

ADOPTION OF MANGO VAR. BARI AAM-3 BY THE GROWERS IN NAOGAON AND CHAPAINAWABGANJ DISTRICTS OF BANGLADESH*

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Abstract

The mango variety 'BARI Aam-3', popularly known as 'Amrapali', represents a remarkable innovation by the Bangladesh Agricultural Research Institute. This study investigated the extent of its adoption among mango growers in the Porsha and Nachole upazilas of Naogaon and Chapainawabganj districts, respectively, selected for their high concentration of 'BARI Aam-3' cultivation. Data were gathered from 111 growers using proportionate random sampling and analyzed via descriptive statistics and multiple regression. Findings revealed that while respondents also cultivated other mango varieties except 'BARI Aam-3' among which 'Langra', 'Fazli', and 'Himsagar' ('Khirshapat') were popular, the majority had been growing 'BARI Aam-3' for 6 to 12 years. The rank order of these mango varieties cultivated by the growers was 'BARI Aam-3' > 'Langra' > 'Fazli' > 'Himsagar'. The average adoption rate of 'BARI Aam-3' was 67.8%, with most respondents exhibiting a medium level of adoption. Regression analysis indicated that the adoption of 'BARI Aam-3' was significantly influenced by the respondents' education, farm size, annual income, extension contact, innovativeness, and mango cultivation knowledge.

Keywords: Mango, 'BARI Aam-3', adoption, cultivation period, innovativeness, extension contact, training experiences.

Introduction

Mango is the national tree of Bangladesh where the production of mango was 12,22,368 MT from 2,35,348 acres area under garden (2019-20). The production of mango in Naogaon and Chapainawabganj districts was 28,780 MT from 4,457 acres area and 1,87,174 MT from 62,800 acres area under garden, respectively in 2019-20 (BBS, 2022). Among the varieties developed by Bangladesh Agricultural Research Institute (BARI), 18 mango varieties were included, which have special characteristics (Rahman *et al.*, 2022). Among the 18 different mango varieties, 'BARI Aam-3' has become exceptionally popular and is being cultivated in various locations of Bangladesh. This variety is also popularly known as 'Amrapali' in

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Bangladesh. It was released by BARI in 1996 through introduction method of breeding from abroad (Azad *et al.*, 2020). The fruit is exceptionally delicious and possesses a high sweetness level (TSS 23.4%) exhibiting a sweet flavor when it is completely ripened. 'BARI Aam-3' is a late variety with a regular bearing habit with fruit yield of 20 MT/ha. The variety is commercially cultivable in all areas of Bangladesh (Azad *et al.*, 2020; Uddin, 2012). 'BARI Aam-3' was the most adopted variety (57.0%) among all mango varieties and 47.5 percent of the total mango production was covered by 'BARI Aam-3' (Rahman and Khatun, 2018). The highest 77.0 percent farmers adopted 'BARI Aam-3' due to its sweetness, flavor and high market demand followed by 'BARI Aam-4' (22.1%) and 'BARI Aam-8' (15.9%) (Uddin *et al.*, 2018). A few researches were conducted on the adoption of 'BARI Aam-3' (Amrapali) in certain locations of Bangladesh. Moreover, no studies were found so far regarding the cultivation period of 'BARI Aam-3'. Therefore, the study on the adoption of 'BARI Aam-3' was undertaken in Porsha Upazila under Naogaon district and Nachole Upazila under Chapainawabganj district, which are situated in High Barind Tract characterized by drought, low rainfall and unpredictable climatic conditions, making it a challenging environment for agriculture. The present study was carried out to: (i) describe the selected socio-demographic characteristics of the growers, (ii) explore the mango varieties cultivated by them, (iii) determine the cultivation period of 'BARI Aam-3' cultivated by them, (iv) investigate the extent of adoption of 'BARI Aam-3' by them, and (v) examine the contribution of the selected characteristics of the growers to their adoption of 'BARI Aam-3'.

Materials and Methods

The study was conducted in Porsha upazila under Naogaon district and Nachole upazila under Chapainawabganj district (Fig. 1), which were purposively selected based on the abundance of cultivation of 'BARI Aam-3' (Rahman and Khatun, 2018; DAE, 2019a; DAE, 2019b; DAE, 2020a; DAE, 2020b; DAE, 2021).

