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FARMERS' KNOWLEDGE TOWADRS FERTILIZER APPLICATION IN BORO RICE CULTIVATION IN SUNAMGANJ DISTRICT OF BANGLADESH

NAFISA TABASSUM

Department of Agricultural Extension Education, Faculty of Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh.

AYSHA AKTER*

Associate Professor, Department of Agricultural Extension Education, Faculty of Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh. *Corresponding Author E-mail: aysha.sau@gmail.com

MD. RUHUL AMIN

Department of Agricultural Extension Education, Faculty of Agriculture, Sylhet Agricultural University, Sylhet, Bangladesh.

Abstract

The study was conducted to determine the level of knowledge of farmers regarding fertilizer application in Boro rice cultivation and to identify the factors associated with it in the haor region of Bangladesh. Appropriate application of fertilizer leads to higher economic growth through 40-60% increase in crop output and inefficient fertilization causes lowers productivity. Hence, it is quite logical to understand farmers' knowledge towards fertilizer application in rice and to determine the factors in applying fertilizer in rice of Bangladesh. The study findings might be assisted policymakers in designing more effective policies to increase the fertilizer application at an optimal level by farmers in rice. Moreover, the findings can be helpful for the academicians and extension experts to improve their studies and extension activities. Data were collected from 60 randomly selected farmers through a pre-tested structured interview schedule. Correlation tests were performed to explore the relationship between selected socio-economic characteristics of the farmers and their knowledge level concerning fertilizer application. The results revealed that education and agricultural training experience had a significant positive relationship with farmers' knowledge, while age, annual household income, and cosmopoliteness were negatively but non-significantly related. Family size, farm size, extension media contact, and organizational participation showed no notable association with fertilizer knowledge. The findings suggest that improving education and providing effective agricultural training can enhance farmers' understanding of proper fertilizer use. Strengthening agricultural extension services and implementing targeted capacity-building programs could therefore contribute to improved Boro rice productivity and sustainable agricultural development in Bangladesh.

Keywords: Farmers, Socio-Economic Characteristics, Fertilizer Application, Knowledge.

1. INTRODUCTION

Agriculture is the backbone of Bangladesh (BBS, 2011; Mondal, 2011). About 14% of the nation's GDP comes from this industry, provides 46% of the total employment (BBS, 2016). With a cropping intensity of 192%, crop cultivation is the main agricultural activity in Bangladesh. In terms of value addition, rice is the main crop, making up over 60% of the overall value of crop agriculture. Rice makes up for more than 90% of all cereal output & is grown on about 75% of all cultivated land (Assaduzzaman *et al.,* 2010). Bangladesh

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is the fourth largest producer of rice in the world (Awal & Siddique, 2011). This crop is very important in Bangladesh for several reasons. While the traditional consumption pattern has been considerably varied by the invasion of western dietary habits, rice is still a staple meal in Bangladesh (Islam, 2012). It plays a big role in the social and cultural identity of the country. The ubiquitous expression "Macche Bhat-e Bangali" embodies the essence of Bangladeshi nationality, meaning "Fish and rice is what defines a Bengali." It is an essential component of celebrations like "Paus Praban," "Durgapuja," and "Annaprashan," where eating rice is seen as a religious and cultural emblem (Islam, 2012). According to (Ahmed, 2004), rice has been the most important commodity for Bangladesh's economy. In Bangladesh, like in many other countries, "rice security" is seen as "food security" (Brolley, 2015). Because political instability in the country is mostly caused by the insecurity of rice, rice security is not just an economic concern but also a social and political issue (Nath, 2015).

Bangladesh previously referred as the “Bottomless Basket,” has now been redefined as the “Full of Food Basket” (Kabir *et al*., 2015). After the country gained its independence, rice production increased threefold; it went from producing about 11 million tons of milled rice in 1971–1972 to approximately 35 million tons in 2014–2015 (AIS, 2016). In this specific crop subsector, the country has attained self-sufficiency and has even engaged in the export market on occasion (BER, 2015). Because of the growing population, there will likely be a greater need for rice in the future. According to (Kabir *et al*., 2015), by 2050, the current population of 162.2 million is expected to increase to 215.4 million. The amount of rice needed will be significantly impacted by this demographic transition; 44.59 million tons (as milled rice) is the expected amount. The need for manufacturing is predicted to rise by 27% by 2050 as compared to 2014.

Rice (Oryza sativa L.) is grown in more than 100 countries across 160 million hectares of land, making up 11% of the world’s agricultural area. It produces over 700 million tons of rice which feeds over 50% of people worldwide (IRRI 2010). Rice is Asia’s main crop where 90% of the world's rice is grown & consumed (Sarker *et al*., 2013).

