Bangladesh J. Agri. 2025, 50(2): 158-172 *DOI: https://doi.org/10.3329/bjagri.v50i2.86154*

IMPACT OF BARI AAM3 MANGO VARIETY ADOPTION ON THE GROWERS' LIVELIHOOD

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Abstract

BARI aam3 is one of the 18 mango varieties that Bangladesh Agricultural Research Institute (BARI) released. It gained popularity throughout the country mainly due to its delightful taste and flavour. The study assessed the impact of BARI aam3 adoption on the growers' livelihood. The research was purposively conducted in Porsha Upazila under Naogaon district and Nachole Upazila under Chapainawabganj district based on the abundance of cultivation of BARI aam3. Data were collected from 111 growers selected following a proportionate random sampling technique. Descriptive statistics and paired t-test were used for data analysis. BARI aam3 growers' access to livelihood capitals increased by 49.4-91.7%. Growers' access to human, social, natural, physical, and financial capitals was increased by 87.5%, 91.7%, 50.7%, 49.4%, and 52.8% respectively, due to the adoption of BARI aam3. They experienced an improvement in their knowledge, access to information, employment generation, decision-making, clothing, health care, attitude, social status, and respect. There was increased involvement in social activities. Increases were also noticed in their forestry/trees, safe drinking water use, leased cultivable land, use of electricity, electronic communication devices, livelihood assets, furniture, agricultural tools, and annual agricultural income after BARI aam3 cultivation. Its cultivation also significantly influenced their increase in participation in income-generating activities.

Keywords: BARI aam3, Livelihood, Natural capital, Physical capital, Social capital.

Introduction

Bangladesh Agricultural Research Institute (BARI) is the largest agricultural research institute in Bangladesh. BARI has generated a good number of crop varieties including fruits for growing at the farm level. Bangladesh is one of the major mango producing countries (Islam *et al.*, 2018). According to BBS (2024) the production of mango in Bangladesh was 14,82,937 MT from 3,06,274 acres area in 2022-23. The production of mango was 3,46,539 MT from 42,412 acres area under garden in Naogaon district and the production of mango was 1,17,354 MT from 66,133 acres area under garden in Chapainawabganj district in 2022-23. Among the 18 mango varieties developed

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by BARI, BARI aam3 (Amrapali) gained notable popularity (Rahman *et al.*, 2022) due to its lovely taste and flavour. This mango variety was developed in 1971. Dr. Pijush Kanti Majumdar developed this mango variety as a hybrid variety of 'Dashehari' and 'Neelum' at the Indian Agriculture Research Institute in Delhi (Uddin, 2012; Wikipedia, 2021). The Amrapali mango variety was later released by Bangladesh Agricultural Research Institute as BARI aam3 in 1996 by introduction (Azad *et al.*, 2020). The fruit is very tasty, very sweet (TSS 23.4%) with a sweet flavour when ripe. The fruit is fibreless, moderately juicy and the flesh is 71.0% of the fruit. BARI aam3 is a late variety with a regular bearing habit. The yield of this variety is 20 MT/ha. The variety is commercially cultivable in all areas of Bangladesh (Uddin, 2012; Azad *et al.*, 2020). Farmers became solvent, and their lives were changed because of BARI aam3 cultivation. It was also observed that their human capital, physical capital, social capital, natural capital and financial capital were increased due to cultivation of BARI aam3 mango variety (Rahman *et al.*, 2019). BARI aam3 was the most adopted variety (57%) among all mango varieties, and 47.5 percent of the total mango production was covered by BARI aam3 (Rahman and Khatun, 2018). A study conducted by Uddin *et al.* (2018) revealed that a large portion (77%) of the farmers adopted this variety due to its sweetness, flavour, and high market demand, followed by BARI aam4 (22.1%) and BARI aam8 (15.9%). Amrapali mango variety is also popular in our neighbouring country India, and about 12 percent of the total mango production was occupied by this variety (Sarkar *et al.*, 2018). Ghosh *et al.* (2024) also observed that the majority of the growers cultivated Amrapali.

BARI, being the largest agricultural research institute in Bangladesh, is involved in formulating policy guidelines for the betterment of farmers. Hence, it was expedient to determine the impact of the research and development activities of BARI on the livelihoods of growers. Few studies have been conducted so far, regarding the impact of the popular mango variety BARI aam3 on growers' livelihoods in certain locations of Bangladesh. Specifically, there were no studies regarding the impact of BARI aam3 on growers' livelihood in Porsha Upazila under Naogaon district, and Nachole Upazila under Chapainawabganj district, located in High Barind Tract, where the areas of mango are expanding rapidly. Therefore, it was important to explore the impact of BARI aam3 adoption on the livelihoods of the growers in those areas.

