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Assessment of farmers' knowledge, attitude, and challenges towards biofertilizer application in the Northern Region of Bangladesh

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ABSTRACT

Biofertilizer, considered sustainable agricultural input, holds the potential to replace chemical fertilizers and improve soil health. Still, its limited adoption prompts the need to explore farmers' awareness of the challenges in Bangladesh. Our study focuses on the knowledge, attitude, and challenges related to biofertilizer usage among a hundred randomly selected farmers in the Chapainawabganj District. We exerted a cross-sectional descriptive research technique and a pre-structured questionnaire for data collection through face-to-face interviews. According to the findings, about 52% of the respondents had shallow knowledge about biofertilizers, although the majority (about 67%) had a moderately favorable attitude, indicating enthusiasm to adopt this technology. Additionally, the majority of the farmers strongly supported the idea that increasing publicity initiatives to promote biofertilizer usage would be helpful. Moreover, most of the socio-demographic characteristics of farmers had a significant and positive relationship with their knowledge, where only education and training facilities were positively correlated to their attitude, pointing out that improving these aspects may promote biofertilizer adoption. The study also found that the critical challenges of biofertilizer usage were personal interest gaps, inadequate publicity, lack of awareness about benefits, disorganized training, and high prices or lack of availability. These findings suggest that policymakers and extension service providers should prioritize targeted training and demonstrations to enhance awareness as well as ensure that biofertilizer supplies are affordable and easily accessible.

Keywords: biofertilizer, knowledge, attitude, challenges, sustainable agriculture

INTRODUCTION

Agriculture, the backbone of many economies, is pivotal in ensuring food security and sustainable development. Bangladesh predominantly operates as an agrarian nation, where the majority of its population relies on diverse agricultural subsectors for their sustenance, either through direct involvement or indirect dependence. Based on a report of the Bangladesh bureau of statistics (BBS), approximately 11.20% of the gross domestic product (GDP) for the fiscal year 2022-23 was derived from agriculture, while the agricultural sector engages 45.33% of the total workforce (BBS, 2023). In 2016, agricultural production contributed 17% to the country's GDP, and the proportion of the labor force involved in agriculture exceeded 45% (BBS, 2016). Additionally, the global report on food crises by the Food and Agriculture Organization listed Bangladesh among the top-50 nations with the highest rates of severe food insecurity (Siddique, 2022). All information reflects the contribution of agriculture to our national income and health, appears to be declining. Many entities, including the government, researchers, stakeholders, and crop growers, are working desperately to withstand the situation. As a part of these initiatives, synthetic agrochemicals have been actively pursued in our country. Farmers are injudiciously incorporating these chemicals into their fields, disregarding the potential long-term undesirable consequences. According to the Ministry of Agriculture, Bangladesh required approximately 5 million tons of fertilizer annually in 2016 (BBS, 2016). In the fiscal year 2021-22, the demand for chemical fertilizers was 5.75 million tons. (BBS, 2023). The annual escalation in the utilization of chemical-based fertilizers persists unabated, consequently leading to the gradual depletion of soil fertility in Bangladesh.

Soil Resource Development Institute of Bangladesh stated that soil quality is considered satisfactory when it contains a minimum of 2.5% organic matter. However, a significant portion of Bangladesh's soil contains less than 1.5% organic matter (Siddique, 2022). As a result, several difficulties develop in agriculture, such as the rapid decline of beneficial microorganisms in the soil. Even after using an immense amount of fertilizer, some plants are not growing appropriately because they are not getting the nutrients they need from the soil. Hence, serious consideration is needed for sustainability in agriculture. This situation has led to a surge in demand for alternative, eco-friendly farming practices. Within these practices, biofertilizers have garnered significant recognition owing to their capacity to augment soil fertility, crop yields, and environmental sustainability. Biofertilizer, often referred to as "nature's growth catalyst," is an eco-friendly and living agricultural input derived from beneficial microorganism sand organic matter that actively enhance soil fertility, plant health, and overall crop yield.

