Bangladesh Rural Development Studies, 26(1), 2023 (49-60)

Bangladesh Rural Development Studies (BRDS)
ISSN 1019-9624; Web: www.rda.gov.bd

Adoption of rice production technologies: Experience from farmer field schools in Bangladesh

M. Nazrul Islam[1*], M. Hammadur Rahman[2], M. Zulfikar Rahman[2]

[1] Department of Agricultural Extension, Ministry of Agriculture, Bangladesh.

[2] Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh, Bangladesh.

ARTICLE INFO

Keywords:
Adoption
Farmer field school
Integrated farm management
Department of Agricultural Extension
Rice production technologies

Received: 11 December, 2022
Revised: 26 May, 2023
Accepted: 14 June, 2023

***Corresponding Email:**
nazrul67588@gmail.com

ABSTRACT

Adoption of improved agricultural technologies is important drivers of agricultural development. On the other hand, farmer field school (FFS) approach is an important extension approach to disseminate the technologies provided an empirical framework for the study. The main focus of this study is to determine the extent of adoption and factors affecting adoption of selected rice production technologies in Bangladesh using the FFS approach. A sample of 338 farmers (including 182 FFS farmers and 156 non-FFS farmers) was chosen for the study using random sampling. Data were collected from Kaliganj Upazila under Lalmonirhat district in Bangladesh where the Department of Agricultural Extension (DAE) implemented FFSs under integrated farm management component (IFMC) Programme from the first phase (2013-2018). Data were collected by using a pre-test interview schedule. The Statistical Package for Social Sciences (SPSS) version 20 software was employed in analyzing primary data. As per results, the adoption rate was found to be higher among the FFS farmers compared to non-FFS farmers. Factors (farmers' characteristics) like innovativeness, risk orientation, knowledge on Integrated Farm Management (IFM), extension media contact, and access to market facilities affected adoption of rice production technologies. Therefore, it is recommended that the Department of Agricultural Extension (DAE) conduct more FFS in the country, and five factors, namely risk orientation, extension media contact, innovativeness, market access and knowledge on integrated farm management that significantly affect adoption, should be taken into account when disseminating new technologies for rice cultivation. The findings of the study may be a support for DAE and other extension organizations in planning to further design programmes filling the research gap in rice production of the country.

How to Cite: Islam, M. N., Rahman, M. H., & Rahman, M. Z. (2023). Adoption of rice production technologies: Experience from farmer field schools in Bangladesh. *Bangladesh Rural Development Studies, 26*(1), 49-60.

Introduction

The world population is increasing day by day. It is no longer possible to meet the needs of increasing numbers of world population and to achieve food security by expanding areas under cultivation since the fertile land is not increasing over time. But this problem can only be solved by increasing agricultural productivity of farm households. However, achieving agricultural productivity growth will not be possible without developing and disseminating yield-increasing technologies and adoption of these technologies by farm households (Challa and Tilahun, 2014).

In Bangladesh, almost 72% of the cropped land is used to grow rice, which accounts for more than 90% of the grain production in the country (BBS, 2018). Rice productivity and total rice output in Bangladesh have chance to expand if appropriate management technologies are applied. However, farmers usually do not use improved agricultural technologies, which cause a yield gap between the farmer's field and the possible output of a specific variety of rice in the country (Shelly et al., 2016). It is true that in order to make a beneficial impact on agriculture, it is essential to convey modern technologies to rice farmers and encourage their adoption of those technologies. The farmer field school (FFS) is a popular way to teach farmers how to make farming decisions that fit different and changing field conditions (Van den Berg et al., 2020). It is obvious from the existing literature that the adoption of technologies is influenced by a number of factors (Farid et al., 2015). Understanding the factors that influence or hinder adoption of agricultural technology is essential in planning and executing technology related programmes for meeting the challenges of food production in developing countries (Mwangi & Kariuki, 2015). Some studies (Hossain, 2017; Jacob, 2012; Kabir, 2015; Moniruzzaman, 2009; Roy et al., 2013) have been undertaken in Bangladesh addressing different farming components and constraints related to FFS approach. But no direct study was conducted on adoption of modern technologies through FFS. On the other hand, it is a great challenge to recognize the major adoption barriers in order to successfully encourage farmers' adoption of advanced agricultural technologies (Zheng et al., 2022). To find the way to overcome this challenge, a number of adoption related studies were undertaken by Miah et al. (2015), Nazu et al. (2021), Rahman et al. (2020), and Sarker et al. (2021). However, not enough literature related to adoption of agricultural technologies at the household level is available in the country (Tama et al., 2021). Considering the facts, the researcher has undertaken the study to get answers of the following research questions:

i. What is the status of FFS and non-FFS farmers in adopting rice production technologies?
ii. What are the factors affecting the adoption of rice production technologies transferred through FFS by the farmers?

Materials and methods

Locale, population and sample

The study was conducted at Kaliganj Upazila in Lalmonirhat district, the northern part of Bangladesh where 52 integrated farm management FFS (IFM-FFS) were implemented during 2013–2018. An experimental design was used in association with a cross sectional survey. Using Cochran's (1977) sample size formula 182 farmers were randomly selected from the list of 2600 FFS farmers. As there is no list of non-FFS farmers and potential participants were hard to find, 156 non-FFS farmers were randomly selected from the same communities of FFSs in eight unions (at least 18 per union). Thus, a total of 338 farmers (both FFS and non-FFS) were selected as a sample for the study.

Variables and their measurement

Farmers' adoption of rice production technologies was the main focus variable of the study. Ten technologies out of 21 transferred through IFM-FFS were chosen for the study based on judge ratings. The technologies were ideal seedbed, proper aged seedlings, roguing, line transplanting, farm yard manure (FYM), vermicompost, guti urea and light trap. Adoption of these technologies was measured by asking the respondents whether they adopted the technologies or not where the responses for a particular technology were coded as 1 and 0, respectively. Sixteen characteristics of the farmers

Table 1: Selected characteristics of the farmers and their measurement

Farmers' characteristics	Methods of measurement
Age	Measured based on actual years
Level of education	Unit scores (1, 2, 3 etc.) was given for each completed schooling year
Household size	Total number of household members
Farm size	Total land owned by the respondents measured in hectare (ha)
Annual household income	Measured by calculating annual household income of a respondent from different sources (calculated in Thousand Taka)
Farming experience	Year of farming experience of the respondents
Aspiration	A 4-point rated scale (score 0, 1, 2 and 3 for four options) was used for nine items of aspiration. Possible score range was 0 to 27.
Training exposure	Measured by counting duration of different training received in days
Risk orientation	A 5-point Likert scale (1, 2, 3, 4 and 5 for 'strongly disagree', 'disagree', 'undecided', 'agree' and 'strongly agree' respectively) was used for nine items of risk orientation. Possible score range was 9 to 45.
Extension media contact	A 4-point rating scale (0, 1, 2 and 3 for contact with media as 'frequently', 'occasionally', 'rarely' and 'not at all' respectively) was used for twelve items of extension. media contact. Possible score range was 0 to 36
Credit exposure	Measured based on credit received by a respondent in the previous year expressed as thousands of taka.
Innovativeness	Measured based on the extent of adoption of specific technology using by a respondent. A 4 point rated scale (0, 1, 2, and 3 for 'do not use', 'adopted after 1 year', 'adopted after 2-3 year' and 'adopted after 4-5 year') was used for ten innovations (modern technologies. Possible score range was 0 to 30.
Organizational participation	Measured based on the degree of a respondent's involvement in all organizations. A 4 point rated scale (0, 1, 2, and 3 for extend of participation as 'no involvement', 'ordinary member', 'executive committee member' and 'president/secretary/treasurer. Secretary/ Treasurer) was used for nine items. Possible score range was 0 to 27.
Attitude towards FFS	A 5-point Likert scale (1, 2, 3, 4 and 5 for 'strongly disagree', 'disagree', 'undecided', 'agree' and 'strongly agree' respectively) was used for ten items. Possible score range was 10 to 50
Market access	A 5-point rated scale (1, 2, 3, 4 and 5 for degree of facilities as 'very poor', 'poor', 'average', 'good' and 'very good') was used for three items regarding nature of market access for the respondent. Possible score range was 10 to 50.
Knowledge on IFM	Measured assigning score for twenty items as per Bloom's revised taxonomy of cognitive learning domain (Anderson and Krathwohl, 2001). Twenty one items were assigned for different knowledge components (Scoring for remembering-04, understandning-04, understanding-04, applying-04, analyzing-04, evaluation-03 and creating-02).Possible score range was 0 to 43.