Rice occupies more than three-fourth of the total cropped area and more than 90% of the total cereal area. In Bangladesh, Boro rice has gain popularity as a potential crop to reach the goal of rice self-sufficiency. Boro rice is recognized as the leading cereal crop in Bangladesh, crucial for farmers' livelihoods & national food supply (Hossain *et al.,* 2012). The crop's cultivation is particularly vital in the North-West region, where it significantly contributes to agricultural development (Mainuddin *et al.,* 2021). Research indicates that Boro rice varieties, such as Binadhan-24, exhibit high yield potential, with recorded yields reaching up to 7.03 tons per hectare (Hossain *et al.,* 2024). The adaptability of Boro rice to different environments enhances its production stability, making it a reliable choice for farmers (Islam *et al.,* 2014). While Boro rice is paramount for Bangladesh's agricultural landscape, challenges such as soil salinity and credit constraints can impact its cultivation efficiency & sustainability (PAUL *et al*., 2024) (Rabbany *et al.,* 2021). Addressing these issues is crucial for maintaining the crop's significance in the future. Boro rice is produced during the period from November to April and gives a much better yield than the rice that

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is produced during the monsoon, namely aman, rice or the pre monsoon, aus rice. This could be as a result of the fact that Boro rice is grown mostly under irrigated conditions which favour water and nutrient control (BRRI, 2020). In the past three decades, the Bangladesh government has introduced a series of policies and programs to enhance rice production especially Boro rice, to meet the food security and reduce poverty in the rural areas. These policies have intended and emphasized on improvement in agricultural output which involves capital expenditure on irrigation facilities, subsidies on fertilizers and popularizing of high yielding rice varieties (Ahmed *et.al.,* 2013).

However, most of the farmers do not possess adequate knowledge about the methods and proper amount of balanced fertilizers play an important role in increasing food production. Nowadays, fertilizer use is characterized by excessive N application, moderate P use, and neglecting K and micro-nutrients consequently, thus nutrient imbalance occurs in crop plants. Microorganisms can be harmful to human health if consumed in higher quantities (Carmichael, 2001).

Knowledge and proper attitude of the farmers in fertilizer application are important factors for increased agricultural production. Attitudes are influenced by the past usage of fertilizer and perceived benefits or risks of fertilizer use & perceived credibility of information provided by extension agents and other sources (Meijer *et al.,* 2015). Analysis of different factors can help improve the ability of an individual to do his or her job better.

The major elements of fertilizer used in Boro rice cultivation in Bangladesh are nitrogen (N), phosphorus (P) and potassium (K) which play an important role in plants growth, photosynthesis, health and quality of the produce as stated by (Ali *et al.,* 2015). Nitrogen is of significance to rice crops because it improves on the vegetative growth and enhances the grain yield. Nonetheless, nitrogen fertilizers like the urea type are highly susceptible to loss through volatilization, leaching and runoff hence its low efficiency contaminates the environment (Khatun *et al.,* 2020). Phosphorus, for example plays an important role in root formation and energy transfer in plants while potassium works on water absorption and resistance to diseases. It is imperative that these macronutrients be applied in the correct proportions in order to obtain good yields and at the same time preserve the soil. However, fertilizers are extremely important for the production of Boro rice, many farmers in Bangladesh find it hard to apply the inputs properly. Some of the challenges include inadequate information on appropriate type of fertilizers, quantities to be applied, and time when such fertilizer application should be carried out (Lim *et al.,* 2013). Some farmers continue using conventional techniques, while others use the information provided by local traders which could be misleading concerning the exact nutrients needed by the plants. This leads to the over application or under application of the nutrient salts that can be very detrimental to crop yield and the environment (Islam *et al.,* 2018).

As modern farming practices require fertilizer application. It is required that farmers have adequate knowledge and practices, which can be enriched by extension services (Qamar, 2005; Agholor *et al.,* 2013). In Bangladesh the Department of Agricultural Extension (DAE) has been assigned with the task of extending services to the farmers with emphasis on dissemination of new technology and enhancement of agricultural production. The

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DAE operates hand in hand with the research institutions including the BRRI and the Bangladesh Agricultural Research Institute (BARI) for delivering information regarding new developed auspicious crop varieties, use of appropriate amount of fertilizers and controlling pest problems (Ahmed *et al.,* 2013). Some of the current issues affecting agricultural extension services in Bangladesh include low human capital in terms of extension agents and their ability to dispense information and knowledge to diverse areas including the Sunamganj District (Islam *et al.,* 2018). Some of the constraints that hinder the farmers in these areas from gaining access to extension services are: inadequate physical access, low literacy levels and inability to attend training sessions due to lack of means. Unfortunately, the datasets developed at universities and other research institutions and institutions are often different from those that farmers have. This gap may limit the application of optimal practices in the use of fertilizers and other mechanisms in agriculture to low-impact extension services in increasing agricultural productivity and sustainability of crops.