When applied to plant, seed, or soil, biofertilizers introduce a variety of mechanisms, such as boosting the amount of nutrients available to plants, their ability to absorb nutrients, and the amount of biomass from roots or root areas available for crop growth (Vessey, 2003). It has been reported to enhance crop output by 20%-35% in comparison to controls and to decrease the use of pesticides and inorganic fertilizers, such as nitrogen (N), phosphorus (P), and potassium (K) fertilizers, by up to 60% (Basak et al., 2015; Singh et al., 2021a).

Realizing the importance of biological approaches in the context of sustainable agriculture, many scientific organizations and institutes are now focusing on the advancement of biofertilizer application. The Bangladesh Institute of Nuclear Agriculture (BINA) developed a nitrogen-fixing biofertilizer and gave it to farmers for testing. They achieved a successful consequence and are anticipated to provide 2 kg of biofertilizer per hectare of pulse field to augment urea of 20-30 kg (Siddique, 2014). BINA has introduced its biofertilizers to the market, and RDA is marching forward in making biofertilizers (troche-compost) and providing training to the farmers. Government and non-government organizations (PROYASH, Chapainawabganj) are currently educating farmers about biofertilizers. However, to the authors' knowledge, a systematic investigation of biofertilizer usage in farmers' fields in the selected northern area of Bangladesh has yet to be reported.

Farmers are the end users of biofertilizers. So, assessing their knowledge, attitude, and challenges about the technical usage of this biological compound can bring significant outcomes that can play a crucial role in lessening environmental pollution and improving soil health. Thus, the study was designed to address the level of knowledge, attitude, and challenges farmers face towards biofertilizers and establish a foundation for future studies across Bangladesh.

METHODOLOGY

Location of the Study Area

The study was conducted in the Chapainawabganj District, which is situated in the northern region of Bangladesh. Consequently, the diverse soil composition in this area provides an advantageous environment for cultivating a wide array of crops, thereby contributing to agricultural prosperity. The study encompassed four upazilas, namely, Chapainawabganj Sadar, Shibganj, Nachole, and Gomostapur, as depicted in **Figure 1**.

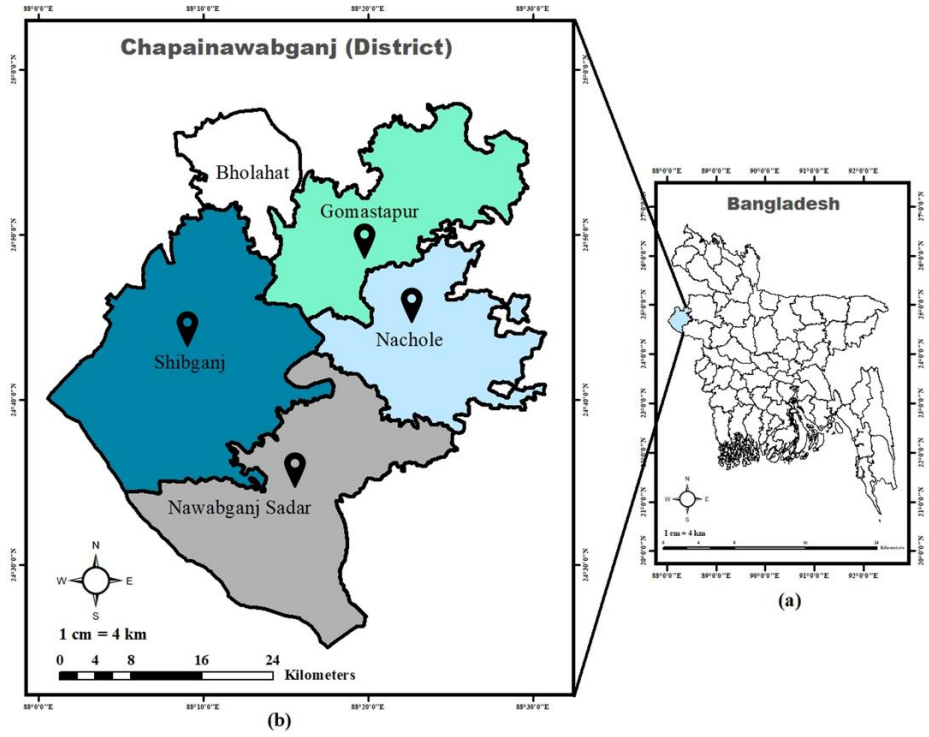

Figure 1. Map of the study area: (a) Chapainawabganj District in Bangladesh and (b) selected four upazilas in Chapainawabganj District viz. Chapainawabganj Sadar, Shibganj, Nachole, and Gomostapur (Source: Authors' own elaboration, generated using ArcMap Version 10.5)

Research Design

This study utilized a cross-sectional descriptive research design and provided a snapshot of the current view of farmers' knowledge, attitudes, and challenges regarding biofertilizer use within a specific period (from March to April 2023).