were considered as factors (independent variables) affecting the adoption. The variables were measured as stated in the Table 1. Test-retest (Table 2) was done in this study as it is one of the most straightforward methods for estimating reliability. In this case, a correlation (the r' value) was found to be greater than 0.90, which is considered good for perceptual field tests (Hajjar, 2018). The values of the Chronbach's alpha (between 0.6 and 0.8) used to measure the internal consistency for the items of the scale variables (Table 3).

Table 2: Results of the test-retest method for scale variables

Sl. No.	Variables	Test-retest 'r' value (N=20)
1	Aspiration	0.962**
2	Risk orientation	0.984**
3	Extension contact	0.996**
4	Innovativeness	0.948**
5	Attitude towards FFS	0.924**
6	Market access	0.989**
7	Knowledge on IFM	0.995**
8	Attitude towards intension	0.917**
9	Subjective norms	0.988**
10	Perceived behavioural control	0.993**
11	Intensions to adopt technologies	0.914**
12	Adoption of rice production technologies	0.996**

Data collection and analysis

A structured interview schedule was developed in accordance with the objectives of the study and through a series of activities, which include literature review, discussion with the farmers of the study area and consultation with the academicians, extension experts and researchers from various research institutes and universities. The interview schedule was piloted among 20 farmers of the study area and necessary modifications and improvements were done based on the experiences of the pilot study. Data were collected by the researcher through face-to-face interviews using the pre-tested structured interview schedule from August to November, 2021. Data were coded, compiled and analyzed with the use of SPSS version 20. Descriptive statistics like frequency distribution, percentages, mean and standard deviations were used to describe the characteristics of the respondents and the main variables. The t-test for the difference in mean values was done to compare the specific characteristics of FFS and non-FFS farmers. The Pearson correlation coefficient was used to examine the probability relationship between adoption and specific farmer characteristics.

Table 3: Results of the internal consistency for the items of scale variables

Sl. No.	Variables	Chronbach's Alpha (n = 338)
1	Aspiration	0.777
2	Risk orientation	0.709
3	Extension contact	0.736
4	Innovativeness	0.606
5	Attitude towards FFS	0.724
6	Market access	0.721
7	Knowledge on IFM	0.812
8	Attitude towards intension	0.654
9	Subjective norms	0.580
10	Perceived behavioural control	0.846
11	Intensions to adopt technologies	0.606
12	Adoption of rice production technologies	0.704

Linear and stepwise multiple regression analyses were conducted in order to determine the overall influence of the characteristics on the adoption of selected agricultural technologies for rice production. Only factors with a significant association to rice production technology adoption were included in the regression analysis model.

Results and discussions

Socio-economic characteristics of farmers

In total 16 socio-economic characteristics of respondent farmers were taken into account for the study. The characteristics were age, education, household size farm size, annual household income, farming experience, aspiration, training exposure, risk orientation, extension contact,