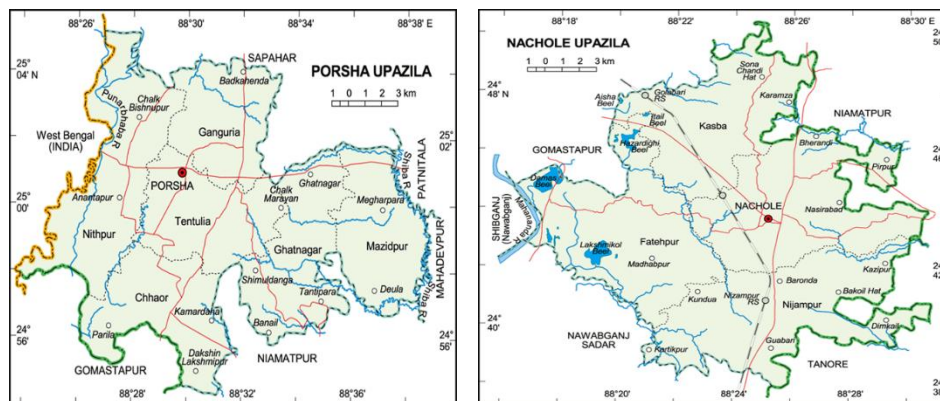


Fig. 1. Map showing Porsha upazila under Naogaon district and Nachole upazila under Chapainawabganj district.

The population of the study was the growers who cultivated 'BARI Aam-3' for at least five years. The sampling population under study was 589 (472 and 117 in Porsha and Nachole upazila, respectively). Among them 111 growers (19.0% of population) were selected as respondents (Loki *et al.*, 2019) using a proportionate random sampling technique. The data were collected during January to April, 2021. Fifteen selected characteristics of the respondents – age, level of education, family size, farm size, annual income, training experience, extension contact, farming experience, access to credit, off farm activities, availability of irrigation water, organizational membership, cosmopolitaness, innovativeness and knowledge on mango cultivation were the independent variables of the study. The independent variables were measured following standard procedure. Adoption of 'BARI Aam-3' was the focus variable of the study. The extent of adoption of 'BARI Aam-3' was measured following the formula used by Kashem (2004), Bhuiyan (2012) and Khalil *et al.* (2013) which is as follows:

$$\text{Extent of Adoption of 'BARI Aam-3'} = \frac{\text{Area (hectare) covered by 'BARI Aam-3'}}{\text{Potential area (hectare) for BARI Aam-3 cultivation}} \times 100$$

The basis of categorization of the extent of adoption of BARI Aam-3 was mean $\pm$ SD). The observed extent of adoption of 'BARI Aam-3' ranged from 1.6 percent to 100.0 percent. The cultivation period of 'BARI Aam-3' cultivated by the respondents was measured by counting the years of cultivating 'BARI Aam-3' from the adoption of the technologies. A score of one (1) was assigned to each year. The basis of categorization of cultivation period of 'BARI Aam-3' was mean $\pm$ SD. The observed cultivation period of BARI Aam-3 ranged from 5 to 23 years. Data were coded, compiled, tabulated and analyzed according to the objectives of the study using SPSS V20. Descriptive statistical measures like number and percentage distribution, range, mean, standard deviation etc. were used. Multiple regression analysis was employed to examine the contribution of the selected characteristics of the respondents to their extent of adoption of 'BARI Aam-3'.

Results and Discussion

The findings presented in Table 1 showed that about half (49.5%) of the respondents were middle aged. Ninety-one percent of them were literate and the highest percentage (43.2%) of them belonged to higher secondary education level. Majority of the respondents (45.0%) had small sized family.

Table 1. Characteristic profile of the respondents

Sl#	Characteristics (Measurement unit)	Possible and observed range	Respondents (n=111)		Mean
			Categories	%	
01.	Age (Years)	Unknown (24-73)	Young (up to 35)	34.2	40.7
			Middle aged (36-50)	49.5	
			Old (above 50)	16.3	
02.	Level of education (Years of schooling)	Unknown (0-18)	Illiterate (0)	1.0	10.2
			Can sign only (0.5)	8.1	
			Primary (1-5)	10.8	
			Secondary (6-10)	36.9	
			Higher secondary (>10)	43.2	
03.	Family size (Number)	Unknown (2-12)	Small (up to 4)	45.0	5.2
			Medium (5-6)	37.0	
			Large (above 6)	18.0	
04.	Farm size (Hectare)	Unknown (0.3-32.8)	Small (0.21-1.00)	8.1	4.7
			Medium (1.01-3.00)	38.7	
			Large (above 3.00)	53.2	
05.	Annual income (‘000’BDT)	Unknown (79-4500)	Low (up to 353)	37.0	766.6
			Medium (354-1180)	43.2	
			High (above 1180)	19.8	
06.	Training experience (Number of days)	Unknown (0-276)	No training (0)	22.6	18.0
			Low (1-5)	29.7	
			Medium (6-10)	11.7	
			High (above 10)	36.0	
07.	Extension contact (Score)	0 to 72 (10-55)	Low (up to 28)	18.0	38.9
			Medium (29-50)	70.3	
			High (above 50)	11.7	
08.	Farming experience (Years)	Unknown (5-60)	Low (up to 9)	16.2	20.8
			Medium (10-32)	65.8	
			High (above 32)	18.0	
09.	Access to credit	-	No	2.7	-
			Yes	97.3	

