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## ADOPTION AND FARMER'S PERCEPTIONS OF BARI AAM-3 MANGO VARIETY IN SELECTED AREAS OF BANGLADESH

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### ABSTRACT

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The study was conducted to assess the level of BARI Aam-3 mango variety adoption, factors affecting adoption and farmer's perceptions about this variety in four districts namely Khagrachori, Bandorban, Naogaon, and Satkhira of Bangladesh during February to March, 2018. A total of 128 BARI Aam-3 growers and 72 non-growers were selected using multi-stage random sampling technique. Logit model was used to assess the determinants of adoption. The study revealed that BARI Aam-3 was the most adopted variety (57%) than other and it covered 47.5% of the total mango production in the study areas. Most of the rice and vegetable fields are occupied by BARI Aam-3 and majority of the respondents practiced intercropping with BARI Aam-3. Family size, sex, training, and extension linkage had significant positive effect on adoption of BARI Aam-3 mango variety while age and farm size had negative effect. Three fourth (75%) of the respondents collected information about this variety from other neighbor farmers while about 43% learned from Department of Agricultural Extension office. More than half of the respondents (63%) have strong ambition to enlarge their BARI Aam-3 mango variety orchard in the future for its unique features such as non-alternate bearing and early fruiting. Climate change, price fluctuation, higher labour costs and access of Indian mango to the market prior releasing this variety were the major bottlenecks for wider adoption of this variety. The study concluded that there is an urgent need to create a sustainable market environment to ensure a better market price for the mango growers. In addition, training and extension services need to expand all over the country to increase the rate of adoption of BARI Aam-3 mango variety.

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## INTRODUCTION

Mango (*Mangifera indica L.*) is one of the most delicious and admired tropical fruit in the world. It is acknowledged as the "King of Fruits" among all the fruits of Bangladesh (Kobra et al., 2012). Generally mango is consumed at all stages of fruit development from the tiny imperfectly set fruits, that shed abundantly on to develop beyond the initial stage to the fully mature ones and the nutritional value of mango varies from variety to variety and developmental stages of the fruit including mature and ripened stage (Leghari et al., 2013). It is not only delicious but also rich in pre-biotic dietary fiber, vitamins, minerals and poly-phenolic flavonoid antioxidant compounds. It also contains sugar, small amount of protein, fats and other nutrients. It is mostly eaten fresh as a dessert also processed as juices, jams, jellies, nectars as well as crisp mango chips (Hamdard et al., 2004). It has also strong economic impact on the economy of Bangladesh. Bangladesh is the world's eighth largest mango producing country as it produces about 1,047,850 tons of mangos every year which accounts for 3.9 percent of the world total mango production (The Daily Star, 2016). Among the fruits in Bangladesh, banana stands the top position in terms of area coverage (32%) and production (17%) followed by mango (25% area and 24% production) and pineapple (9% area and 4% production). In 2015-16, mango acreage was 37823 hectares with the highest level of production throughout the last decade i.e., 1161685 metric tons (BBS, 2016). Mango is grown everywhere but due to soil and climatic limitations the Northern and North-western parts of Bangladesh are well known for better mango production (Bhuiyan and Ganguly, 1999). With the innovation of modern developed mango variety, it is now cultivated commercially in other districts of Bangladesh.