Table 4: Salient features of the selected characteristics of respondents

Characteristics (Measuring unit)	Possible range	Observed range		Mean and Standard deviation		't' value for difference of means
		FFS farmer	Non-FFS Farmer	FFS farmer	Non-FFS farmer	
Age (Year)	Unknown	23-76	25-76	46.66 (11.53)	47.30 (13.40)	-0.473
Level of education (Level of pass year)	Unknown	0-14	0-14	6.97 (4.47)	5.36 (4.54)	3.274**
Household size (Number of person)	Unknown	1-15	1-12	5.32 (2.11)	5.01 (1.97)	1.372
Farm size (Hectare)	Unknown	0.06-4.87	0.11-3.93	1.11 (0.78)	0.75 (0.56)	4.768**
Annual household income (Thousands Taka)	Unknown	55-1530	87-1127	387.86 (197.23)	278.90 (158.6)	2.487*
Farming experience (Year)	Unknown	5-60	3-60	31.26 (14.07)	30.49 (12.24)	-0.536
Aspiration (Scale score)	0-27	3-23	7-24	15.20 (4.1)	13.46 (3.73)	4.028**
Training exposure (Days)	Unknown	0-90	0-10	2.30 (7.80)	0.30 (1.25)	3.167**
Risk orientation (Scale score)	9-45	21-40	19-35	31.84 (3.96)	26.56 (3.217)	13.303**
Extension media contact (Scale score)	0-36	4-22	2-20	14.13 (3.67)	9.16 (3.23)	13.105**
Credit exposure (Thousands Taka)	Unknown	0-600	0-200	26.19 (60.22)	10.49 (26.70)	3.012**
Innovativeness (Scale score)	0-30	5-24	2-16	11.66 (3.22)	7.38 (2.35)	13.746** (0.000)
Organizational Participation (Scale score)	Unknown	0-114	0-120	12.18 (19.76)	4.46 (13.92)	4.089**
Attitude towards FFS (Scale score)	10-50	24-45	21-37	35.30 (4.15)	30.53 (3.30)	11.563**
Market access (Scale score)	3-15	5-12	6-12	8.96 (1.32)	8.57 (1.28)	2.689**
Knowledge on IFM (score)	0-43	14-43	3-35	27.59 (5.42)	18.46 (4.26)	16.999**

SD[1]= Standard deviation

***** P<0.01, **P<0.05 and *P<0.10 are the level of significance**

Table 5: Categories of the respondent farmers based on their overall adoption status of rice production technologies

Possible score range: 0-10, observed range:1-9

Categories based on adoption of technologies (score)	FFS farmer (n=182)		Non-FFS farmer (n=156)		FFS farmer		Non-FFS farmer		't' value (for compare means)
	Freq.	Percent	Freq.	Percent	Mean	Std.	Mean	Std.	
Non adoption (0)	0	0	2	1.3	6.70	1.14	4.21	1.36	18.38***
Low adoption (Less than 4)	3	1.6	41	26.3					
Medium adoption (4 to 7)	138	75.9	112	71.8					
High adoption (above 7)	41	22.5	1	0.6					

Freq. = Frequency; Std. = Standard deviation, ***= P<0.01

credit exposure, innovativeness, organizational participation, attitude towards FFS, market access and knowledge on IFM. Based on the analysis, it was found that most of the farmers were between middle-aged and old. The highest proportion of the farmers had secondary level education, while a considerable portion had no formal education or was illiterate. Because of the FFS selection procedure, a few FFS farmers had a graduate or higher level of education. The average household size of both FFS and non-FFS farmers (5.32 and 5.01 persons, respectively) was higher than the national average of 4.06 (BBS, 2018a). The majority of FFS (56.6%) and non-FFS (69.9%) farmers were classified as small to medium. The majority of FFS farmers (43.4%) had a high annual income, while the majority of non-FFS farmers (46.8%) had a low annual income. The majority of FFS (88.5%) and non-FFS farmers (85.3%) had high levels of farming experience. The majority of farmers, both FFS and non-FFS, had a moderate level (above 60%) of aspiration. FFS farmers received more training than non-FFS farmers. It could be observed that the majority of FFS farmers (60.5%) had a medium to high level of risk orientation. On the contrary, most of the non-FFS farmers (93%) were medium-risk oriented, and only a negligible portion (1.9%) had a high-risk orientation. The majority of the FFS farmers (78.1%) had medium level extension media contact. However, the majority of non-FFS farmers (73.1%) had little or no extension contact. The majority of FFS (56%) and non-FFS (74.4%) farmers had no credit exposure. It was found that FFS farmers had more access than non-FFS farmers. The majority of FFS farmers (61.6%) had moderate innovativeness, whereas most non-FFS farmers (91.7%) had low innovativeness. The highest number of FFS farmers (37.9%) and non FFS farmers (75%) had no organizational participation, indicated that FFS farmers participated in more organizations than non-FFS farmers. FFS farmers were more likely to participate in social organizations also. The majority of the respondent farmers (>60%) had a favourable attitude towards FFS. The majority of the farmers (>70%) had medium access to market facilities. FFS farmers had significantly higher IFM knowledge scores than non-FFS farmers. The t-value for the difference in means and other additional information are presented in Table 4.