Sl#	Characteristics (Measurement unit)	Possible and observed range	Respondents (n=111)		Mean
			Categories	%	
10.	Off farm activities	-	No	45.0	-
			Yes	55.0	
11.	Availability of irrigation water	-	No	10.8	-
			Yes	89.2	
12.	Organizational membership (Score)	Unknown (0-213)	Low (up to 7)	37.8	22.4
			Medium (8-38)	42.3	
			High (above 38)	19.9	
13.	Cosmopoliteness (Score)	0 to 15 (1-15)	Low (up to 8)	18.9	10.6
			Medium (9-14)	75.7	
			High (above 14)	5.4	
14.	Innovativeness (Score)	0 to 21 (0-15)	Low (up to 3)	50.5	4.6
			Medium (4-6)	27.9	
			High (above 6)	21.6	
15.	Knowledge on mango cultivation (Score)	0 to 30 (16-30)	Low (up to 22)	18.0	25.2
			Moderate (23-28)	68.5	
			High (above 28)	13.5	

More than ninety percent (91.9%) of the respondents had medium to large farm. The average annual income of the respondents was Tk. 766.6 thousand which was much higher than the national average (Tk. 137.8 thousand) (BBS, 2021) and most of them (80.2%) belonged to medium to low annual income category. More than one-fourths (36.0%) of the respondents had high training experience. The large majority of them (77.4%) received agricultural training which was an opportunity for the growers in the study area. The highest portion of the respondents (70.3%) had medium extension contact. Most of them (65.8%) had medium farming experience. Most of the respondents (97.3%) had access to credit. More than half (55.0%) of them had some kind of off farm activities. Most of the respondents (89.2%) had available irrigation water. Majority of them (42.3%) had medium organizational membership. Majority of the respondents (75.7%) had medium cosmopoliteness. Most of the respondents (78.4%) had low to medium innovativeness. Majority of them (68.5%) had moderate knowledge on mango cultivation.

Adoption of 'BARI Aam-3'

The findings related to the adoption of 'BARI Aam-3' by the growers in Naogaon and Chapainawabganj districts have been discussed in this section.

Mango varieties cultivated by 'BARI Aam-3' respondents

The results presented in the Table 2 indicate that all the respondents (100.0%) cultivated 'BARI Aam-3'. The majority of the 'BARI Aam-3' respondents cultivated 'Langra' (76.6%) followed by 'Fazli' (64.0%) and 'Himsagar'/ 'Khirshapat' (55.9%). The reason could be that 'BARI Aam-3', 'Langra', 'Fazli', and 'Himsagar'/'Khirshapat' were the popular mango varieties due to their better taste and high income, leading majority of the growers to cultivate those mango varieties.

Table 2. Rank order of different mango varieties cultivated by 'BARI Aam-3' respondents

Sl.#	Mango variety	Respondents (%)	Rank
1.	BARI Aam-3 (Amrapali)	100.0	1 st
2.	Langra	76.6	2 nd
3.	Fazli	64.0	3 rd
4.	Himsagar/Khirshapat	55.9	4 th
5.	Ashwina	49.5	5 th
6.	BARI Aam-4	36.0	6 th
7.	Gopalbhog	30.6	7 th
8.	BARI Aam-2 (Lakhkhanbhog)	10.8	8 th
9.	Katimon	8.1	9 th
10.	Gutee	7.2	10 th
11.	Gouramati	5.4	11 th
12.	Khudi gopalbhog/ Raniprashad	3.6	12 th
13.	Harivanga	3.6	12 th
14.	Banana mango	3.6	12 th
15.	BARI Aam-11	2.7	13 th
16.	Chinimohon	1.8	14 th
17.	Mallika	1.8	14 th
18.	Bombai	1.8	14 th
19.	Kachamitha	0.9	15 th
20.	Chakukata	0.9	15 th
21.	Chusha	0.9	15 th
22.	Nepali Khirsha	0.9	15 th
23.	Khirsha Hybrid	0.9	15 th
24.	Sun Mango	0.9	15 th
25.	Kalibhog	0.9	15 th

Rahman and Khatun (2018) also reported that ‘BARI Aam-3’ was the most adopted mango variety (57%) followed by ‘Khirshapat’ (12.0%), ‘Langra’ (10.0%) and ‘Gobindabhog’ (6.0%).