Since 1996 to 2015, Bangladesh Agricultural Research Institute (BARI) has developed 11 types of improved high yielding mango varieties (Azad et al., 2017). Agricultural development is accelerated through adoption of improved agricultural technologies and formulating policies favouring appropriate institutional and infrastructural changes (Rajni et al., 2009). Adoption to improved production practices is the key to higher production of fruits and higher income to farmers. The technical knowledge of farmers appears to be the key link to higher level of adoption. Among farmers, there is great variation in their levels of knowledge as well as their readiness to accept, try new methods and adopt improved production practices (Singh et al., 2010). Among the mango varieties of BARI, BARI Aam-3 is an important innovation in Bangladesh. It is a hybrid mango variety, has been produced by crossing between Kiron (female) and Deshari (male) (Hossain *et al.*, 2003). At field level this variety is well known as Amropali. The tree is Dwarf, regular bearer, cluster bearing, small sized fruits, and good keeping quality. Its flesh is deep orange red and the fruit contains approximately 2.5–3.0 times more  $\beta$  carotene content than other commercial varieties of mango (Wikipedia). The climate and soil of Bangladesh are suitable for high yielding BARI Aam-3 cultivation and farmers get yield within three years of plantation with relatively less efforts. Out of 11 BARI mango varieties, five varieties such as BARI Aam-1, BARI Aam-2, BARI Aam-3, BARI Aam-4 and BARI Aam-8 were evaluated by Barua et al. (2013) as suitability judgment for the Chittagong region where the highest TSS content (21.36%) and the lightest fruit (172.6 g) was in BARI Aam-3. Uddin et al. (2018) also found that per household the highest yield was recorded from BARI Aam-3 followed by BARI Aam-4 and BARI Aam-8. Shiblee (2015) conducted a study on assessing BARI released mango varieties at field level. It was found that BARI Aam-3 was the best in all the firms under investigation in terms of sale of stions (stock + scion). But there is no specific research on adoption of BARI Aam-3 mango variety and the factors responsible for wide acceptance of this variety and constraints towards its further expansion in Bangladesh. Keeping this in view the present study has taken to fulfill the following objectives-

- I. To assess the level of BARI Aam-3 variety adoption and determine the factors responsible for its adoption at farm level;
- II. To find out farmer's perceptions towards BARI Aam-3 variety and
- III. To evaluate potentialities of BARI Aam-3 mango variety adoption at the farm level.

## MATERIALS AND METHODS

The study was based on the primary data collected from four BARI Aam-3 growing districts namely Khagrachori, Satkhira, Bandarban, and Naogaon of Bangladesh. Two major BARI Aam-3 growing Upazilas from each district were purposively selected for selecting sample. A total of 200 mango growers were randomly selected from four districts for the study of which 128 growers were BARI Aam-3 and 72 were from other mango varieties. In case of BARI Aam-3, a total of 32 (16 x 2) growers were interviewed from each districts making a total of 128 (32 x 4). For other mango varieties from one district the total sample was 18 (9 x 2) and from 4 districts total number of other mango variety growers were 72 (18 x 4). Data were collected following face to face interview with pretested questionnaire during the month of February to March, 2018. Thus collected primary data were analyzed using tabular and appropriate statistical techniques.

### Analytical techniques

#### Logit model

Logistic regression analysis was used to identify the factors affecting adoption of BARI Aam-3 mango variety. With respect to the logit model, linear probability model (LPM) is not logically a very attractive model because it assumes that  $Y_i$  increases linearly with  $X_i$  that is the marginal or incremental effect  $X_i$  remains constant throughout. In reality,  $Y_i$  does not increase linearly with  $X_i$  in many situations. In that case a superior probability model is needed; this possesses at least two features as follows:

- As  $X_i$  increases,  $Y_i$  increases but never steps outside the 0-1 interval; and
- The relationship between  $Y_i$  and  $X_i$  is not linear. The logit regression or logit model possesses these features (Gujarati, 2003).

Therefore, logistic regression analysis was used for investigating the extent of influence on the decision making status. In the empirical situation under consideration, the marginal or incremental effect of  $X_i$  does not remain constants throughout. Thus the logit model suits to the empirical situation better than the LPM. Hence, it is employed in this research.