There has been awareness of the need for enhancing the quality and availability of the agricultural extension services throughout the country and most especially for the small-scale farmers who are very vulnerable and encounter many problems in the process of adopting change. It has given rise to the creation of extension practices that include like farmer field schools, participatory techniques and information and communication technology (ICT) in the transmission of information to farmers (Islam *et al.,* 2018). These approaches are designed to exacerbate farmers' participation in the learning-teaching processes and to equip them with necessary knowledge for decision making with regard to the uptake and application of fertilizers and also other farming practices.

1.1. Concept of Knowledge

The main fact to gain efficiency is knowledge (Butler *et al.,* 2006). It is the based on individual's behaviour. Without knowledge, actions are unworthy (Harun, 2016). (Nonaka & Von Krogh, 2009) defined knowledge as the fact of mastery action and the potentiality of defining a situation or condition to permit skilful action. Moreover, knowledge is the product of integration of information, ideas, experience, intuition, skills and lessons learned that develop added value for the organization (Dana *et al.,* 2007). Knowing something means getting an actionable understanding (Sehai, 2006). Individuals achieve knowledge through the procedure of learning and thought (Islam, 2010).

The individuals' performance is affected by the effective use of knowledge in any process at basic and advanced levels. In the aspect of agriculture, knowledge facilitates developing technologies that rectify products' quantity and quality.The main asset for farmers is agricultural knowledge. With bountiful quality of knowledge, farmers know what information they need, who to look for and what to do in their tasks. Knowledge flourishes farmers' experiences. (Goven & Morris, 2012). To improve farming practices and increase agriculture production, farmers looks for opportunity to gain as much knowledge as they can (Hansson, 2008).

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There are many types of knowledge (Prat, 2006). Among them (Lee & Yang, 2000) mentioned two different types of knowledge - explicit and tacit (or implicit) knowledge. Explicit knowledge refers to knowledge that is expressed by formal techniques (Pardo *et al.,* 2006); while explicit knowledge exists in the form of documents and visual materials. (Wang & Wang, 2012) stated that explicit knowledge sharing has significant effects on innovation speed and financial performance whereas tacit knowledge sharing associates to innovation quality and operational performance. According to (Rogers, 2003) there were three types of knowledge:

(i) Awareness knowledge that motivates individuals to learn new or fresh thing about innovation and adopt it;

(ii) How-to-knowledge need information to use an innovation accurately;

(iii) Principles-knowledge aid in understanding how and why innovation works.

In the context of farm management, to construct new knowledge and exchange it throughout the community farmers need to combine their knowledge that enhances workforce productivity (Bogner & Bansal, 2007). Moreover, effective management of knowledge assures people receive and understand the knowledge to boost their performance (Sabherwal & Becerra-Fernandez, 2003). A farmer needs to pick technology based on his ability to understand the necessary information regarding that technology and his ability to convert that information into action (Abebe, 2007). Thus, farming knowledge improves farming practices and increase productivity.

1.2. Objectives

The specific objectives are:

1. To determine the knowledge of the farmers towards application of recommended fertilizer in Boro rice cultivation
2. To ascertain farmers’ existing practices of different fertilizers in Boro rice.
3. To explore relationship between the socio-economic characteristics with knowledge of the farmers towards fertilizer application.

2. METHODOLOGY

2.1. Location, Population and Sample

The research was carried out in one union, belonging to major rice producing haor area Jagannathpur upazila. From one upazila (Chilaura haldipur) three villages (Notun punji, chilaura & bari jagannathpur) were selected under Sunamganj district was selected purposively for this study due to its’ ideal location which have distinctive geographical, agricultural and socio-economic characteristics for studying Boro rice cultivation. Jagannathpur upazila is situated in the north-eastern part of Sunamganj district within the Sylhet division in Bangladesh bordered by Chhatak and Dakshin Sunamganj to the north, Bishwanath and Osmani Nagar to the east, Derai to the west and Nabiganj to the south. These region is low-lying and located at the foot-hills of Meghalaya mountain chain.

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A total farmers were selected using simple random sampling technique from a population of 365 across the union. The study population comprised farmers involved in Boro rice cultivation within these villages. 16 percent of farmers from each village were randomly chosen as respondents, resulting in a total sample size of 60.