Adoption of improved agricultural technologies transferred through FFS

Respondent farmers were classified based on their adoption of 10 different technologies. The descriptive statistics are presented in Table 5. It was found that there were no FFS farmers who did not adopt any of the 10 technologies, whereas a few (1.3%) non-FFS farmers belonged to this category. The majority of FFS farmers were medium (75.9%) to high adopters (22.5%) and only a few (1.6%) were low adopters. Similarly, the majority of non-FFS farmers (71.8%) were medium adopters, but a considerable percentage of them (26.3%) were low adopters. High adoption rates were found in only a negligible percentage (0.6%) of non-FFS farmers. Shah et al. (2014) and Ekram et al. (2018) found almost similar result in their study.

Table 6: Adoption of improved technologies for rice production by the farmers

Technologies	FFS farmer (182)		Non-FFS farmer (156)	
	Frequency	Percent	Frequency	Percent
Ideal seedbed	177	97.3	120	76.9
Air sealed container	179	98.4	151	96.8
Proper aged seedling	182	100	139	89.1
Rogueing	180	98.9	71	45.5
Line transplanting	173	95.1	119	76.3
Crop rotation	159	87.4	32	20.5
FYM	108	59.3	8	5.1
Vermicompost	32	17.6	2	1.3
Guti urea	27	14.8	9	5.8
Light trap	3	1.6	0	0

There was a difference between FFS and non-FFS farmers in the adoption of various technologies transferred through IFM-FFS ('t'-value 18.38). The descriptive statistics on the adoption of specific IFM technologies for the production of rice by FFS and non-FFS farmers are presented in Table 6.

Ideal seedbed

From Table 6, it can be revealed that 97.3% of FFS farmers adopted ideal seed bed technology, whereas 76.9% of non-FFS farmers adopted this. FFS farmers had a high percentage because they practiced ideal seedbed in an experimental plot during FFS sessions and observed the results.

Air sealed container

Using an airtight container is a very effective and popular technology for seed preservation. Table 6 demonstrates that 98.4% of FFS farmers used this technology, while 96.8% of non-FFS farmers used it for seed preservation. FFS farmers had a slightly higher adoption rate because they were taught about this in FFS sessions and practiced in experimental plots. Non-FFS farmers in the community, however, had access to the technology from DAE personnel and FFS farmers. As a result, the adoption rate of them has also been found to be high.

Proper aged seedling

The age of the seedling is important because it has a significant impact on tiller production, grain formation, and other yield-related characteristics (Faruk et al., 2009). From the table, it has been found that, all of the FFS farmers (100%) utilized this technology in their crop cultivation. But in case of non-FFS farmers, 89.1% of farmers adopted this technology.

Rouging

Two times roguing, combined with an optimal fertilizer dose, results in the best seed production in rice (Sultana et al., 2019). As per Table 6, almost all FFS farmers (98.9%) adopted roguing for quality seed production, whereas only 45.5% of non-FFS farmers did. FFS farmers had the opportunity to learn and practice quality seed production in experimental plots during FFS sessions. Therefore, their percentage was comparatively high in this case.

Line transplanting

Line transplanting method produce the highest total tillers, effective tillers hill^{-1}, grain yield and harvest index of rice (Sarker et al., 2014). Almost all FFS farmers (95.1%) transplanted rice in line; on the contrary, 76.3% of non-FFS farmers did exactly the same thing (Table 6).