In this study, the dependent variable  $Y$  (adoption and non-adoption) was defined to have two possible outcomes: (1) the farmers are adopting BARI Aam-3 variety and (2) the farmers are not adopting which are coded 1 and 0, respectively. This shows that, the dependent variable is dichotomous and it can be represented by a variable taking the value 1 with probability  $P$  and the value 0 with probability  $(1-P)$ . The logit model has been specified as follows:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + U_i$$

$$L_i = \left( \frac{P}{1-P} \right) = Z = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + U_i$$

$$L = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + \beta_7 X_{7i} + U_i \dots \dots \dots (1)$$

Here,

$Y_i$  = it is a binary variable having 1 for indicating adoption and 0 indicating non-adoption;

$X_1$  = Age of the respondents (years);

$X_2$  = Sex (i.e., male =1, female = 0),

$X_3$  = Education level (year of schooling)

$X_4$  = Family size (no.)

$X_5$  = Training (Training received =1 otherwise = 0)

$X_6$  = Farm size (ha);

$X_7$  = Farm income (Tk.)

$X_8$  = Mango cultivation experience (years)

$X_9$  = Research linkage (linkage Yes=1, No=0)

$X_{10}$  = Extension linkage (linkage Yes=1, No=0)

$U_i$  = Error term.

$L$ , the log of the odds ratio; is not only linear in  $X$ , but also linear in parameters. For the data on individual or micro level

$Y_i=1$  if BARI Aam-3 mango farmers and

$Y_i=0$  if other mango variety farmers.

If this values are put directly into the logit  $L$ , then

$L_1 = (1/0) \log$  if BARI Aam-3 farmers, and

$L_1 = \log (0/1)$  if other mango variety farmers.

### The SWOT analysis

The SWOT analysis was carried out to analyze the opportunities and threats in the external environment, and the strengths and weakness looking internal to the BARI Aam-3 production. SWOT analysis is a planning tool which aims to identify the strengths and weaknesses of an organization and the opportunities and threats in the environment and was adopted in 1980s by public administration across such areas as regional development and municipal planning (Markovaska et al., 2009; Dyson, 2004) When facing a situation and making a decision, we should consider the positive and negative aspects, advantage and disadvantage of this option. SWOT analysis can help us to identify the current situation and consider more compressive before making a choice. There have been several examples of successful application of SWOT analysis in the fields of crop production and industry planning strategy (Swaan, 2010; Cadmore, 2009; Safarik, 2003; Han et al., 2009).

## RESULTS AND DISCUSSION

### Level of Adoption of Different Mango Varieties in the Study Areas

More than 10 varieties were found very popular in the survey areas. Three BARI developed varieties namely BARI Aam-2, BARI Aam-3 and BARI Aam-4 were found there. Among all the varieties, BARI Aam-3 appeared to be the most preferred in terms of last four-year sale of stions (stock + scion). Uddin *et al.* (2018) and Shiblee (2015) got similar result. Figure 1 shows that, BARI Aam-3 covers 57% of the varieties cultivated in the survey areas followed by Khirsapat (12%), Langra (10%) and Gobindabhog (6%). Only 2% of the garden contains another promising BARI variety BARI Aam-4. Hence, it is easily comprehended that BARI Aam-3 is likely to be the single most popular variety to be unparalleled with any other variety.

### Adoption of BARI Aam-3 Mango Variety

Figure 2 enumerates the extent of adoption of BARI Aam-3 in the study areas. Among the four survey areas, BARI Aam-3 is highly adopted in Sapahar Upazila under Naogaon district which is 57% of the total mango production in that area. Beside this 52% of the mango orchards are occupied by this variety in Satkhira Sadar Upazila. The lowest adopted area was Bandorban Sadar which is only 32% of the total mango production. This is due to the wide acceptance of Ranguai mango variety in that area. Therefore, the extent of adoption of BARI Aam-3 in four Upazila is 47.5% of the total mango production.

