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Research Article

FACTORS AFFECTING ADOPTION OF ORGANIC FERTILIZER PRODUCTION AMONG THE CATTLE FARMERS IN BOGURA DISTRICT OF BANGLADESH

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Abstract

Organic fertilizer production from cattle waste lessens environmental damage and improves the standard of living of cattle farmers through uncovering additional income sources. Majority of the cattle farmers in Bangladesh either are unaware about eco-friendly farming, or they fail to comprehend the potentials of utilizing cattle waste as organic fertilizer. This study aims to determine the socio-economic and farm-level factors that influence the farmers to produce organic fertilizer from cattle waste. From four rural villages in Bogura district of Bangladesh, 84 households who rear cattle were selected randomly, and then interviewed following a well-structured survey schedule. Descriptive statistics and binary logit model were used to analyze the data. It was evident that, 71% of the selected cattle farmers adopted organic fertilizer production. Minimum socioeconomic differences were observed among the cattle rearing households. Six explanatory variables namely education of the household head, farming experience, risk perception, cattle rearing subsidy, access to internet, and farm's distance from the nearest extension office were found to have significant influence towards farmer's adoption of organic fertilizer production. For ensuring sustainable adoption, farmers should be made aware regarding green farming through proper on field training and frequent campaigns. In addition, continuous subsidy along with logistic support from both government and non-government organizations must be ensured to encourage the farmers towards organic fertilizer production.

Introduction

The diverse and advantageous agro-climatic conditions of Bangladesh are conducive to livestock production. The country's fertile plains, abundant water resources, and various agricultural by-products create an ideal environment for a thriving cattle industry (DLS, 2023; Islam and Rahman, 2020). In particular, the biodiversity of the country helps to sustain various cattle breeds, including dairy and beef cattle, essential for agricultural and economic productivity (BBS, 2023). Furthermore, ample grazing land and nutritious fodder support the cattle sector, making it one of the most important sectors for the country's agricultural sustainability (Rahman *et al*., 2022).

However, with the increase incattle production, the waste generation also increases, which, if not appropriately managed, can lead to severe environmental damage. Livestock waste, particularly manure, has been identified as a significant water contamination source, exacerbating environmental degradation (Rahman *et al*., 2022). Improper disposal of manure from cattle farming in rural Bangladesh often releases harmful methane gases and nitrates, adversely contributing to climate change (Khan *et al*., 2022; Hossain *et al*., 2021).

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At the same time, livestock waste contaminates water bodies, deterioratingdrinking water quality and aquatic ecosystems (Haque and Zaman,2023). The environmental impact of this untreated waste is continuously posing serious challenges to sustainable farming and rural development (Chowdhury *et al*., 2022).

One promising solution to this environmental challenge is the production of organic fertilizer from cattle waste. Organic fertilizer such as cow dung is an environmentally friendly alternative to chemical fertilizersthat can help to reduce pollution caused by improperly disposed manure while supporting agricultural productivity (Gill and Osborne, 2019; Hasan *et al*., 2021; Rahman andAhmed, 2021). It also assists the global efforts to be eco-friendly by reducing dependency on chemical fertilizers (Jahan *et al*., 2021). Being an effective waste management tool, it contributes to sustainable farming by improving soil fertility, increasing microbial activity, and moisture retention of the soil (Akter *et al*., 2022; Haque andZaman, 2023).

In addition to environmental benefits, organic fertilizer production can offer substantial economic gains, particularly for farmers in rural Bangladesh who face financial limitations (Sarker and Alam, 2022). It also facilitates their diversification of income sources, ultimately improving their standard of living (Ahmed and Hossain, 2023; Rahman and Uddin, 2023). Indeed, organic fertilizer production addresses environmental concerns and promotes rural economic development (Islam *et al*., 2021).

Bogura District of Bangladesh is known for its extensive cattle farming practices, and this region contributes significantly to national livestock production, especially dairy farming (BBS, 2023). The rich agricultural landscape of this district provides a steady supply of fodder that further ensures its suitability for livestock farming (Islam and Rahman, 2020). Consequently, an increasing number of cattle farmers in this area emphasizethe significance of improved livestock management practices, particularly waste management (Zaman and Haque, 2021).

As a waste management option, organic fertilizer production among cattle farmers in Bangladesh faces several socio-economic barriers. Limited access to information, inadequate infrastructure and training, lack of awareness, and financial constraints are some of the major factors hindering the widespread adoption of organic farming, including the use of organic fertilizer (Hossain and Banu, 2021; Mollah and Rahman, 2022).