Methodology

Study area

The study was purposively conducted in Porsha Upazila under Naogaon district and Nachole Upazila under Chapainawabganj district based on the abundance of cultivation of BARI aam3 variety (Rahman and Khatun, 2018; DAE, 2019a; DAE, 2019b; DAE, 2020a; DAE, 2020b; DAE, 2021).

Research design

The population of the study was the growers in the study areas who cultivated BARI aam3 for at least five years.

Sample and sampling technique

The sampling population under study was 589 (472 and 117 in Porsha and Nachole Upazilas, respectively). Among them, 111 growers (89 and 22 in Porsha and Nachole Upazilas, respectively) (19.0% of population) were selected as respondents (Loki *et al.,* 2019) using a proportionate random sampling technique.

Methods and tools of data collection

Data were collected during January to April, 2021 with the aid of a pre-tested interview schedule by the researcher herself through face-to-face interview of the selected growers.

Variables and their measurement

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, cosmopoliteness, innovativeness and knowledge on mango cultivation were the independent variables of the study. The independent variables were measured following standard procedure.

The impact of BARI aam3 adoption on growers' livelihood was the dependent variable of the study. The impact of BARI aam3 adoption on growers' livelihood was measured in terms of five livelihood capitals namely human capital, social capital, natural capital, physical capital, and financial capital known as asset pentagon (DFID, 2000). The livelihood assets parameters were selected through extensive literature review and pretesting of interview schedule. Necessary correction and modification were made in the interview schedule based on pretest. After correction, the interview schedule was finalized for data collection. The impact was measured by the changes in assets position of the growers before and after the adoption of BARI aam3 and the changes in assets position were measured in nominal scale where increase/improvement was denoted as (2), decrease was denoted as (1) and no change was denoted as zero (0) (Rahman *et al., 2*019). The changes in participation in income-generating activities were measured in terms of participation in different income-generating activities scores before and after the adoption of BARI aam3. The income-generating activities listed in the instrument were production and marketing of quality seed, fish culture in pond, cattle, goat and poultry rearing, establishing nursery and selling saplings, leasing land/pond for cultivation, tree plantation, homestead gardening, preparation and selling of handicrafts, business, tailoring, labour, service and farm. Each respondent was asked to mention the frequency of his/her extent of participation in different income-generating activities. His/her participation in different income-generating activities score was obtained by adding the weights for his/her responses to all the income-generating activities listed in the instrument. It was measured by assigning scores and the scoring was conducted in the following manner: '3', '2', '1', and '0' were assigned for 'regularly', 'occasionally', 'rarely', and 'not at all' respectively. The basis of categorization of participation in income-generating activities was mean ± sd. The respondents' observed score of participation in income generating activities before cultivation of BARI aam3 ranged from 0 to 20 and the observed score of participation in income generating activities after

cultivation of BARI aam3 ranged from 3 to 20. The participation in income-generating activities scores before and after the adoption of BARI aam3 were computed, and a comparison between the scores before and after the adoption of technology was assessed by a paired t-test. The research framework of the study has been presented in a schematic diagram (Fig. 1).