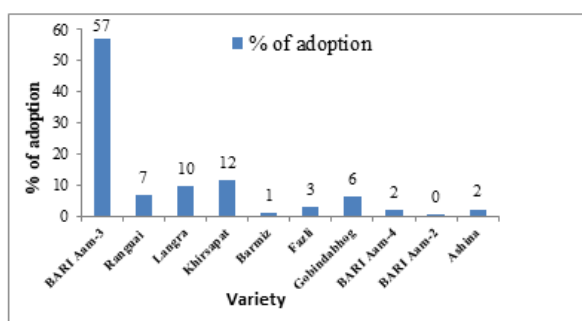


Figure 1. Varietal adoption of different mango varieties

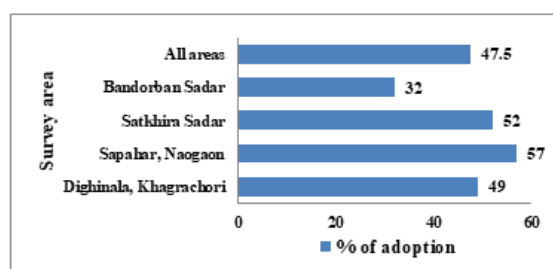


Figure 2. Adoption of BARI Aam-3 mango variety

### Crops Replacing by BARI Aam-3

Adoption of BARI Aam-3 has replaced some other crops which are shown by Figure 3. The figure represents that 40% of the rice field in the survey area were occupied by this mango variety. The figure also shows that farmers used a significant percentage of their fallow land (15%) by cultivating this variety. Besides, farm lands of vegetable (15%) and mustard (13%) are also replaced by BARI Aam-3.

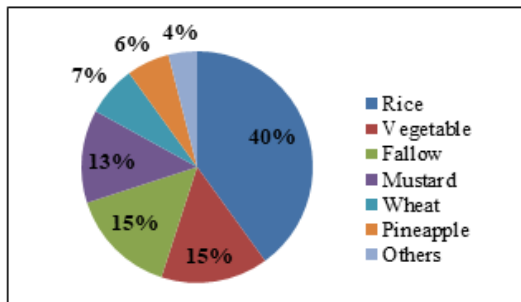


Figure 3. Crops replaced by BARI Aam-3

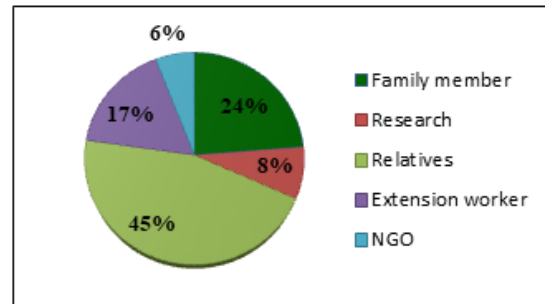


Figure 4. Percent of farmers influence to adopt BARI Aam-3 variety

### Intercropping with BARI Aam-3

Farmers told that it is easy to practice intercrops along with BARI Aam-3 mango variety up to 4-5 years as size of BARI Aam-3 mango trees are not bushy and large. Table 1 shows that about 51% of the respondents practiced intercropping in the survey areas where majority was occurred in Satkhira sadar Upazila (63%) followed by Bandarban sadar (56%). The most popular crops used as intercrop in Satkhira were paddy and vegetables and in Bandarban were banana, pineapple, papaya, turmeric and vegetables. About 59% of the respondents of Sapahar, Naogaon district didn't do any intercrop because Naogaon is a drought prone high barind tract where water scarcity is high.