Crop rotation

The social, economic, and environmental benefits of rice cultivation are considerably increased when agricultural diversification is achieved through rotations (Dun-Chun et al., 2021). That is why crop rotation is considered important technology for modern rice production. Table 6 shows that 87.4% of FFS farmers and only 20.5% of non-FFS farmers adopted this technology in their crop cultivation. FFS farmers had a higher adoption rate because they had more opportunities to realize the benefits of crop rotation through FFS sessions.

Farm yard manure (FYM)

Table 6 demonstrates that farm yard manure (FYM) was used by 59.3% of FFS farmers and only 5.1% of non-FFS farmers. This was due to the fact that FFS farmers had greater opportunities to learn about soil and crop management technology than non-FFS farmers (Bunyatta et al., 2006). The non-FFS farmers adopted this less likely than FFS farmers because they were unaware of its benefits.

Vermicompost

Vermicompost enhances productivity significantly when combined with other traditional inputs, and its users are more technically proficient (Rahman & Barmon, 2019). However, the technology did not make a significant impact on the farming community. Table 6 shows that 17.6% of FFS farmers and only 1.3% of non-FFS farmers adopted it. This might be the reason that FFS farmers learned the use and application of vermicompost in FFS sessions but did not broadly apply it in their fields because of technical complexity and other limitations. On the other hand, the non-FFS farmers practically had no or very few opportunities to observe the benefits of the application of vermicompost.

Guti urea

Farmers' involvement in the use of guti urea technology has a large beneficial effect on farm productivity and a 1.00% increase in adoption of guti urea technology results in a considerable boost in agricultural productivity when other factors remain the same (Sarma, 2021). But this technology was not properly adopted by the farmers due to many constraints, like sandy soil type, unavailability in the market during the season, high price, and application complexity (Sikder & Xiaoying, 2014). As per Table 6, 14.8% of FFS farmers and only 5.8% of non-FFS farmers adopted this technology in rice fields. This was because FFS farmers were actively involved in the application of guti urea during training sessions and could see the direct benefits from it.

Light trap

The light trap is an effective instrument for forecasting and controlling insect pest attacks in crop fields. However, this is not widely used by the farmers in Bangladesh. DAE officials and other extension agents make an attempt to spread this information to farmers. According to Table 6, only 1.6% of FFS farmers used this in their field. However, the adoption rate was found to be 0% among non-FFS farmers.

Contribution of the farmers' characteristics and adoption of rice production technologies transferred through FFS

The correlation coefficient (r) reported in Table 7 indicates that twelve of the sixteen selected characteristics were significantly associated with

Table 7: Relationship between adoption and selected characteristics of all farmers (both FFS and non-FFS farmers)

Farmers' Characteristics	Correlation Coefficient (r) with 336 df
Age	-0.057
Level of education	0.159**
Household size	0.044
Farm size	0.214**
Annual household income	0.191**
Farming experience	-0.063
Aspiration	0.200**
Training exposure	0.103
Risk orientation	-0.148**
Extension media contact	0.567**
Credit exposure	0.158**
Innovativeness	0.652**
Organizational participation	0.121**
Attitude towards FFS	0.438**
Market access	0.187**
Knowledge on IFM	0.540**

** Correlation is significant at the 0.01 level; df = degrees of freedom

Table 8: Regression coefficient of adoption with the selected characteristics of the farmers

Farmers' characteristics	Unstandardized coefficients B	Unstandardized coefficients Beta	t- value
Constant	-1.206		-1.585
Level of education	-0.012	-0.031	-0.689
Farm size	-0.008	-0.003	-0.070
Annual household income	-0.834	-0.009	-0.182
Aspiration	-0.006	-0.015	-0.316
Risk orientation	0.090	0.230***	4.604
Extension media contact	0.061	0.149***	2.745
Credit exposure	-0.001	-0.024	-0.566
Innovativeness	0.188	0.379***	7.128
Organizational participation	-0.003	-0.028	-0.669
Attitude towards FFS	-0.005	-0.013	-0.261
Market access	0.103	0.079**	2.025
Knowledge on IFM	0.046	0.173***	3.207

R^2 = 0.545, Adjusted R^2 =0.528 F value = 32.432, P<.001

the adoption of rice production technologies through FFS. However, the results of the linear regression analysis (Table 8) showed that the regression coefficients of five factors, namely risk orientation, extension media contact, innovativeness, market access, and knowledge on IFM were statistically significantly associated to rice production technology adoption. The other variables had no meaningful impact on adoption.