Sampling

To determine the appropriate sample size, the maximum possible sample size was selected, denoted as p = 0.5. Subsequently, Cochran's (1997) sample size formula was employed to determine the sample size:

$$n=Z^2\frac{pq}{d^2}, \quad (1)$$

where n is the desired sample size, Z is the z-score corresponding to the desired level of confidence, specifically the type I error at a 5% significance level, which is 1.96, p is the estimated proportion of the attribute present in the population, assumed to be 0.5, q is the proportion of individuals lacking the attribute, thus $q = 1 - p$, resulting in $q = 1 - 0.5 = 0.5$, and d is the preferred level of precision or margin of error, with a value of 0.1 used in this case. Thus, n canculated, as follows:

$$n=1.96^2\frac{0.5\times 0.5}{0.1^2}=96.04. \quad (2)$$

However, we collected data from 100 participants of four upazilas by applying the simple random sampling technique. It was applied to obtain a representative sample reflecting the population's knowledge and attitude towards biofertilizers.

Data Collection Procedure

Primary data were collected thorough face-to-face interviews from respondents of four selected upazilas from 19 March to 4 April 2023. We prepared a pre-structured questionnaire incorporating both closed and open ended questions. Closed ended questions utilized rating scales or multiple-choice options to enable quantitative analysis of responses, while open-ended questions encouraged participants to deliver detailed elucidations and opinions. All possible precautions were taken into consideration to reduce bias and to preserve the fidelity of the responses. Secondary data was acquired from journals, books, daily newspapers, and websites.

Measurement of Independent Variables

Independent variables of this study incorporate different socio-demographic factors, viz. age, occupation, education, family-size, farmers' category, annual income, training received, personal contact, and contact with extension personnel.

The age of respondents were calculated in terms of actual years based on his or her statement. The family-size was collected as the actual number of family members. This variable was classified into small (< 4), medium (5-6), and large (> 6) groups. The annual income of the respondents was measured in Bangladeshi taka (BDT) and divided into 3 sections: low (< 83,676 BDT), medium (83,676 to 330,000 BDT), and high (> 330,000 BDT). Educational qualification was measured by the years of schooling and organized into illiterate (0), primary (1-5), secondary (6-10), and higher (above 10). The farm size was grouped into following categories: landless (0.2 ha), marginal (0.21-0.6 ha), small (0.61-1.0 ha), medium (1.01-2.5 ha), and large (> 2.5 ha). Major occupations classified all participants into four categories according to their own statements: farming, dealer farming, business farming, and job farming. Data on respondent's farming experience was collected in actual years and categorized into three different groups: low (< 10 years), medium (11-20 years), and high (> 20 years), and their land types were own, shared, and leased. A 'yes or no' question was asked to assess whether a respondent had received biofertilizer application training from a government organization or not. Personal source encompasses various forms, including interpersonal communication, personal experiences, expert opinions, and direct observations. It was designed into four parts: frequently (one or two times in a month), occasionally (one time in two months), rarely (one to three times per year), and never, and each category was given a score: 4, 3, 2, and 1, respectively. Communication with extension services indicated that farmers became more open to diversified information channels through different teaching methods. The level of interactions with extension agents such as village heads, SAAOs, and AEOs were 'frequently', 'occasionally', 'rarely', and 'never' and the corresponding scores were 4, 3, 2, and 1, respectively. The media source variable captures the extent to which individuals rely on different channels, such as television, daily newspapers, social media, or any online platforms, to gather information. They were divided into four categories in this study: frequently, occasionally, rarely, and never. Each category was assigned a score: 4 = frequently, 3 = occasionally, 2 = rarely, and 1 = never.