### Determinants of adoption of BARI Aam-3 mango variety

The results of logit regression are presented in Table 2. Six out of 10 variables included in the model were significant in adopting BARI Aam-3 mango variety by the farmers. These variables were age, sex, family size, received training, farm size and extension linkage in the study areas. Therefore, the estimated equation is as follows:

$$Y_i = 3.926 - 1.314X_1 + 0.073X_2 - 0.078X_3 + 0.343X_4 + 0.484X_5 - 0.439X_6 + 0.143X_7 - 0.482X_8 - 0.127X_9 + 0.139X_{10}$$

The result shows that age had significant negative impact on the probability of adopting BARI Aam-3 mango variety. It demonstrated that the farmers who are senior in age have a lower probability of adopting BARI Aam-3 mango variety than other farmers. The value of the coefficient of the variable sex (i.e., 1= male and 0= female) was positive and it was 0.073, which was significant at 1% level. It indicated that adoption of BARI Aam-3 mango variety was positively influenced by 0.073 units, for one-unit increase of adopting this variety by female farmer. Family size was found significant positive effect on adoption level i.e. farmers with larger family size were more adopter compared to the smaller family size. Training shows significant positive effect on adoption implying that farmer who received training was more adopter compared to non-receiver. Farm size had negatively significant effect on adoption level, implied that the higher the farm size, the lower the adoption. Normally, farmers having large farm areas were able to cultivate other mango variety than the BARI Aam-3 mango variety. Besides, positive and significant coefficient of extension linkage implies that the farmers those had better communication with extension services providers were higher adopter. Especially, Department of Agricultural extension office is the main sources of all kinds of information in the field level. Uddin *et al.* (2018) got similar result for training and extension contact.

### Farmers Knowledge on BARI and Its Released Mango Varieties

Table 3 indicates that 55% of the respondents were familiar with the existence and performance of BARI and 69% of the respondents didn't know that Amropali has released by BARI and its name is BARI Aam-3. They told that lack of information about it from BARI and extension personnel is the main reason behind this. Only 19% of the respondents search for BARI released mango variety because existing varieties have fulfilled their demand.

**Table 1.** Intercropping practices with BARI Aam-3 mango variety

Items	% of intercropping practices				
	Bandarban Sadar	Sapahar, Naogaon	Satkhira Sadar	Dighinala, Khagrachori	All areas
Intercropping with BARI Aam-3	56	41	63	43	51
No intercropping	44	59	37	57	49
Total	100	100	100	100	100

Source: Field survey, 2018

**Table 2.** Empirical results of logistic regression of determinants of BARI Aam-3 mango variety

Variables	Coefficient	S.E.	T	Level of significance	Odds ratio
Age (X <sub>1</sub> )	-1.314 **	0.699	-1.88	0.060	0.268
Sex (X <sub>2</sub> )	0.073***	0.490	1.50	0.003	2.086
Education level (X <sub>3</sub> )	-0.078	0.271	-0.29	0.772	0.924
Family size (X <sub>4</sub> )	0.343**	0.514	0.67	0.051	1.409
Training (X <sub>5</sub> )	0.484*	0.441	1.10	0.093	1.622
Farm size (X <sub>6</sub> )	-0.439***	0.182	-2.40	0.016	0.644
Farm income (X <sub>7</sub> )	0.143	0.207	0.69	0.490	1.153
Mango experience (X <sub>8</sub> )	-0.482	0.308	-1.56	0.118	0.617
Research linkage (X <sub>9</sub> )	-0.127	0.477	-0.27	0.789	0.880
Extension linkage (X <sub>10</sub> )	0.139 *	0.524	0.27	0.079	1.149
Constant	3.926	3.450	1.14	0.255	

Source: Author's estimation, 2018; Note: '\*\*\*\*' '\*\*\*' and '\*\*' indicate significant at 1%, 5% and 10% probability level, respectively.

**Table 3.** Extent of farmer's knowledge on BARI released mango varieties

Knowledge categories	% of respondents	
	Yes	No
Knowledge about the activities of BARI	55	45
Knowledge about the name Amropali as BARI Aam-3	31	69
Knowledge about other BARI released mango variety	19	81

Source: Field survey, 2018

#### Farmer's motivation

About 45% farmers were influenced by relatives to adopt this variety followed by family member (24%), and extension personnel (17%). About 8% of the respondents opined that they started to cultivate BARI Aam-3 mango variety by observing different program of BARI and participating field day organized by BARI (Figure 4).