Figure 1: A map of Jagannathpur upazila showing study area

2.2. Preparation of Questionnaire

A questionnaire was prepared for collecting necessary by the researcher from 60 farmers concerned with Boro rice cultivation, using a structured questionnaire. Prior to the interview, the researcher built rapport with the participants and clearly communicated the purpose of the study, using local language whenever possible both open-ended and close-ended questions are incorporated. In most instances, closed form questions were used. Additionally, appropriate measurement scales were used where necessary to assess selected characteristics of the farmers as well as the dependent variable.

2.3. Period of Data Collection

Data collection was done from May 10 to May 23, 2025 using a pre-tested interview schedule. The pre-tested enable the researcher to identify and revise unclear or problematic questions. Adjustments were made accordingly based on the feedback.

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2.4. Variables of the Study

Independent variables of the study such as age, education, family size, farm size, annual household income, agricultural training experience, extension media contact, cosmopoliteness and organizational participation. The dependent variable was farmers' proper knowledge of towards fertilizer application.

2.5. Measurement of Variables

Respondents' socio-economic characteristics were quantified using a scoring system. Age, education, and family size were scored by year or count and categorized into groups using the mean ± standard deviation. Farm size was calculated using the formula Fs = A1 + A2 + ½(A3 + A4) + A5 + A6 – A7 + A8, and farmers were grouped as landless, marginal, small, medium, or large.

Annual family income was obtained by summing agricultural and non-agricultural earnings, assigning one point per 5,000 BDT, and classifying respondents into low, medium, or high-income groups. Agricultural training experience was measured by total training days and grouped as very low (0–3 days), medium (7.1–13 days), or high (>13 days).

Extension media contact was scored on a four-point scale across 14 sources (0–42 total), categorized as low, medium, or high. Cosmopoliteness was assessed by frequency of visits to nine places (score 0–27), and the gap was measured between farmer and wife. Organisational participation was based on involvement in six organisations (score 0–18).

Independent variables and their measurement

Characteristics	Unit of measurement
Age	Year
Educational level	Year of schooling
Family size	No. of persons
Farm size	Hectare
Annual household income	'000' Taka
Agricultural training experience	No. of days experience
Extension media contact	Score
Cosmopolite-ness	Score
Organisational participation	Score

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Dependent variable, knowledge towards fertilizer application was measured using a five-point Likert scale on ten statements, Ten statements were developed from the literature, and respondents rated each from 1 ("Strongly Low") to 5 ("Strongly High"), with total scores indicating overall knowledge levels.

Measurement of Dependent variables

Variable Name	No.of statements	Types of scale	Description
Knowledge	10	Five (5)-point Likert scale	The scores are given against f ive options of response as- 1=Strongly Low, 2=Low, 3= Not sure, 4 = High,5=Strongly High

2.6 Statistical analysis

The primary data collected were coded and entered into Statistical Package for the Social Sciences (SPSS) software (Version 25+),.Ssecondary information was gathered from office records of different organizations, reports, related journals and other pertinent sources and was utilized as needed.

The coded data were entered into a computer for statistical analysis using the SPSS software, version 25+. A variety of descriptive and inferential statistical techniques- including range, frequency, count, percentage, mean, standard deviation (SD) and rank order- were applied to categorize and describe the variables. Additionally, statistical methods such as Pearson's Product Moment Correlation Coefficient (r) was employed for data analysis and hypothesis testing.

3. RESULTS AND DISCUSSION

3.1. Selected Characteristics of the Respondents

The table presents the socio-economic characteristics of farmers. Their ages ranged from 25 to 75 years, with an average of 42.23 years. The mean education level was 4.19 years of schooling. Average family size was 7.8 members, and average farm size was 0.72 hectares. Annual household income averaged Tk. 238,066.67.

Farmers had limited agricultural training (mean 0.68 days) and moderate extension media contact (mean score 4.72). The mean scores for cosmopoliteness and organizational participation were 2.77 and 0.42, respectively, indicating low external exposure and participation.

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Table 1: Salient features of the selected socio-economic characteristics of the farmers

S.L No.	Characteristics	Unit of measurement	Possible range	Observed range	Mean	Standard deviation
1.	Age	Year	Unknown	25-75	42.2333	11.7953
2.	Educational level	Year of schooling	Unknown	0-10	4.1917	3.7575
3.	Family size	No. of persons	Unknown	4-15	7.800	3.1180
4.	Farm size	Hectare	Unknown	0.06-4.25	0.7164	0.59909
5.	Annual household income	'000' Taka	Unknown	780000-600000	238066.67	115674.71438
6.	Agricultural training experience	No. of days experience	Unknown	0-9	0.6833	2.11926
7.	Extension media contact	Score	0-42	1-19	4.7167	2.88239
8.	Cosmopolite-ness	Score	0-28	0-11	2.7667	2.71447
9.	Organisational participation	Score	0-27	0-1	0.4167	0.49717

3.1.1. Age

Based on the National Youth Policy, farmers were grouped into three age categories: Young aged (below 35 years), Middle-aged (35.1–55 years), and Old aged (above 55 years). The farmers' ages ranged from 25 to 75 years, with an average age of 42.33years and a standard deviation of 11.795. The age-wise distribution of farmers is presented in Table 23.