Measurement of Dependent Variables

The dependent variables in this study were farmers' knowledge, attitude, and constraints on the biofertilizer usage and application.

Knowledge

A series of fifteen questions was prepared (both open and closed-ended) to evaluate the knowledge of farmers about biofertilizers. A score of 5 was assigned to the correct answer to each question, 3 to the partially correct answer, and 0 to the incorrect response. During the interview process, each question's response was instantly marked. To measure farmers' knowledge of biofertilizers, the following knowledge index method was employed (Jaganathan et al., 2012).

$$Knowledge\ index=\frac{Respondent\ total\ score}{Total\ possible\ score}\times 100. \quad (3)$$

The respondents were split into four different classes based on their achieved knowledge score: very low (<40%), low (40%-59%), moderate (60%-79%), and high (80% and above).

Attitude

The attitude towards technology can be assessed in various ways. In this study, a five-point Likert (1967) scale was utilized to estimate the attitude of farmers toward the application of biofertilizers. There were 18 statements on the scale; 9 were positive, and nine were negative to avoid biases.

Respondents were asked to weigh in on the following responses: 'strongly agree,' 'agree,' 'undecided,' 'disagree,' and 'strongly disagree.' For a positive statement, the states of strongly agree, agree, undecided, disagree, and strongly disagree received the scores of 5, 4, 3, 2, 1, and in that order, the reverse scoring method was applied in case of a negative statement. Rana et al. (2017) employed this method in their respective research to determine the total score of each attitude statement by epitomizing the weights for responses against all respondents.

$$Statement\ attitude\ score = 5 \times SA + 4 \times A + 3 \times UD + 2 \times DA + 1 \times SDA, \quad (4)$$

where SA is the total number of respondents stating their attitude 'strongly agree' with the given statement, A is the total number of respondents indicating their attitude 'agree' with the statement, U is the total number of respondents showing their attitude 'undecided' with the statement, DA is the total number of respondents expressing their attitude 'disagree' with the statement, and SDA is the total number of respondents conveying their attitude 'strongly disagree' with the statement.

Respondents' attitude toward biofertilizers was calculated by adding their scores on all 18 items. The mean (M) and standard deviation (SD) were calculated to categorize the attitude score. According to Hasan et al. (2017), the formula for categorizing attitude based on mean and standard deviations is, as follows:

A = Low: M - 2SD < B ⩽ M − SD

B = Moderate: M - SD < C < M + SD

C = High: M + SD ⩽ D < M + 2SD

The reliability of the attitude was estimated by employing Cronbach's alpha test, a reliability indexing method, connected with fluctuation with an alpha coefficient that ranges from 0 to 1 (Santos, 1999). Cronbach's alpha score was computed for 18 statements of 100 farmer's responses. The established guidelines to explain the internal consistency of Cronbach's alpha value are: '> 0.9 = excellent', '> 0.8 = good', '> 0.7 = acceptable', '> 0.6 = questionable', '> 0.5 = poor', and '< 0.5 = unacceptable'.

Challenges

In this study, twelve statements were used to assess the challenges faced by farmers. Every respondent was independently queried about their obstacles concerning biofertilizers. Responses were instantly noted and further assigned a ranking from 1 to 12. Rank 1 denotes the most frequently marked constraints and rank 12 indicates the least encountered hindrances by farmers.

Data Analysis

The collected data underwent meticulous scrutiny, coding, and successive entry into the computer system for analysis. Descriptive statistics (frequency, percentage, mean, and standard deviation) were employed to reorganize the collected data into informative summaries of findings. We analyzed our data with the help of SPSS, version 26.0. Microsoft Excel was used to produce a diverse array of visually illustrative representations, including graphs and charts.

RESULTS AND DISCUSSION

Socio-Demographic Characteristics of the Respondents

The socio-demographic attributes that can influence farmers' knowledge and attitude of the relative relevance of biofertilizers include age, family size, annual income, educational status, main occupation, farming experience, farmers' category, land ownership, training received, personal source, extension contact, and media source are enlisted in **Table 1**.