### Causes of Choosing BARI Aam-3 Mango Variety

Figure 5 shows that 85% of the respondents cultivated this variety as it is free from alternate bearing. At the same time 81% farmers also told that BARI Aam-3 cultivation make them financially profitable and 75% farmers mentioned that they got good yield. Beside this, a number of some other reasons were responsible to adopt this variety such as early bearing than other variety (82%), sweet to taste (71%) and can plant a lot of saplings to a small piece of land (58%).

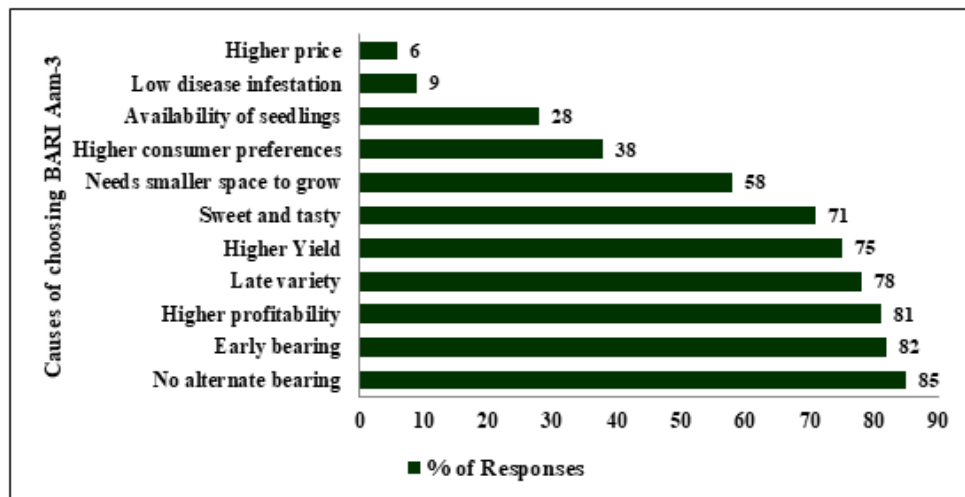


Figure 5. Causes of choosing BARI Aam-3 over other variety

### Sources of Information about BARI Aam-3

Majority of the respondents (75%) got information from other neighbor farmers who are already cultivating this variety. About 43% of the respondents told that they got information from Department of Agricultural Extension office through sub assistant agricultural officer, and it is very reliable for them. Uddin *et al.* (2018) found similar result. Besides, television (24%) and agricultural fair or tree fair (22%) were also other types of sources to get information about this variety (Figure 6).