Several previous studies have mainlyemphasizedapplying organic fertilizer instead of chemical fertilizer in the agricultural fieldwhile overlooking the potential of cattle farmers to produce organic fertilizer from cattle waste (Rahman andAhmed, 2021; Rahman *et al*., 2021). Again, individual-level challenges of utilizing livestock waste as organic fertilizer production have not been addressed comprehensively (Sultana *et al*., 2021). The current research seeks to fill this knowledge gap by uncovering the potentialof utilizing cattle waste to produce organic fertilizer for eco-friendly farming practices. This innovative study highlights a vital issue within Bangladesh's agricultural and environmental sectors. The precise goal of this research is to explore the factors influencing cattle farmers to produce organic fertilizer from cattle waste. By addressing the issue, present study intends to promote improved farming practices, findings of which can help the policy makers to decide on waste management and sustainable farming.

Materials and Methods

Study area, sample, and data collection

The study was conducted in the Bogura district of Bangladesh. It is located in the country's northern region and is popularly known as a significant hub for cattle production.The livestock sector of the Bogura district plays a crucial role in generating employment and income for rural households, thus directly impacting the national economy (Sultana *et al*., 2021).

Four villages, namely Aguniatair, Heyatpur, Ghorapir, and Kabilpur of Bogura district, were selected purposively for the study., A total 84 cattle farmers (21 from each of the four villages) were finalized randomly. Primary data were collected through face-to-face interviews. For it, a well-structured survey schedule was pre-tested and modified accordingly. Data was collected in November 2024.

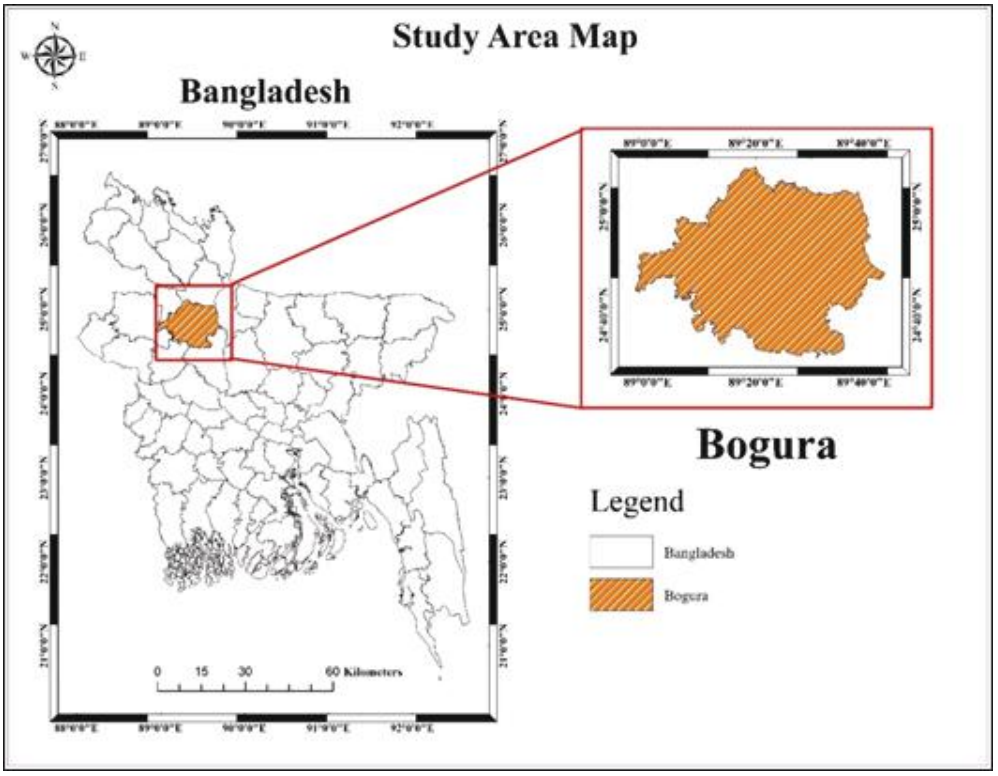

Figure 1. Map of the study area.

Analytical technique

The study employed the random utility theory. According to this theory, a farmer will accept a particular technology only if the advantages of adopting it exceed its disadvantages. For example, a farmer will only produce organic fertilizer from cattle waste when $U_{1A} > U_{0A}$, indicating that the utility of adopting (U_{1A}) is greater than the utility of not adopting (U_{0A}).These utilities can be modeled in the latent variable as a function of observable socio-demographic and farm-specific factors (Ghimire *et al*., 2015; Asfaw *et al*., 2012). Following that, the function (Begho, 2021; Teklewold *et al*., 2013; Ward*et al*., 2018) can be expressed as follows:

$$Z_i^* = \beta X_i + e_i \text{ , with } Z_i = \begin{cases} 1 & if\ Z_i^* > 0 \\ 0 & otherwise \end{cases}$$

Here, is a matrix of parameters to be estimated; is a matrix of explanatory variables and is the error term, which is assumed to be independent and normally distributed with ~ N (0, 1). Both binary probit and logit model can be used to evaluate the relationship in the above equation. However, we utilized binary logit model for sound properties over the probit model. The binary logit model can be written as:

$$Z_i^* = \text{Ln}\frac{P_i}{1-P_i} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots + \beta_k X_k$$

Description of the explanatory variables

Twelve explanatory variables have been considered to explore farmers' adoption of organic fertilizer production from cattle waste. Five of these variables were related to household characteristics, and the rest were related to farming characteristics (Table 1).