According to the age data, the study area had the highest proportion of middle-aged farmers (51%), with an average of 50.90 years, followed by 46% old and 3% young-aged farmers. This finding represents that people in the most productive age actively engage in biofertilizer applications. Concerning the educational status, most of the respondents (41%) had a primary level of education, and 17% of those interviewed had not attended any formal or informal education. The majority of the respondents selected their principal occupation as farming (76%), with an average farming experience of 16.86 years. Out of the 100 farmers interviewed, only 10% were from large families, while 52% of the respondents had medium-sized families with 5 to 6 members, and 38% were from small families. The yearly income of the respondents was 166,660 BDT, which is almost half of the per capita income of 2,765 USD or 303,202 BDT (BBS, 2023). The survey showed that about 53% of farmers had a medium annual income ranging between 83,676 to 330,000 BDT, followed by low (26%) and high (21%) income. The mean land holding per farmer was estimated to be 0.83 ha, where almost two-thirds were categorized as small farmers (61%), and a maximum number of farmers (79%) had their own land for crop cultivation.

According to **Table 1**, 83% of respondents did not experience any training facility for biofertilizer application. This is possible as most of them neither had contact with extension personnel (61%) nor maintained enough networking to possess personal sources of information (73%) about biofertilizers. Moreover, 81% of the respondents interviewed did not use any media to obtain up-to-date information on biofertilizer usage and application strategy.

Knowledge of Farmers on Biofertilizer Application

Farmers need to have basic knowledge of biofertilizers for their appropriate and convenient application in agricultural lands. Existing knowledge about this biological approach can help to identify gaps and develop educational activities to maximize benefits.

Figure 2 illustrates that most of the farmers (52%) under study went through a shallow level of knowledge of biofertilizer applications. This could be logical as a significant number of respondents under study had just completed their elementary education level, and a specific percentage was found illiterate. Meanwhile, only 14% of respondents experienced a high level of knowledge about biofertilizer utilization, maybe because they had constant contact with their personal source or got training on biofertilizer.

Table 1. Distribution of the farmers according to their socio-demographic characteristics (N = 100)

Variables	Respondents				
	Categories	Number (N = 100)	Percentage (%)	M	SD
Age (years)	Young (< 29)	3	3	50.90	11.01
	Middle-aged (29-52)	51	51		
	Old aged (52 >)	46	46		
Educational status	Illiterate (0)	17	17	5.39	4.05
	Primary (1-5)	41	41		
	Secondary (6-10)	24	24		
	Higher (above 10)	18	18		
Main occupation	Farming	76	76	0.39	0.77
	Dealer-farming	9	9		
	Business-farming	12	12		
	Job-farming	3	3		
Farming experience	Low (< 10years)	23	23	16.86	8.77
	Medium (11-20 years)	36	36		
	High (> 20 years)	41	41		
Family size	Small (< 4)	38	38	5.32	6.51
	Medium (5-6)	52	52		
	Large (> 6)	10	10		
Annual income	Low (<83,676 BDT)	26	26	166,660.00	89,828.34
	Medium (83,676 to 330,000 BDT)	53	53		
	High (> 330,000 BDT)	21	21		
Farmer's category	Landless (0.2 ha)	6	6	0.83	0.52
	Marginal (0.21-0.6 ha)	11	11		
	Small (0.61-1.0 ha)	61	61		
	Medium (1.01-2.5 ha)	17	17		
	Large (> 2.5 ha)	5	5		
Land ownership	Own	79	79	2.66	0.69
	Shared	8	8		
	Leased	13	13		
Training	Yes	17	17	0.17	0.37
	No	83	83		
Extension contact	Frequently (1-2 times/month)	14	14	0.83	1.14
	Occasionally (once/2 month)	16	16		
	Rarely (1-3 times per year)	9	9		
	Never	61	61		
Personal source of information	Frequently (1-2 times/month)	18	18	0.72	1.21
	Occasionally (once/2 month)	9	0		
	Rarely (1-3 times per year)	0	9		
	Never	73	73		
Media source of information	Frequently (1-2 times/month)	1	1	0.27	0.61
	Occasionally (once/2 month)	6	6		
	Rarely (1-3 times per year)	12	11		
	Never	81	82		