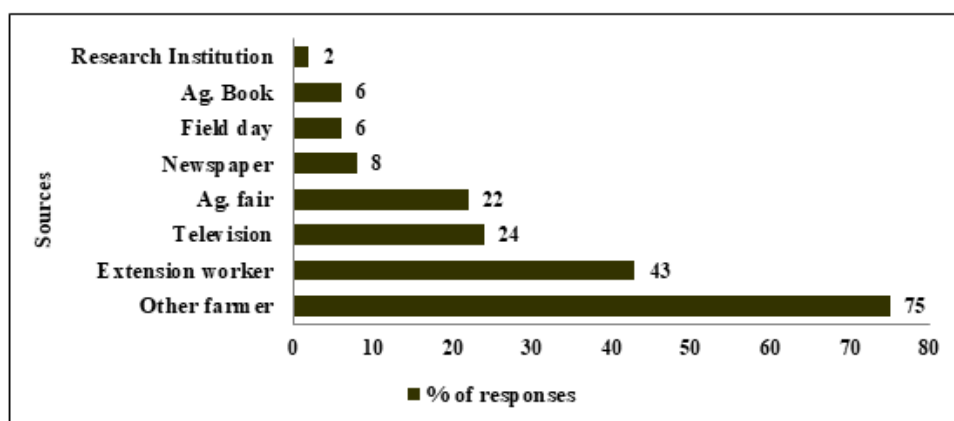


Figure 6. Sources of information on BARI Aam-3

### Future prospects of BARI Aam-3

About 63% of the respondents showed their interest to grow more BARI Aam-3 mango trees in the future. The causes were good market price, higher profit, use of fallow land, and higher demand. Beside, 37% of the respondents opined that they have no interest to further increase this variety due to a number of demerits viz., BARI Aam-3 mangoes are difficult to ripe and in the rainy season crake has been found in the lower portion of the fruit and the duration to giving fruit is shorter. (Table 4)

**Table 4.** Willingness to increase BARI Aam-3 cultivation

Willingness to increase	% of respondents	Causes
Yes	63	Good Market Price High Profit Use of Fallow land Very sweet to taste Income comes early than the other variety Higher demand Low cost Difficult to ripe and short shelf life
No	37	Crake when rain Short duration of the tree life Difficult to storage Mango becomes smaller after 10-12 years

Source: Field survey, 2018

**Table 5.** Factors identified in SWOT categories of BARI Aam-3 adoption

Category	Internal	External
<b>Positive</b>	Strengths Education and livelihood improvement opportunities Eagerness and willingness of the farmers Land availability Improving rural economy and enhancing rural economy Demand is high No alternate bearing Availability of technical knowledge and information Late arrival in the market than other variety	Opportunities Availability of external training Market existence Low costs and inputs availability Income generation from intercropping Huge global export market Promoting self sufficiency and food reliance Premium prices Employment opportunities Fruit processing sector Policy encouragement and Technology development
<b>Negative</b>	Weakness Lack of external help and monitoring Lack of storage facilities Lack of co-operative organizations High prices of inputs Yield reduction after 12-15 years of tree Labour shortage during the harvesting season	Threats Climate change Price fluctuation Higher labour costs Access of Indian mango to the market prior releasing this variety Dwindling supply of organic sources of manure Pests and disease incidence

Source: Field survey, 2018



### Constraints to Further Dissemination of BARI Aam-3

About 94% of the respondents mentioned that crack in the body of mango during rainy season are the main hindrances of this mango variety adoption followed by marketing problem (91%). Beside this, very low bearing after 13-14 years of tree (88%), unequal size (87%), short shelf life (74%), and susceptibility to diseases (51%) are some of the constraints towards disseminating this variety (Figure 7).