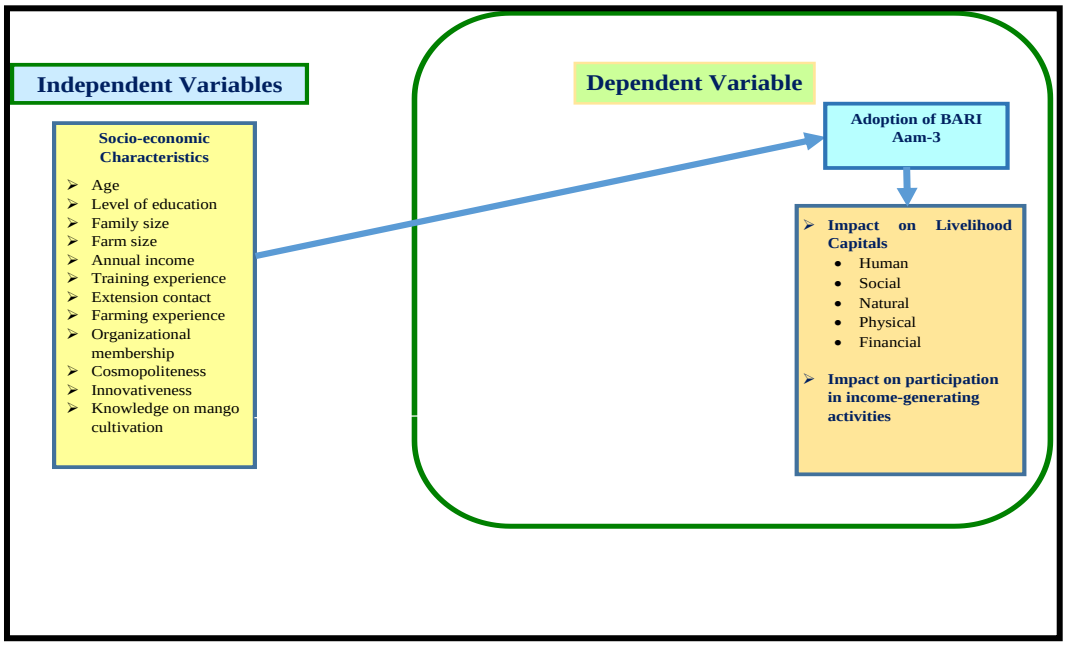

Fig. 1. Research framework of the study

Data analysis

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.

Results and Discussion

Socio-economic profiles of the respondents

Table 1 shows that around 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 the higher secondary education level. The majority of the respondents (45.0%) had small-sized family. More than ninety percent (91.9%) of the respondents had medium to large farms. More than half (53.2%) of them had large farm. The average annual income of the respondents was BDT 766.6 thousand, which was much higher than the national average (BDT 137.8 thousand) (BBS, 2021), and most of them (80.2%) belonged to the medium to low annual income category. About half (43.2%) of the respondents had a medium annual income. About two-fifths (36.0%) of the respondents had high training experience.

Table 1. Socioeconomic profiles of the respondents

Sl#	Characteristics (Measurement unit)	Possible and observed range	Respondents (n=111)		Mean
			Categories	%	
01	Age (Year)	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)	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’ Tk.)	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	
10	Off-farm activities	-	No	45.0	-
			Yes	55.0	
11	Availability of irrigation water	-	No	10.8	-
			Yes	89.2	

Sl#	Characteristics (Measurement unit)	Possible and observed range	Respondents (n=111)		Mean
			Categories	%	
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	

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 kinds of off-farm activities. Most of the respondents (89.2%) had available irrigation water. The majority of them (42.3%) had medium organizational membership. The majority of the respondents (75.7%) had medium cosmopoliteness. Most of the respondents (78.4%) had low to medium innovativeness. More than half of them (50.5%) had low innovativeness. The majority of them (68.5%) had moderate knowledge of mango cultivation.

Impact of BARI aam3 adoption on growers' livelihood

The overall livelihood status of a grower depends on different types of socio-economic activities of the grower as well as the society in which he lives. In this study, different changes in the livelihood assets position of the respondents were measured before and after the cultivation of BARI aam3. However, the findings related to the impact of BARI aam3 adoption on growers' livelihood have been discussed in the following sections.

Perceived changes in livelihood status

Human capital

The findings presented in Table 2 indicate that 87.5 percent of the respondents' access to human capital was increased after the cultivation of BARI aam3, which represents a good range of improvement in knowledge (100.0%), access to information (99.1%), self-employment generation (98.2%), decision-making (97.3%), employment generation (hired) (93.7%), clothing (91.9%), health care (88.3%), quality of food intake

(84.7%), and dietary diversity (82.9%). It may be because growers had greater access to human capital as a result of being more solvent after BARI aam3 cultivation. However, the lowest percentage (61.3%) of the respondents experienced increase in training. Thirty five percent of the respondents experienced no change in training. The possible explanation could be that those growers did not get the opportunity to get training or had limited access to various training sessions organized by DAE and other organizations. Rahman *et al.* (2019) also observed that the majority of the medium BARI aam3 mango orchard owners (80%) and the majority of the large BARI aam3 mango orchard owners (83.8%) experienced constant change in training. Seventy five percent of the respondents experienced increase in education. Some respondents (15.3%) experienced decrease in education after BARI aam3 cultivation. The reason could be that some of the respondents did not increase their educational expenses for their children due to a lack of necessity. Perhaps their children's education was completed after BARI Aam-3 cultivation. Therefore, their education was decreased after BARI aam3 cultivation. Rahman *et al.* (2019) revealed that some of the small BARI aam3 mango orchard owners (27.3%), some of the medium BARI aam3 mango orchard owners (20%) and some of the large BARI aam3 mango orchard owners (27%) experienced constant change in education.