Table 2: Age distribution of the farmers

Categories(Years)	Number	Percentage	Mean	Standard deviation
Young aged (below 35 years)	20	33.3	42.23	
Middle-aged (35.1–55 years)	30	50.0		11.795
Old aged (above 55 years).	10	16.7		
Total	60	100		

The age-wise distribution revealed that 50% of the respondents were middle-aged, 33.3% were young, and 16.7% were old.

The dominance of middle-aged farmers suggests that agricultural activities in the haor region are primarily undertaken by individuals who possess both physical ability and farming experience.

This finding corresponds with the observations of (Akter & Ahmed, 2020) who reported that middle-aged farmers tend to be more engaged in agricultural practices due to their greater economic responsibility and decision-making roles.

3.1.2. Level of education

The educational status of the farmers was divided into five categories: Illiterate (0 years of schooling), Can sign only (0.5 years), Primary level (1–5 years), Secondary level (6–10 years), and Higher Secondary level and above (more than 10 years).

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The years of schooling among the farmers ranged from 0 to 10, with an average of 4.1917 years and the standard deviation was 3.75. The classification of farmers based on their educational background is presented in Table 3.

Table 3: Educational background distribution of the farmers

Categories	Number	Percentage	Mean	Standard deviation
Illiterate (0) score	15	25	4.1917	3.75
Can sign only (0.5) score	1	1.7		
Primary level (1-5) score	22	36.7		
Secondary level (6-10) score	22	36.7		
Total	60	100		

Educational attainment among the respondents was generally low. About 25% were illiterate, 1.7% could only sign their names, while 36.7% had completed primary and another 36.7% secondary education. None of the respondents had higher education, reflecting limited access to formal education in rural areas. Education plays a vital role in shaping farmers' capacity to comprehend agricultural innovations and adopt modern farming practices. The result is consistent with findings by (Akter &Ahmed, 2020), who noted that education significantly influences farmers' ability to process and apply agricultural knowledge effectively.

3.1.3. Family size

Based on the mean ± standard deviation method, the respondents were grouped into three categories: Small families (1–4 members), Medium families (5–6 members), and Large families (more than 6 members). The family size among respondents ranged from 4 to 15, with an average size of 7.80 and a standard deviation of 3.11. The distribution of farmers by family size is presented in Table 4.

Table 4: Distribution of farmers by family size

Categories	Number	Percentage	Mean	Standard deviation
Small family (1-4) person	8	13.3	7.80	3.11
Medium family (5-6) person	18	30.0		
Large family (above 6) person	34	56.7		
Total	60	100		

More than half of the respondents (56.7%) belonged to large families, while 30% had medium and 13.3% small families. The average family size of 7.80 indicates a predominance of extended or joint family structures. Larger families are often viewed as advantageous in rural Bangladesh as they provide labor support for farm operations. However, large households may also create economic pressure if non-earning dependents outnumber income earners.

3.1.4. Farm size

Farmers were categorized based on their total landholding into five groups: Landless (0.00-0.20ha), Marginal (0.21-0.50ha), Small (0.51-1.0ha), Medium (1.01-2), Large (above 2.0). The farmers' farm sizes ranged from 0.06 to 4.25 hectares, with an average

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of 0.7164 hectares and a standard deviation of 0.59909 hectares. The distribution of farmers based on their effective farm size is presented in Table 5.

Table 5: Distribution of farmers by farm size

Categories(Hectare)	Number	Percentage	Mean	Standard deviation
Landless (0.00-0.20ha)	2	3.3	0.7164	0.59909
Marginal (0.21-0.50ha)	19	31.7		
Small (0.51-1.0ha)	27	45.0		
Medium (1.01-2)	8	13.3		
Large (above 2.0)	4	6.6		
Total	60	100		

Farm size distribution indicates that 45% of farmers were smallholders (0.51–1.0 ha), 31.7% were marginal farmers, 13.3% medium, and 6.7% large, with 3.3% landless. The mean farm size of 0.72 ha confirms that small-scale agriculture dominates in the haor ecosystem. With the rising population in Bangladesh, the amount of cultivable land available per person is steadily declining (Kabir, 2015). Nevertheless, despite owning small landholdings, most farmers continually strive to maximize production from their limited land resources.

