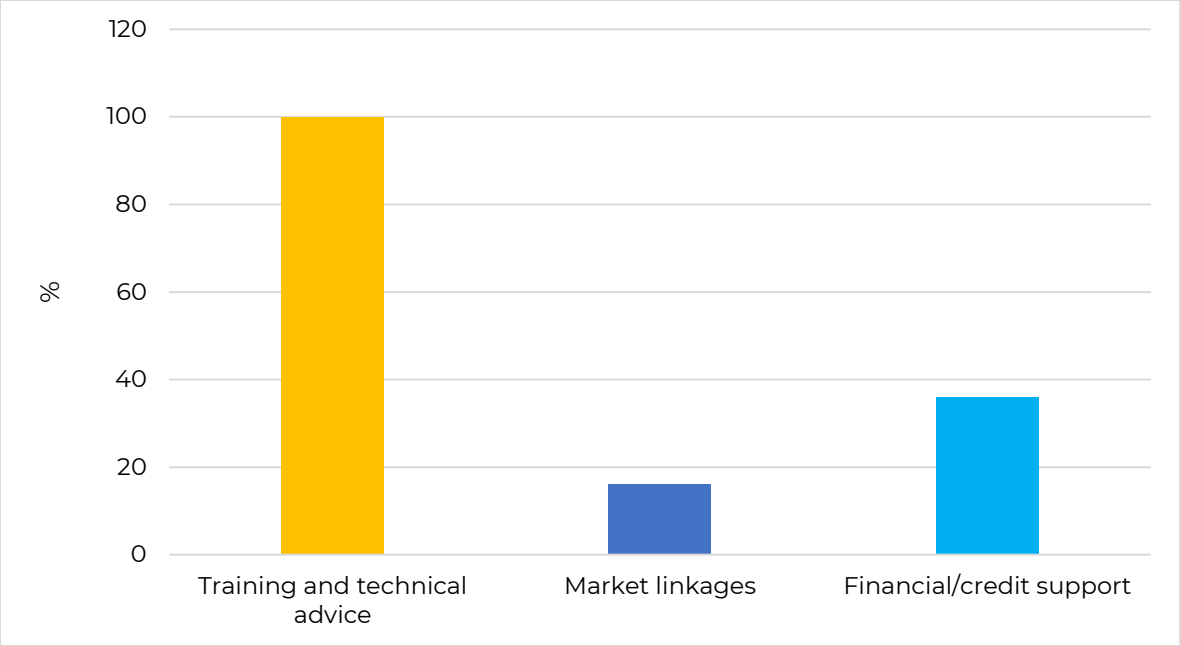

Figure 10: Farmers' support needs to continue or improve compost production (% of respondents).

As shown in Figure 11, farmers show a strong commitment to compost use, with 66% planning to continue their current compost production and 34% intending to expand it. These results indicate that all surveyed farmers are motivated to maintain or increase compost production, reflecting positive attitudes toward sustainable farming practices and the perceived benefits of compost for soil fertility and crop productivity.

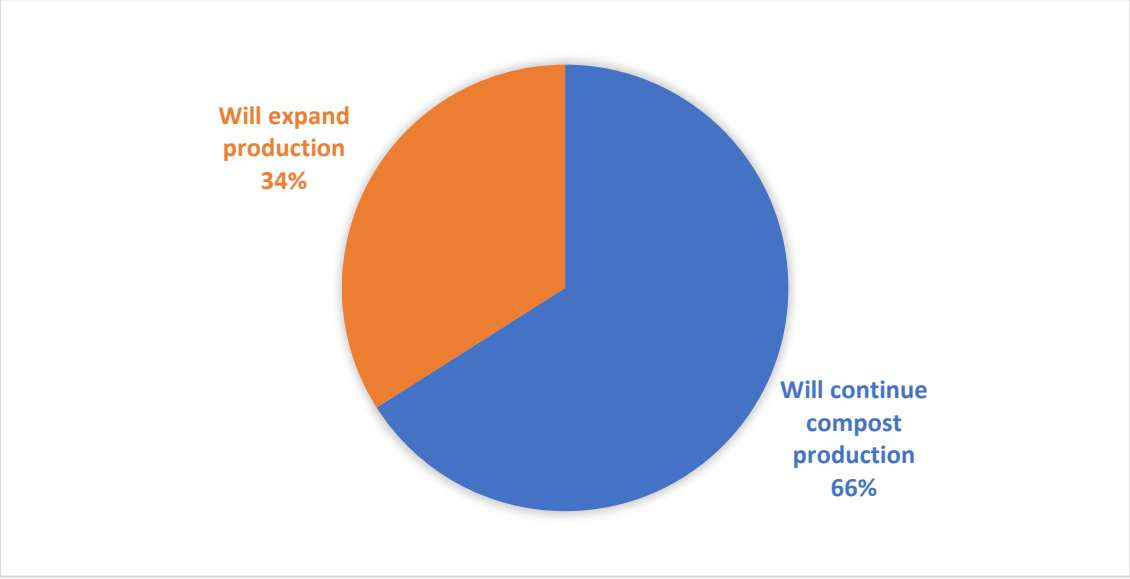

Figure 11: Farmers' future plans for compost production (% of respondents).

Discussion

Household systematic compost production presents a promising opportunity to strengthen agricultural sustainability in Bangladesh. The combined ecological and economic advantages make compost a valuable input for both rural and peri-urban households. While compost alone cannot fully meet crop nutrient demands, integrating compost with reduced chemical fertilizers creates a balanced and resilient production system.

Scaling compost production at the household level can significantly reduce pressure on municipal waste systems and contribute to climate-smart agriculture. However, adoption depends on effective awareness campaigns, training, and reliable access to composting inputs such as earthworms, bins, and starter materials.

Government agencies, NGOs, and extension services need to collaborate to promote simple, low-cost composting methods through demonstrations, farmer training, and community compost hubs.

Conclusion and Recommendations

Household-level systematic compost production in Bangladesh offers a practical, cost-effective, and environmentally friendly solution for improving soil fertility, enhancing crop productivity, managing organic waste, and reducing methane emissions. Compost enriches the soil with essential nutrients, improves soil structure, increases water-holding capacity, and stimulates beneficial microbial activity, which together support healthier plant growth. Field evidence indicates that integrating compost with reduced chemical fertilizers can optimize crop yields, particularly in homestead gardens and smallholder farms.

Despite its clear benefits, adoption of household composting remains limited due to factors such as insufficient knowledge, limited space in homesteads, and perceptions that compost is slower-acting than chemical fertilizers. Addressing these challenges requires a combination of awareness, training, and practical support.

Recommendations

1. **Training and awareness:** Conduct community workshops and demonstration programs to build farmers' knowledge and skills on composting techniques.
2. **Integration with fertilizers:** Promote integrated nutrient management by combining compost with reduced doses of chemical fertilizers to maximize soil fertility and crop yields.
3. **Community compost hubs:** Establish shared composting facilities for households with limited space, enabling collective management and production of compost.

4. **Policy support:** Include household and community composting initiatives in national soil health, waste management, and climate-smart agriculture strategies.

By implementing these recommendations, household-level composting can be scaled effectively across Bangladesh, contributing to sustainable agriculture, improved food security, and environmentally responsible waste management.

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