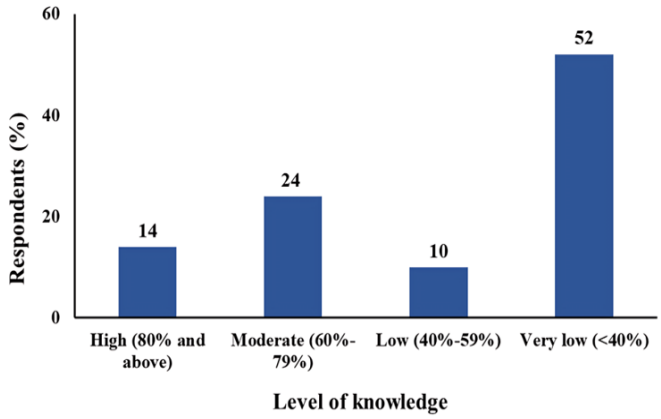

Figure 2. Respondents' knowledge on biofertilizer application in selected areas of Chapainawabganj District (Source: Authors' own elaboration)

Farmers' Attitude Toward Biofertilizer Application

Respondents were asked to rate their attitude towards biofertilizer applications in their field. A rank order was prepared by computing each statement to decide the extent of their attitude to the biofertilizer (**Table 2**). A positive statement, viz. 'a publicity effort to promote using biofertilizers would be helpful', was ranked highest with the maximum average score. This result is consistent with several earlier studies where publicity was described to be more promising in promoting ideas like biomass production and preservation of natural resources (Huang et al., 2016; Xue et al., 2021). The free distribution of biofertilizer for its enhanced use and appropriate instructions from experts on biofertilizer preparation and application were recorded as the second and third most important statements in this study, respectively.

Table 2. Rank order of statements according to attitude score regarding biofertilizers (n = 100)

Attitude statements	Total score	M	Rank
The use of biofertilizers increases the crop yield.	453	4.53	4th
Biofertilizers maintain soil fertility and productivity in the long-term.	451	4.51	5th
Only large farmers can adopt biofertilizers.	435	4.35	11th
Biofertilizers can provide total plant nutrient requirement.	426	4.26	14th
Biofertilizers play an important role in the recycling of plant nutrients.	439	4.39	9th
Biofertilizers have adverse effects on the environment.	449	4.49	6th
Chemical fertilizers work better than biofertilizers.	447	4.47	7th
Biofertilizers can meet up the nutrient requirement of crops as well as improve soil health.	419	4.19	17th
The use of biofertilizers doesn't help to increase the lifespan of farm.	430	4.30	12th
Biofertilizers application & use is complex.	425	4.25	15th
Obtaining biofertilizer on time is challenging.	444	4.44	8th
There is much confusion regarding the use of different biofertilizers.	428	4.28	13th
If biofertilizers are given away for free, their use may increase.	459	4.59	2nd
A publicity effort to promote using biofertilizers would be useful.	463	4.63	1st
Blackening of hands & clothing can't be caused by using biofertilizers.	332	3.32	18th
Specialists should provide instruction on how to prepare and apply biofertilizers and demonstrate the results.	456	4.56	3rd
Using biofertilizers could substitute the application of chemical fertilizers.	438	4.38	10th
Biofertilizers don't provide plant protection.	423	4.23	16th

Note.Cronbach's alpha = 0.838, which indicates a good level of internal consistency in a survey

Table 3. Distribution of the farmers according to their level of attitude towards biofertilizers (n = 100)

Categories	Number	Percentage (%)	Possible score range	Observed score range	M	SD
A. Less favorable attitude (up to 72)	16	16				
B. Moderately favorable attitude (73-85)	67	67	18-90	53-88	78.70	6.65
C. Highly favorable attitude (over 85)	17	17				
Total	100	100				

Note. A = Low: M - 2SD < B ⩽ M - SD; B = Moderate: M - SD < C < M + SD; & C = High: M + SD ⩽ D < M + 2SD

According to several findings, farmers showed the tendency to adopt newly applied technologies or methodologies only due to their free distribution (Enyong et al., 1999; Jansen et al., 2010). Moreover, farmers are significantly influenced by agricultural professionals for the application of technologies in their cultivable lands (Govindharaj et al., 2021). Similar findings were also observed regarding pesticide application in farmers' fields (Bagheri et al., 2018; Monfared et al., 2015).