Cultivation period

Information furnished in the Table 3 showed that the observed cultivation period of ‘BARI Aam-3’ ranged from 5 to 23 years, where 5 years indicates very low cultivation period and 23 years indicates very high cultivation period. The respondents cultivated ‘BARI Aam-3’ in the study area for 8.1 years on an average. About three-fourths of them (63.1%) cultivated ‘BARI Aam-3’ for 6-12 years (medium cultivation period) while more than one-fourths of them (25.2%) cultivated it for up to 5 years (low cultivation period) and only 11.7 percent of them cultivated this variety for more than 12 years (high cultivation period). The reason could be that the ‘BARI Aam-3’ variety was released in 1996. After that time, it was introduced in the study area. After its introduction, ‘BARI Aam-3’ became popular among the growers gradually. The growers of the study area became motivated to cultivate ‘BARI Aam-3’ watching the success of the innovator growers of that area.

Table 3. Distribution of the respondents according to their cultivation period of ‘BARI Aam-3’

Categories	Respondents		Mean
	Number	Percent	
Low (up to 5 years)	28	25.2	8.1
Medium (6-12 years)	70	63.1	
High (>12 years)	13	11.7	
Total	111	100.0	

Consequently, it appears that majority of the respondents had the opportunity to cultivate ‘BARI Aam-3’ for medium duration. It was found that the adoption of ‘BARI Aam-3’ was increasing gradually, might be because of its high yield, higher income, high demand, taste, sweetness, etc. The growers were very much motivated to cultivate ‘BARI Aam-3’ and the popularity of ‘BARI Aam-3’ was increasing in the area rapidly.

Extent of adoption

The possible extent of adoption ranged from 0.0 to 100.0 percent, where zero percent (0) indicates no adoption and 100.0 percent indicates full adoption. The observed extent of adoption ranged from 1.6 percent to 100.0 percent, where 1.6 percent indicates very low adoption and 100.0 percent indicates full adoption. Results presented in the Table 4 show that more than half (55.9%) of the respondents adopted 'BARI Aam-3' to medium extent while more than one-fourths (27.9%) of them adopted it to high extent and only 16.2 percent of them adopted the technology to low extent. The large majority (83.8%) of them adopted BARI Aam-3 to medium to high extent. This could be attributed to the fact that 'BARI Aam-3' is a popular mango variety recognized for its many special attributes including its delightful taste and sweetness which allows growers to earn high profit from its cultivation.

Table 4. Distribution of the respondents based on their adoption of 'BARI Aam-3'

Categories	Respondents		Mean
	Number	Percent	
Low (up to 41.33)	18	16.2	67.8
Medium (41.34-94.25)	62	55.9	
High (above 94.25)	31	27.9	
Total	111	100.0	

Rahman and Khatun (2018) noted that 'BARI Aam-3' was the most adopted mango variety (57.0%) among all mango varieties. The highest 77.0 percent farmers adopted 'BARI Aam-3' 'due to its sweetness, flavor and high market demand followed by 'BARI Aam-4' and 'BARI Aam-8' (Uddin *et al.*, 2018).

Contribution of the selected characteristics of the respondents

Multiple regression analysis was conducted to test the hypothesis that there is no significant contribution of the selected characteristics of the respondents to their extent of adoption of BARI Aam-3. Results presented in Table 5 indicate that there were significant contributions of respondents' level of education, farm size, annual income, extension contact, innovativeness and knowledge on mango cultivation to their extent of adoption of 'BARI Aam-3'.