3.1.5. Annual family income

Based on the mean ± standard deviation method, the respondents were categorized into four income groups: Low income (≤2,52,000BDT), Medium income (2,52,001-4,26,000BDT), High income (Above 4,26,000BDT). The annual family income of the farmers ranged from Tk.7,80,000 to Tk. 6,00,000 with an average income of Tk. 238066.67 and a standard deviation of Tk. 115674.71438. The distribution of farmers by their annual family income is shown in Table 6.

Table 6: Distribution of farmers according to their annual family income

Categories('000' Taka)	Number	Percentage	Mean	Standard deviation
Low income (≤2,52,000)	45	75.0	238066.67	115674.71438
Medium income (2,52,001-4,26,000)	9	15.0		
High income (Above 4,26,000)	6	10.0		
Total	60	100		

About 75% of respondents belonged to the low-income group, 15% to the medium, and 10% to the high-income group. The average annual income was Tk. 238,066.67. Low income limits the ability of farmers to purchase adequate fertilizers and other inputs, thereby constraining yield potential and productivity.

These findings are consistent with previous research. For example, (Billah, 2013) reported that 85.0% of respondents had low annual income, 11.2% had medium income, and only 3.8% had high income.

Although the current study shows a slightly higher proportion of medium and high-income farmers (25% combined), the majority still remain within the low-income bracket, underscoring the continued economic fragility of Boro rice cultivators in the haor region.

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3.1.6. Agricultural training experience

The respondents were categorized into four groups based on their agricultural training duration: Very low training received (0–3 days), Medium training received (7.1–13 days), and High training received (more than 13 days), determined using the mean ± standard deviation. Farmers' training experience ranged from 0 to 9 day, with a mean of 0.6833 days and a standard deviation of 2.11926. The distribution of farmers according to their agricultural training experience is presented in Table 7.

Table 7: Distribution of farmers on the basis of their agricultural training experience

Categories(Days)	Number	Percentage	Mean	Standard deviation
Very low training received (0-3 days)	54	90	0.6833	2.11926
Medium training received (3.1-6 days)	1	1.7		
High training received (above 6 days)	5	8.3		
Total	60	100		

Most respondents (90%) reported very low exposure to training, while only 8.3% received moderate training and 1.7% received high-level training. The mean training duration was 0.68 days, highlighting a critical gap in capacity development. Lack of training prevents farmers from adopting improved fertilizer management practices. Similarly, (Bagum *et.al*., 2021) reported that 47% of respondents didn't receive any kind of training whereas 53% received training on different crop production issues.

The data suggest that the number of trained farmers in the study area is low, indicating a shortage of skills required to adopt agricultural technologies. Training in agricultural technology enhances farmers' knowledge and abilities, which in turn leads to increased crop yields and higher farm income (Gautam *et al.*, 2017).

3.1.7. Extension media contact

Farmers were divided into five categories based on their level of agricultural extension contact: Low contact (scores 0 to 7), Medium contact (scores between 8 and 13), and High contact (scores above 13). This classification was done using the mean ± standard deviation method. The contact scores among the farmers ranged from 1 to 19, within a possible range of 0 to 42.

The average contact score was 4.7167 with a standard deviation of 2.88239.A detailed distribution of farmers based on their agricultural extension contact is presented in Table 8.

Table 8: Distribution of farmers according to their communication exposure

Categories(Score)	Number	Percentage	Mean	Standard deviation
Low contact (0-7)	52	86.7	4.7167	2.88239
Medium contact (8-13)	7	11.7		
High contact (above 13)	1	1.7		
Total	60	100		

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The majority (86.7%) of farmers had limited contact with extension services, and only 1.7% maintained high contact. Limited access to extension agents restricts the dissemination of agricultural innovations and constrains the adoption of recommended fertilizer application methods.

3.1.8. Cosmopoliteness

The level of cosmopoliteness among the farmers was categorized into three groups: Low (0-6 score), Medium (7 to 12 score), High (above 12 score). The cosmopoliteness scores among the farmers ranged from 0 to 11, within a possible range of 0 to 28. The average contact score was 2.7667 with a standard deviation of 2.71447.

Table 9: The distribution of respondents based on their cosmopoliteness.