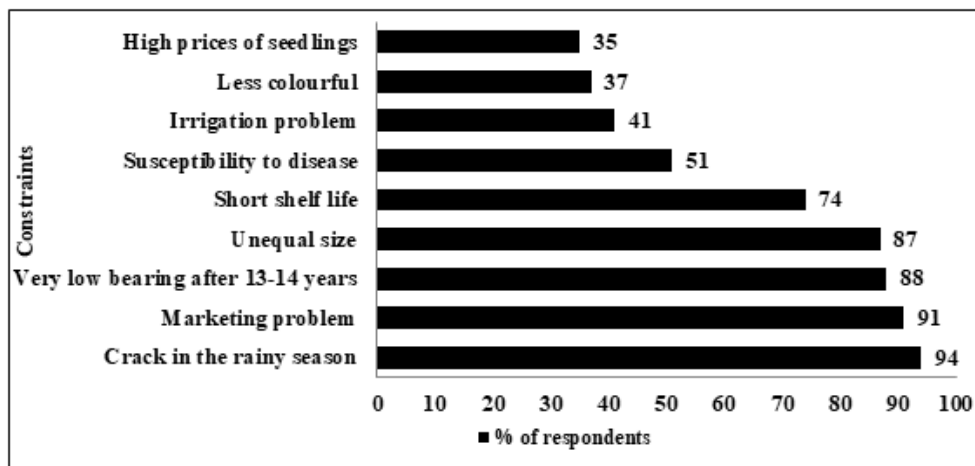


Figure 7. Constraints for expanding BARI Aam-3 variety

### Potentialities of BARI Aam-3 mango variety adoption at Farm Level

#### Strengths

Education is the key element to bring livelihood improvements. It is found that the income earning from BARI Aam-3 mango orchard were used mainly for educational purposes. Farmers are improving their livelihoods because of higher income from mango production. They are able to have better houses with improved necessities. BARI Aam-3 adopted in such areas where potentiality of other crops is marginal. It facilitates enough space for adopting this variety without any disruption. Due to its phenotypic features farmer select this mango variety willingly. Its demand gradually increased to the consumer due to late arrival in the market (Table 5).

#### Opportunities

All the inputs required for the BARI Aam-3 mango tree are locally available and costs are almost the same in local and urban dealers. Due to huge adoption at the farmer's field, different programs and projects are available in the survey areas. This avails the farmer a good number of training on agronomic practices of BARI Aam-3 production. Intrusion of this variety at the end of other mango variety creates off season employment opportunities. As the size of BARI Aam-3 mango tree are not big enough like the other local variety so farmers gained a lot by intercropping up to five years of the tree (Table 5).

This variety is readily available in premium prices and sizes. High adoption fosters farmers' income thereby promotes self-sufficiency and food reliance.

#### Weakness

Lack of external help and monitoring, high prices of inputs and yield reduction after 12 years of mango tree featured more prominently in the study areas. Most of the inputs were purchased on the condition to pay its price after selling the mango. This gives dealers to take high prices of inputs. A vast majority of farmers mentioned that lack of storage facilities during peak harvesting period along with labour shortage were major weakness (Table 5).

### Threats

Climate change is very crucial threat hanging like a domicile's sword over total agricultural system of Bangladesh. It has affected the features of different seasons which cause uncertain rain. Majority of the respondents are aware of this fact. They told that climate change results an emergence of new insect and diseases which cause significant damages to the color, size and price fluctuation of BARI Aam-3 mango. A good number of participants raise their voices against imports of Indian mango before ripening of local mango. They regarded it a major threat in mango business in Bangladesh. Price in local market is unstable. The other important threats were that most participants unanimously agreed on were dwindling supply of organic sources of manure for which they have to depend on chemical fertilizer and artificial and harmful growth regulator (Table 5).

### CONCLUSION AND RECOMMENDATION

This study tried to examine the adoption status, factors affecting adoption and potentialities of BARI Aam-3 mango variety in some selected areas of Bangladesh. It was revealed that BARI Aam-3 was the most popular variety in the study areas. But only a few farmers are informed that it has released by BARI and its name is BARI Aam-3. Gradually BARI Aam-3 occupies the rice and vegetable field as a best alternative in the survey areas. More than fifty percent respondents practiced intercropping different crop up to 4-5 years along with BARI Aam-3 mango orchard. Estimates of coefficients using logit function indicate that variable sex, family size, training, and extension linkage had significant positive impact on BARI Aam-3 mango variety adoption. It implies that if the values of the variables increase the adoption extent of on BARI Aam-3 mango variety was also increase. Absence of alternate bearing, good yield and early bearing were the important features of BARI Aam-3 for which it covered 47.5% of the total mango production in the survey areas. Crack in the mango body during rainy season, low bearing after 15 years of tree and marketing problem are some of the constraints towards adopting this mango variety. So, it is necessary to conduct more extensive research to solve crack issues and very few bearing comes after fifteen years. A positive and strong farmers-agriculture extension-research linkage is also necessary for the betterment of the farmers. Therefore, Department of Agriculture Extension and different research institution should work jointly for transferring information and technology to the farm level. At the same time, government, research institution and agriculture extension should work together to make a sustainable market environment for the growers so that they can get fair price and to ban mango import before the season.

### COMPETING INTEREST

We declare that we have no competing interests on this paper.

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