Table 5. Multiple regression coefficients showing the contribution of respondents' selected characteristics to the adoption of 'BARI Aam-3'

Dependent variable	Independent variables	β	P value	SE
Extent of adoption of 'BARI Aam-3'	Age	0.125	0.326	0.331
	Level of education	-0.210	0.018*	0.439
	Family size	-0.063	0.436	1.088
	Farm size	0.235	0.048*	0.633
	Annual income	-0.319	0.007**	0.004
	Training experience	-0.055	0.494	0.062
	Extension contact	0.396	0.000**	0.239
	Farming experience	-0.041	0.740	0.284
	Organizational membership	0.039	0.676	0.080
	Cosmopolitaness	0.062	0.486	0.763
	Innovativeness	-0.178	0.033*	0.606
	Knowledge on mango cultivation	0.191	0.043*	0.794
	Constant	-5.655		
	R ²	0.447		
	Adjusted R ²	0.379		
	F value	6.600		
	P value	0.000**		

* Significant at 0.05 level ** Significant at 0.01 level; SE = Standard Error.

Of these, their extension contact and annual income were the most important contributing factors (significant at 1.0% level) which profoundly influenced their extent of adoption of 'BARI Aam-3' and level of education, farm size, innovativeness and knowledge on mango cultivation were the second most important contributing factors (significant at 5.0% level). Respondents' farm size, extension contact and knowledge on mango cultivation had positive significant contribution to their extent of adoption of 'BARI Aam-3'. Farm size is related to their economic strength. It may be attributed to the fact that the growers with larger farms had greater opportunity to cultivate 'BARI Aam-3' across extensive land areas. They had the capability to adopt 'BARI Aam-3' to high extent due to having a larger area available for cultivation. Different finding was observed by Rahman and Khatun (2018) where growers' farm size had significant negative effect on their adoption of 'BARI Aam-3' mango variety. The predictor variables, such as extension contact and knowledge on mango cultivation might have influenced the respondents' awareness and positive attitude towards 'BARI Aam-3', motivating them to adopt this variety. The growers who had more extension contact may have had better communication with extension personnel and other agricultural

information sources, influencing them to adopt 'BARI Aam-3' on a large scale. Rahman and Khatun (2018) in their studies reported that the farmers' extension linkage had significant positive effect on their adoption of mango var. 'BARI Aam-3'. It is likely that the growers who had more knowledge on mango cultivation were interested in 'BARI Aam-3' due to its many special characteristics. Different finding was revealed by Uddin *et al.* (2018) where the mango growers' possession of modern knowledge on mango production had no significant contribution to their adoption of the BARI mango varieties. Respondents' level of education had negative significant contribution to their extent of adoption of 'BARI Aam-3'. Perhaps the educated growers were more involved with other sources of income like service, business, and self-entrepreneurship other than mango cultivation, which left them with less time to dedicate to mango cultivation. Therefore, they had poor adoption of 'BARI Aam-3'. Different finding was observed by Rahman and Khatun (2018) where the farmers' education level had no significant effect on their adoption of 'BARI Aam-3'. The annual income of the respondents had negative significant contribution to their extent of 'BARI Aam-3' adoption. The reason could be that the growers who had higher income were involved with business and other off-farm activities; consequently, they had limited time available for the large-scale cultivation of 'BARI Aam-3'. Different finding was found by Rahman and Khatun (2018) where farmers' farm income had no significant effect on their adoption of mango variety 'BARI Aam-3'. Respondents' innovativeness had negative significant contribution to their extent of adoption of 'BARI Aam-3'. The reason could be that the innovative growers were always engaged in trying new technologies; thus, they may not have dedicated themselves to the cultivation of a single technology and cultivated 'BARI Aam-3' along with other technologies.

It was observed that 44.7 percent ($R^2 = 0.447$) of the variation in the extent of adoption of 'BARI Aam-3' by the respondents can be attributed to their age, level of education, family size, farm size, annual income, training experience, extension contact, farming experience, organizational membership, cosmopolitaness, innovativeness and knowledge on mango cultivation. The F value 6.600 indicates that the model is significant ($p = 0.000$). Each predictor variable may contribute some of the variations in the extent of adoption of 'BARI Aam-3' by the respondents simply by chance. Adjusted R-square value penalizes the addition of extraneous predictors in the model, and the value of 0.379 still indicates that the variance in the extent of adoption of 'BARI Aam-3' by the respondents can be attributed to the predictor variables rather than by chance, and the model is suitable model.