Categories(Score)	Number	Percentage	Mean	Standard deviation
Low (0-6 score) Medium (7 to 12 score) High (above 12 score)	57 2 1	95 3.3 1.7	2.7667	2.71447
Total	60	100		

Cosmopoliteness were found to be low among respondents. The limited interaction with external information networks reduces farmers' exposure to new technologies and restricts collective problem-solving opportunities. (Akter and Ahmed, 2020) similarly observed that low social participation among rural farmers weakens their access to shared agricultural knowledge. Also, (Sarwar *et.al.,* 2022) reported that 83.8% of farmers had low level of cosmopoliteness, 13% had medium level of cosmopoliteness, and no one (0%) had high level of cosmopoliteness. This indicates that most of the farmers were confined to their local environment and had limited exposure to external sources of information, knowledge, and innovation. Such a condition may restrict their ability to adopt modern agricultural practices and to respond effectively to changing farming challenges.

3.1.9. Organizational participation

The organizational participation scores of farmers ranged from 0 to 28, with a mean of 0.4167 and a standard deviation of 0.49717. Based on these values, farmers were grouped into one categories: Low participation (0-1score).

Table 10: The classification of respondents according to their level of organizational participation

Categories(Score)	Number	Percentage	Mean	Standard deviation
Low (0-1 score)	60	100	0.4167	0.49717
Total	60	100		

Organizational participation was found to be low among respondents. The limited interaction with external information networks reduces farmers' exposure to new technologies and restricts collective problem-solving opportunities. Similarly, (Mou *et.al*., 2019) reported that The largest proportion of respondents (44.16%) reported having a low level of organizational participation. This indicates that farmers in the study area are minimally involved in social or agricultural organizations. Given that these farmers

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primarily cultivate Boro rice, the lack of organizational involvement may limit their access to collaborative opportunities, shared knowledge, and support systems that could enhance their farming practices. Low participation in organizations might also hinder their ability to address both individual and community-level agricultural challenges effectively.

3.2. Level of dependent Variables

Farmers' knowledge levels were divided into three categories—low, moderate, and high.The classification was done by calculating the score range (maximum score minus minimum score) and dividing it by the number of categories. Descriptive statistics related to these variables are presented in Tables 32 and 33 for the sample size of 60 participants.

3.2.1. Farmers' knowledge

To address the first objective of the study, the researcher assessed the farmers' knowledge level related to fertilizer application in rice cultivation. Farmers were categorized into three groups based on a rating scale ranging from 1 to 5 (Table 11). Scores between 0 to 33 represented low level of knowledge, 34–40 indicated medium level of knowledge, and above 40 reflected a high level of knowledge.

Table 11: Distribution of farmers based on their knowledge level regarding fertilizer use in rice cultivation.

Level	Frequency	Percentage	Mean	Standard deviation
Low level (0-33)	4	6.7	39.7000	4.10993
Medium level (34-40)	28	46.7		
High (above 40)	28	46.7		
Total	60	100		

Table 11. presents the mean and standard deviation score of farmers' knowledge in fertilizer application on rice. The mean is 39.7000 and the standard deviation is 4.1099.

According to the data, a majority of the farmers demonstrated a moderate to high level of knowledge regarding Boro rice cultivation. Specifically, 46.7% of the respondents had medium knowledge, while an equal proportion (46.7%) possessed a high level of knowledge. Only a small percentage (6.7%) exhibited low knowledge. These findings indicate that most farmers are relatively well-informed about Boro rice cultivation practices.

In comparison, the results regarding farmers' knowledge (Basak and Pandit, 2011), reported that most farmers (67%) possessed low to medium knowledge concerning the application of granular urea fertilizer in rice cultivation. In a similar vein, (Haris, 2013) observed that 50.9% of farmers demonstrated a moderate level of agricultural knowledge.

3.3. Relationship between the Farmers' Selected Characteristics and the Degree of Their Knowledge Towards Fertiliser Application in Boro Rice cultivation.

To investigate the relationship between the farmers' selected characteristics and their level of knowledge towards fertiliser application, Pearson's product-moment correlation

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coefficient (r) was calculated. This statistical method identifies which farmer characteristics are significantly linked to their knowledge in farming practices.