Farmers' attitudes towards biofertilizers were measured by collecting and calculating respondents' total attitude scores of 18 statements. The level of attitude was categorized into three categories based on their score (Hasan et al., 2017), which is represented in **Table 3**. According to **Table 3**, 67% of the respondents had a moderately favorable attitude, while 17% had a high and 16% had a less favorable attitude toward biofertilizer application in the selected study area. This result suggests that farmers in the study area are enthusiastic about applying biofertilizers in their fields. Magarvadiya et al. (2014), Rathod et al. (2017), and Vanpariya et al. (2020) also found similar results in their studies.

Barriers Faced by Farmers in Biofertilizer Application in the Study Area

Each biofertilizer applicator involved in the study area was requested to prioritize the problems of biofertilizer application. Accordingly, personal gaps of interest and social barriers, insufficient promotional activities, and inferior knowledge of the benefits of biofertilizer usage were found to be the top three constraints for biofertilizer applicators in the study area. The detailed result is summarized in **Figure 3**.

The result agrees with Parmar et al. (2017), Singh et al. (2021b), Naik and Rakesh (2022), and Sankar (2023), where they mentioned that more than half of the respondents had a lack of knowledge and awareness about biofertilizers. Pathak and Christopher (2019) found similar results in biofertilizer usage in the Madhya Pradesh of India. According to the findings of Katole et al. (2017) and Diptesh and Chauhan (2016), the haphazard arrangement of training and demonstration by the extension personnel on biofertilizer preparation and application was noted as the key reason for the current situation of biofertilizers.

Relationships

Relationships between some selective characteristics of farmers and their knowledge on biofertilizers

The correlation coefficient was assessed to explore the relationships between some selected socio-demographic attributes of farmers and their knowledge about biofertilizer application. The relationships have been shown in **Table 4**.

It demonstrates that annual income, training, contact with extension personnel, and personal and media sources of information of the farmers had a significant positive relationship with their knowledge of biofertilizer application at the 1% significance level. The principal occupation and farming experience were also positively and significantly correlated to the knowledge of the farmers in biofertilizer application. Rathod et al. (2017) found a favorable relationship between knowledge, annual revenue, and farming experience. The results imply that these selected personal attributes have remarkably influenced farmers' knowledge of biofertilizer usage and implementation.