The R^2 value was 0.545 and the corresponding F-value was 32.432 which were significant at .001 level. The R^2 value indicated that 54.5% of the total variation in the adoption of rice production technologies was explained by the 5 variables included the regression analysis. The adjusted R^2 =0.528, indicating that the model accounted for 52.8% of total variance in criterion variables indicating very little multicollinearity. However, to find out actual contribution of the factors affecting the adoption of technologies, the stepwise multiple regressions was carried out (Table 9).

Table 9 reveals that adoption of rice production technologies was positively and significantly influenced by farmers' innovativeness. This could be because innovative farmers realized the benefits of the technologies and gathered practical experiences with the technologies transferred through FFS. They are continuously looking for

Table 9: Stepwise multiple regression coefficient of adoption with the selected characteristics of the farmers

Farmers' Characteristics	Unstandardized coefficients B	Unstandardized coefficients Beta	t-value
Constant	-1.421		-2.343
Innovativeness	0.181	0.367***	7.330
Risk Orientation	0.092	0.235***	5.084
Knowledge on IFM	0.037	0.150***	3.093
Extension media contact	0.055	0.132***	2.580
Market access	0.107	0.082***	2.145

R^2 =0.541, Adjusted R^2 =0.534, F value =78.283, P<.001

new ways to improve their practises; hence, they adopt technologies faster than other farmers. Congnogo et al. (2021) and Mishra et al. (2018) also observed similar finding.

Usually, farmers differ greatly in their willingness to take or avoid risks while making decisions. That is why more risk-oriented farmers are usually more likely to adopt technologies. In this study, the farmers who realized the benefits of the improved technologies took the risk of adopting the technologies. The result is supported by Congnogo et al. (2021).

IFM knowledge had a significant impact on the adoption of rice production technologies. Farmers with greater knowledge of IFM were more inclined to use the technologies because they were more aware of their benefits. This finding is consistent with the study of Chuang et al. (2020).

Access to extension services is often regarded as a critical aspect of technology adoption. Many authors have found a significant relationship between extension services and technology adoption. Agricultural extension agents usually play a significant role in the dissemination of agricultural technologies to farmers through various training programmes, group approaches, individual contact, demonstrations, and field days. Participating farmers might learn technology through the FFS approach, which was led by extension agents or trained farmer facilitators, and non-FFS farmers could learn from them. On the other hand, farmers had a great opportunity to learn and were motivated to adopt technologies through various print and electronic media. That is why extension media contact was found to have a significant relationship with the adoption of improved rice production technologies (Table 5). Almost similar findings were found by Shah et al. (2014) and Walisinghe et al. (2017).

From Table 8, the findings suggest that there was a significant and positive relationship between the adoption of improved rice production technologies and market access. Access to the market primarily consists of the ability to sell agricultural products, as well as storage and transportation facilities for agricultural products from farm to market. Considering these points, a farmer usually decides to adopt improved technologies regarding rice production. This finding is similar to the findings of Ali et al. (2021) and Sarker et al. (2021).

Conclusions

FFS farmers had a much greater adoption rate of improved rice farming technologies than non-FFS farmers. It was discovered that farmers' innovativeness, risk aversion, knowledge of IFM, extension media contact, and access to the market facilities play a significant role in determining the adoption of improved technologies for rice cultivation. Therefore, the implementation authorities (DAE and others) should organize more FFS in other parts of the country to ensure that improved technologies for rice farming are successfully implemented. The factors influencing the adoption of rice production technologies should be taken into account when promoting the adoption of technologies in the rice farming system.

Acknowledgements

The researchers would like to acknowledge the Bangabandhu Science and Technology Fellowship Trust, Ministry of Science and Technology, Government of Bangladesh for funding this research. The authors would also like to express their appreciation to the farmer facilitators and, of course, the responding farmers for their assistance in the research.

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