Table 12: Co-efficient of correlation between selected characteristics and farmers' knowledge towards fertilizer application

Correlation table with df(n-2) =60-2=58

Dependent variable	Independent variables	Correlation of coefficient with knowledge (r)	Tabulated value	
			0.05 level	0.01 level
Farmers knowledge towards fertiliser application on boro rice cultivation	Age	-0.132	0.250	0.325
	Education	0.380**		
	Family size	0.101		
	Farm size	0.062		
	Annual household Income	-0.156		
	Agricultural training experience	0.298*		
	Extension media contact	0.183		
	Cosmopoliteness	-0.008		
	Organisational participation	0.012		

*Significant at 0.05 level & **significant at the 0.01 level of probability

*Authors investigation.2025

To examine the relationship between selected socio-economic characteristics of farmers and their level of knowledge regarding fertilizer application in Boro rice cultivation, Pearson's Product Moment Correlation Analysis was employed at both the 0.05 and 0.01 levels of significance. The results indicated that education (r = 0.380) and agricultural training experience (r = 0.298*) had strong and significant positive correlations with farmers' knowledge, suggesting that higher education and greater training exposure substantially enhance understanding of proper fertilizer use. Conversely, age (r = -0.132) and cosmopoliteness (r = -0.008) exhibited weak negative and non-significant relationships, while family size (r = 0.101), farm size (r = 0.062), annual income (r = 0.062), extension media contact (r = 0.183), and organizational participation (r = 0.012) showed weak positive but insignificant associations. These findings emphasize that education and training play a pivotal role in improving farmers' knowledge and adoption of balanced fertilizer practices in Boro rice cultivation.

4. CONCLUSION

In conclusion, it can be said that the sustainable enhancement of Boro rice cultivation plays a vital role in ensuring food security in Bangladesh, which largely depends on improving farmers' knowledge towards proper fertilizer application. Education and agricultural training were found to have a highly positive and significant influence on farmers' knowledge, suggesting that well-educated and trained farmers are more capable of adopting recommended fertilizer practices effectively. On the other hand, factors such as age, annual income, and cosmopoliteness showed negative but insignificant

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relationships with knowledge, while family size, farm size, extension contact, and organizational participation had positive but insignificant effects.

Although many farmers possessed partial knowledge about fertilizer use, they often failed to apply the recommended doses due to economic hardship, lack of motivation, and limited access to technical guidance. In other words, insufficient knowledge and inadequate training facilities were identified as major constraints to the balanced and efficient use of fertilizers in Boro rice cultivation.

Hence, it is suggested that large-scale, practical, and need-based training programs be introduced to strengthen farmers' understanding of fertilizer application in terms of proper timing, proportion, and method. Strengthened extension services, educational initiatives, and close collaboration among government organizations, NGOs, and agricultural departments can play a crucial role in disseminating accurate information and technical support. Providing farmers with improved access to education, credit, and continuous guidance could enhance their decision-making capacity, leading to better fertilizer management and higher productivity.

Therefore, the study concludes that promoting farmer education, agricultural training, and effective extension support can serve as powerful instruments to improve fertilizer application practices, increase crop yields, and ensure sustainable Boro rice production, ultimately contributing to the socio-economic development of the rural farming communities in Bangladesh.

5. SUGGESTION AND DIRECTION FOR FUTURE RESEARCH

It was a small-scale investigation carried out within a limited period and with constrained resources, which naturally led to the purposive selection of the study area. The research was confined to Sunamganj upazila under Sylhet district and relied primarily on the expressed opinions of the respondents, which might not be entirely free from personal perception and bias, despite the researcher's efforts to maintain objectivity. Moreover, the study covered only nine selected characteristics related to farmers' knowledge towards fertilizer application in rice cultivation, which limits the representativeness and generalizability of the findings.

Future research could be expanded to include a larger and more diverse sample across multiple regions of Bangladesh to gain a clearer understanding of the overall situation. Studies incorporating different explanatory and focus variables may also provide deeper insights into the determinants of knowledge and attitude. Additionally, comparative research on the effectiveness of various agricultural extension methods and the identification of influencing factors is recommended.

The findings of this study highlight that education and agricultural training are crucial for improving farmers' knowledge, attitudes, and practices regarding fertilizer use. Therefore, future initiatives should emphasize adult literacy, farmer education, and hands-on training programs through collaboration between government agencies and NGOs. Moreover, addressing financial and supply constraints through subsidies, credit facilities, and

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reliable fertilizer distribution systems is essential. Strengthening agricultural extension services with ICT tools and engaging youth and farmer groups could further enhance sustainable fertilizer management. Expanding such initiatives to a broader scale would contribute significantly to improving productivity, profitability, and sustainable rice cultivation practices in Bangladesh.

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Author Contribution

Nafisa Tabassum: Conceived and designed the experiments, performed the experiments, analyzed and interpreted the data and wrote the paper.

Aysha Akter; Md.Ruhul Amin: Conceived and designed the experiments; Analyzed and interpreted the data and correction of the manuscript.

Conflict of Interest

All authors declare no conflict of interest

Data Availability

Data presented of this study will be available on a fair request to corresponding author.

Ethic Approval

Not applicable to this paper.

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