Conclusion

BARI Aam-3 is a popular mango variety which is being cultivated widely in Bangladesh. The majority of the 'BARI Aam-3' respondents cultivated 'Langra' followed by 'Fazli' and 'Himsagar' ('Khirshapat'). The majority of the growers cultivated 'BARI Aam-3' for 6-12 years (medium cultivation period). The average level of adoption of 'BARI Aam-3' was 67.8 percent. In this study, the majority of the growers were found to adopt 'BARI Aam-3' to medium extent. The extent of adoption of 'BARI Aam-3' by the respondents was likely to be influenced by their level of education, farm size, annual income, extension contact, innovativeness and knowledge on mango cultivation. The research institutes may be strengthened to develop more appropriate technologies for a sustainable and competitive mango sector. It is evident from the study that hybrid mango varieties like 'BARI Aam-3' and 'BARI Aam-4' capable of producing higher yield, having better taste and other attributes, boosted the mango sector in Bangladesh. The promising mango sector may be further enriched through enhanced breeding programme utilizing the desirable traits of local popular varieties like 'Himsagar', 'Harivanga' and 'Gouramati' and exotic varieties like 'Katimon'. Coordinated programmes of BARI, DAE, BADC, HORTEX Foundation and NGOs under the leadership of BARC may be implemented for expanding and managing mango farming for increased domestic consumption and export. The government/concerned agricultural authorities may promote and disseminate more new agricultural technologies and provide those technologies to growers as incentive in large scale. The concerned authorities may take necessary steps to bring the fallow land under cultivation.

References

- Azad, A. K., M. Miaruddin, M. A. Wahab, M. H. R. Sheikh, B. L. Nag and M. H. H. Rahman (Eds.). 2020. *Krishi Projukti Hatboi (Handbook on Agro-Technology)*, 9th edition. Bangladesh Agricultural Research Institute, Gazipur.
- BBS. 2021. *Statistical Yearbook Bangladesh 2020*. Bangladesh Bureau of Statistics, Statistics & Informatics Division (SID), Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.
- BBS. 2022. *Statistical Yearbook Bangladesh 2021*. Bangladesh Bureau of Statistics, Statistics & Informatics Division (SID), Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.
- Bhuiyan, M. H. 2012. *Generation and Diffusion of Agricultural Innovation*. Gurpukur Research Institute, Dhaka, Bangladesh.
- DAE. 2019a. Report on the area and production of different crop varieties of BARI. Department of Agricultural Extension, Naogaon.

- DAE. 2019b. Information on the area and production of BARI varieties of Chapainawabganj district under Rajshahi region. Department of Agricultural Extension, Chapainawabganj.
- DAE. 2020a. Report of variety wise area and production of mango 2019-2020. Department of Agricultural Extension, Naogaon.
- DAE. 2020b. Information on variety wise mango production/2020, District: Chapainawabganj. Department of Agricultural Extension, Chapainawabganj.
- DAE. 2021. Information on the upazila wise area and production of Amrapali mango variety. Department of Agricultural Extension, Naogaon.
- Kashem, M. A. 2004. *Fundamentals of Extension Education*. Mymensingh, Bangladesh.
- Khalil, M. I., M. E. Haque and M. Z. Hoque. 2013. Adoption of BARI recommended potato (*Solanum tuberosum*) varieties by the potato farmers of Bangladesh. *The Agriculturists* **11(2)**: 79-86.
- Loki, O., M. Mudhara, Y. Pakela-Jezile and T. S. Mkhabela. 2019. Factors influencing land reform beneficiaries' willingness to pay for extension services in Eastern Cape and Kwazulu-natal, South Africa. *South African Journal of Agricultural Extension* **47(4)**: 29-45.
- Rahman, M. B., M. K. Hasan, M. T. Islam, F. Islam, A. K. Choudhury, D. A. Choudhury, H. M. Naser, M. S. A. Khan, M. H. H. Rahman and M. Al-Amin. 2022. *Bangladesh Agricultural Research Institute-ar-Fashol O Jat Porichiti (In Bengali)*. Bangladesh Agricultural Research Institute (BARI), Gazipur.
- Rahman, M. S. and M. Khatun. 2018. Adoption and farmer's perceptions of BARI Aam-3 mango variety in selected areas of Bangladesh. *Research in Agriculture, Livestock and Fisheries* **5(3)**: 301-311.
- Uddin, M. J., M. E. A. Begum, S. M. K. H. Chowdhury and K. S. Rahman. 2018. Adoption of BARI mango varieties in selected sites of Chittagong district. *Bangladesh Journal of Agricultural Research* **43(2)**: 235-252.
- Uddin, M. Z. 2012. Studies on the morpho-physico-chemical characteristics and molecular detection of hybridity of eight mango hybrids. PhD Dissertation. Department of Horticulture, Bangladesh Agricultural University, Mymensingh.