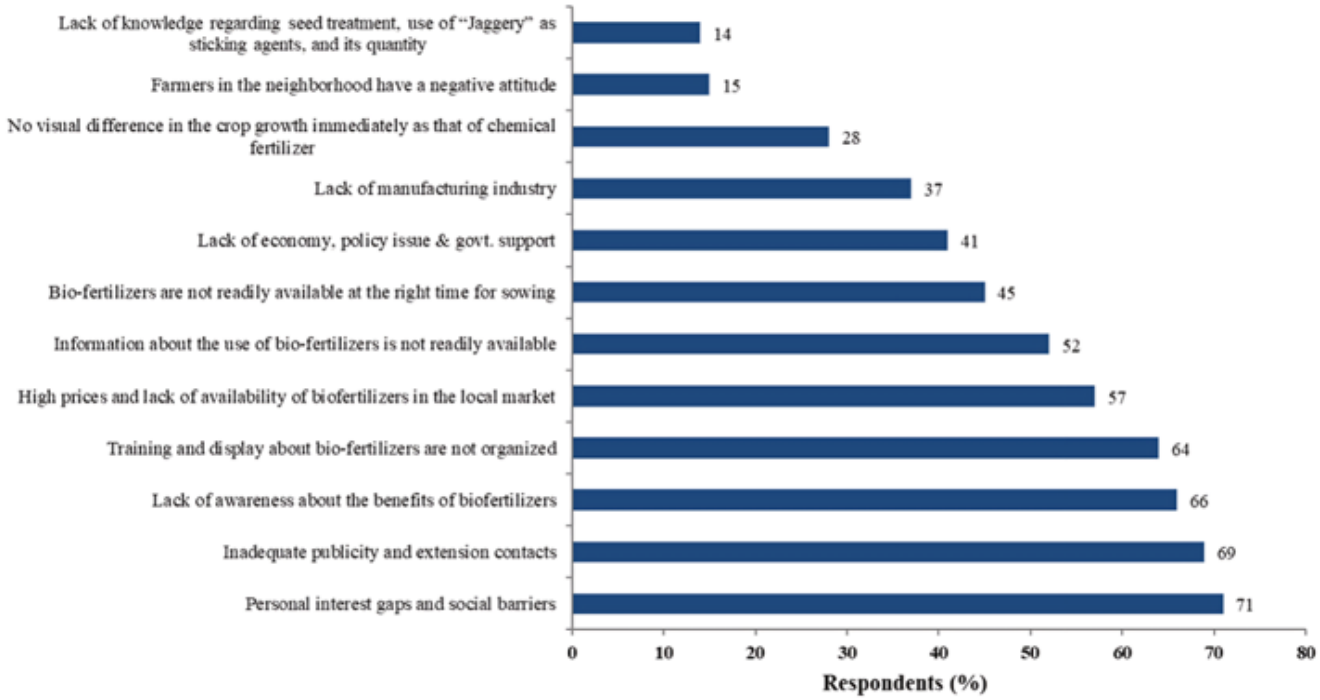

Figure 3. Distribution of the farmers according to challenges related to biofertilizer usage and application (Source: Authors' own elaboration)

Table 4. Relationship between the selective characteristics of farmers and their knowledge on biofertilizers

Selected socio demographic characters	Co-efficient of correlation (r)
Age	0.024
Family size	-0.096
Annual income	0.433**
Educational status	0.081
Main occupation	0.214*
Farming experience	0.206*
Farmers' category	0.021
Land ownership	-0.050
Training received	0.695**
Personal source of information	0.691**
Extension contact	0.610**
Media source of information	0.269**

Note. *Significant at 0.05 level of probability & **Significant at 0.01 level of probability

Table 5. Relationship between the selective characteristics of farmers and attitude on biofertilizers

Selected socio demographic characters	Co-efficient of correlation (r)
Age	0.120
Family size	-0.013
Annual income	-0.017
Educational status	0.224*
Main occupation	0.007
Farming experience	-0.127
Farmers' category	-0.042
Land ownership	-0.016
Training received	0.274**
Personal source of information	0.082
Extension contact	0.070
Media source of information	-0.069

Note. *Significant at 0.05 level of probability & **Significant at 0.01 level of probability

Relationships between some selective characteristics of farmers and their attitude on biofertilizers

Table 5 shows the results of the correlation between each of the farmers' selected socio-demographic characteristics and their attitude towards biofertilizer usage and application.

According to **Table 5**, farmers' educational status and training receiving experience had a positive significant relationship to their attitude towards biofertilizer application. Vanpariya et al. (2020) also reported education as a significant relationship with attitude. This relationship suggests that farmers who received higher education and biofertilizer training facilities were likely to have greater favorable attitude towards biofertilizers.

CONCLUSION

Our study demonstrated that farmers in the selected area possess a minimal level of knowledge about biofertilizer application, which hindered their willingness to adopt it. The key constraints to exploit the untapped potential of biofertilizer usage included lack of personal motivation, poor promotion, limited awareness about benefits, and disorganized training. Despite the knowledge gap and multiple challenges, the attitude indicates that many were open to using biofertilizers. Moreover, the arrangement of special training and educational campaigns on biofertilizer implementation could improve both the attitude and knowledge of farmers. So, the study recommends developing targeted biofertilizer training programs and information sources to encourage biofertilizer use, setting a precedent for future studies in similar farming communities.

Author contributions: MEH: Data curation, formal analysis, software, visualization, writing - original draft; **STM, SA, & MS:** data curation, software, writing - original draft, and revision; **AAR:** conceptualization, investigation, methodology, project administration, resources, supervision, writing - original draft; **MMR:** methodology, project administration, software, supervision, validation, visualization, writing - review & editing. All co-authors agree with the results and conclusions.

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Ethical statement: The authors stated that the ethical committee approval was not needed for the study as the research methods had no effect on the subjects or their environment. The authors further emphasized that the highest ethical standards were followed during the study by maintaining the anonymity of all data and ensuring the results were done with the complete integrity and transparency.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from corresponding author.

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