Table 1. Description and measurement of explanatory variables

Variable	Notation	Description	Types
Age (years)	X_1	Age of the household head	Continuous
Education of household head (years)	X_2	Number of years of education of the household head	Continuous
Education of spouse (years)	X_3	Number of years of education of the household head's spouse	Continuous
Family size (No.)	X_4	Total number of members in the family	Continuous
Farming experience (years)	X_5	Number of years in cattle rearing	Continuous
Risk perception	X_6	0 if the household head is risk averse, 1 if risk neutral, 2 if he is a risk taker	Categorical
Livestock training	X_7	1 if the household head received any livestock training, 0 otherwise	Dummy
Number of cattle (No.)	X_8	Total number of cattle on the farm	Continuous
Cattle rearing subsidy	X_9	1 if the household head received a subsidy for cattle rearing, 0 otherwise	Dummy
Cattle rearing support	X_{10}	1 if the household head received any support for cattle rearing, 0 otherwise	Dummy
Access to internet	X_{11}	1 if the household head had internet access, 0 otherwise	Dummy
Distant from extension office (km.)	X_{12}	Distance of cattle farm from the nearest government extension office	Continuous

Results and Discussion

Farm and farmer's characteristics

About 71% of farmers produced organic fertilizer from cattle waste (Table 2). Among them, 50% of farmers were risk-takers. They were brave enough to accept the various risks of adopting organic production. About 37% were risk averse, while the rest 13% remained neutral in case of risk perception. However, 29% of farmers were not interested in adopting organic fertilizer production from cattle waste. The majorityof the adopters (67%) did not receive any training in livestock farming. Only 38% of adopters received subsidies either from the government or NGOs.However, 55% did not get any other support, particularly for rearing cattle and utilizing its waste to form organic fertilizer.

Table 2. Description of the categorical and dummy explanatory variables

Variable	Adopter (60)		Non-Adopter (24)	
	Frequency	Percentage (71)	Frequency	Percentage (29)
Risk perception				
Averse	22	37.0%	5	21.0%
Neutral	8	13.0%	2	8.0%
Taker	30	50.0%	17	71.0%
Livestock training				
Yes	20	33.0%	9	38.0%
No	40	67.0%	15	62.0%
Cattle rearing subsidy				
Yes	23	38.0%	4	17.0%
No	37	62.0%	20	83.0%
Cattle rearing support				
Yes	27	45.0%	9	38.0%
No	33	55.0%	15	62.0%
Access to internet				
Yes	30	50.0%	6	25.0%
No	30	50.0%	18	75.0%

Source: Author's estimation based on the field survey, 2024

Although half of adopters (50%) had access to ICT services, this needs to be increased for sustainable organic fertilizer production from livestock waste. It is a good sign that 68% of adopters were engaged in other non-farm income-earning sources besides cattle rearing. This helps them to diversify their income sources, further motivating them to expand their cattle farming and production of organic fertilizer.

The average age of household headswas around 49 years for adopters, whereas it was almost 50 years for non-adopters (Table 3). These two groups did not vary, mainly in the case of educational literacy. However, the spouses of non-adopter's household heads were somewhat literate (8.13) compared to another group (7.87). The average family size of adopters and non-adopters was approximately the same. Adopters had nearly 22 years of cattle farming experience, while non-adopters had 20 years of experience. On average, they had the same number of cattle on their farm. However, they had to travel 6 km from their farm to receive the needed extension services (Table 3).

Table 3. Description of the continuous explanatory variable

Variable	Adopter (60)		Non-adopter (24)	
	Mean	Std. deviation	Mean	Std. deviation
Age	48.78	9.80	49.79	8.60
Education of household head	9.77	2.27	9.21	2.45
Education of household head's spouse	7.87	2.48	8.13	2.23
Family size	5.17	1.65	4.96	0.96
Farming experience	21.83	8.29	20.08	6.73
Number of cattle	2.92	0.91	2.83	0.82
Distance of farm from the nearest extension office	6.16	0.58	6.02	0.38

Source: Author's estimation based on the field survey, 2024

Factors affecting the adoption of organic fertilizer production

The binary logistic regression model was utilized to explore the determinants of organic fertilizer production among cattle farmers. Six of the twelve independent variables were significantly correlated with the farmer's adoption (Table 4). Cox & Snell R Square (0.227) and Nagelkerke R Square (0.326) indicate that the estimated model well explained variation in the likelihood of adoption between 22.7% and 32.6%. Also, the result of VIF confirms no multicollinearity among the explanatory variables.

Table 4. Result of Binary Logistic Regression Model

Variable	Coefficient	Significance level	Exp. (B)	VIF
Age of household head	-0.077	0.107	0.926	2.062
Education of household head	0.265	**0.083***	1.304	1.429
Education of spouse	-0.161	0.303	0.851	1.442
Family size	0.322	0.198	1.379	1.240
Farming experience	0.094	**0.071***	1.099	1.969
Risk perception				1.080
Risk perception (1)	-0.420	0.704	0.657	
Risk perception (2)	-1.137	**0.093***	0.321	
Livestock training (1)	-0.373	0.550	0.689	1.167
Number of cattle	0.305	0.437	1.357	1.316
Cattle rearing subsidy (1)	1.647	**0.045****	5.191	1.604
Cattle rearing support (1)	-1.055	0.148	0.348	1.771
Access to internet (1)	1.138	**0.089***	3.120	1.255
Distance from the nearest extension office	1.107	**0.098***	3.025	1.214
-2 Log likelihood		78.834		
Cox & Snell R Square		0.227		
Nagelkerke R Square		0.326		

Source: Author's estimation based on the filed survey, 2024

It was evident from Table 4 that older farmers were less likely to adopt organic fertilizer production. The education of the household head had a significant and positive association with the farmer's adoption. The odds ratio indicated that the likelihood of adopting organic fertilizer production increased by 30.4% with a one-year increase in household head'sschooling. Thus, education plays a significant role in farmer's adoption by improving their awareness and decision-making capability. However, the spouse's education level did not significantly impact the farmer's decision to adopt organic fertilizer. Although it had an insignificant impact, increasing family members necessitated the farmers to emphasize organic fertilizer production as a diversified income source. Experienced farmers always have a rational understanding of the long-term benefits of organic farming. As usual, it significantly influenced the cattle farmers to produce organic fertilizer from farm waste. Their adoption rate was increased by 9.9% with an additional year of experience in cattle rearing. Risk-taker farmers were found to be 0.321 times less likely to produce organic fertilizer than risk-averse farmers. One of the probable reasons is the farmer's unawareness and ambiguous ideas regarding eco-friendly farming practices. Farmers with access to livestock training negatively impacted adoption, indicating they were not effectively trained on environmentally friendly waste management practices. A positive association was observed between the farmer's number of cattle and their adoption. Farmers who received subsidies on cattle rearing were five times more likely to adopt organic fertilizer production. At the same time, they showed less interest in adopting despite getting cattle-rearing support in kind. It truly highlights the effectiveness of financial incentives to encourage sustainable farming practices. Farmers having good internet access had a significant and positive association with their adoption. With the increased access to internet facilities, they were found three times more likely to adopt organic fertilizer. It denotes the significance of internet facilities in motivating farmers towards improved farming practices by enriching them with green information and awareness. The farmer's adoption probability increased three times with the distance between the cattle farm and the nearest extension office. This was much more relevant for those farmers who were self-motivated, literate, organized, and aware of environmental issues.

Conclusions

This study used field level primary data to determine the factors influencing cattle farmer's decision to produce organic fertilizer from cattle waste. . About 71% farmers have been observed producing organic fertilizer from cattle waste. Their decision to produce organic fertilizer was significantly influenced by education of household head, cattle rearing experience, risk perception, cattle rearing subsidy, , access to internet facilities, and the distance between the farm and extension office. Awareness about environment friendly farming should be accelerated among the farmers for widespread adoption of organic fertilizer production. In this regard, government extension authority can play a major role by arranging regular training, field demonstrations, and campaigns. Farmers should be assisted with enough subsidy and other logistic supports particularly for setting organic fertilizer production plant and its sustainable operation. Alongside, the government should take steps for expanding internet facilities in rural areas at affordable cost. It can motivate the farmers about significance of eco-friendly farming practices like use of organic fertilizer in their field. Besides, many environmental organizations should come forward to support the farmers in both cash and kind. Utilizing small sample size in a particular area is one of the study's limitations, even though it produced some important findings. Therefore, caution must be given to extrapolate these findings to other domains. For revealing the full potential of organic fertilizer production, comprehensive studies should be conducted on its economic perspective and effects on poverty and livelihood.

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