Table 2. Perceived changes in human capital of respondents

Livelihood Assets	Degree of change		
	Increased/ Improved (%)	Decreased (%)	No change (%)
Health care	88.3	3.6	8.1
Education	74.8	15.3	9.9
Training	61.3	3.6	35.1
Decision-making	97.3	-	2.7
Employment generation (Self)	98.2	0.9	0.9
Employment generation (Hired)	93.7	4.5	1.8
Knowledge	100.0	-	-
Access to information	99.1	-	0.9
Clothing	91.9	3.6	4.5
Nutrition	77.5	0.9	21.6
Dietary diversity	82.9	-	17.1
Quality of food intake	84.7	-	15.3
Average	87.5	2.7	9.8

Sarker *et al.* (2017) observed that lemon farmer's livelihoods were improved to some extent in terms of health care, education, and decision-making ability due to lemon production in Mymensingh district. In another study, it was observed that human capital increased by 54.3, 68.0, and 60.5 percent of the small, medium, and large category farmers, respectively, due to BARI aam3 cultivation. It was also revealed that the large

mango farmers experienced a good range of improvement in health and sanitation (70.3%), education (72.97%) and nutrition (78.4%). The medium type BARI aam3 farmers experienced a cent percent increase in health and sanitation. The small orchard owners experienced increases in education (72.7%) and training (81.8%) (Rahman *et al.*, 2019).

Social capital

The results (Table 3) indicate that 91.7 percent of the respondents' access to social capital was increased after BARI aam3 cultivation. This includes improvement in attitude (99.1%), social status and respect (99.1%), involvement in social activities (99.1%), social prestige (98.2%), cooperation from others (98.2%), management (98.2%), networking (96.4%), and leadership roles (92.8%). It could be because the growers' increased income from BARI aam3 made them more solvent than they had been previously, which in turn made them more socially acceptable. In a research, it was observed that social capital was increased by 28.5, 43.0, and 46.0 percent for small, medium, and large farmers, respectively, due to BARI aam3 cultivation (Rahman *et al.*, 2019). Farmers' livelihoods were found to be improved in term of social networks due to their engagement in lemon production (Sarker *et al.*, 2017). However, the lowest percentage (51.4%) of the respondents experienced increase in organizational participation. About half (46.8%) of the respondents experienced no change in organizational participation. The reason could be that those growers did not get any opportunity to enhance their organizational participation or had no organizational participation at all.

Table 3. Perceived changes in social capital of respondents

Livelihood Assets	Degree of change		
	Increased/ Improved (%)	Decreased (%)	No change (%)
Organizational participation	51.4	1.8	46.8
Networking	96.4	-	3.6
Social prestige	98.2	-	1.8
Attitude	99.1	-	0.9
Social status and respect	99.1	-	0.9
Involvement in social activities	99.1	-	0.9
Cooperation from others	98.2	-	1.8
Leadership roles	92.8	-	7.2
Management	98.2	-	1.8
Women empowerment	84.7	-	15.3
Average	91.7	0.2	8.1

Natural capital

Table 4 indicates that 50.7 percent of the respondents' access to natural capital was increased after BARI aam3 cultivation. Their forestry/trees (98.2%), safe drinking water (73.9%), leased cultivable land (55.0%), and availability of irrigation water (54.1%) were increased or improved more compared to other natural capital. This could be attributed to higher earnings from BARI aam3 and improved financial stability. About half (48.4%) of the respondents experienced no change in different types of natural capital. Majority of the respondents experienced no change in their homestead land (80.2%), pond (79.3%), and own cultivable land (65.8%).

Table 4. Perceived changes in the natural capital of respondents

Livelihood Assets	Degree of change		
	Increased/ Improved (%)	Decreased (%)	No change (%)
Own cultivable land	33.3	0.9	65.8
Leased cultivable land	55.0	0.9	44.1
Homestead land	19.8	-	80.2
Pond	20.7	-	79.3
Availability of irrigation water	54.1	3.6	42.3
Safe drinking water	73.9	-	26.1
Forestry/trees	98.2	0.9	0.9
Average	50.7	0.9	48.4

This may be attributed to the fact that the natural capital of the growers, such as homestead land, own cultivable land, ponds, etc., typically remains unchanged. The possession of one's own land, pond, etc., is usually fixed. They either inherited those assets from their parents or acquired them through limited purchases. Perhaps, therefore, a considerable portion of the respondents experienced no change in their natural capital. In a study, it was observed that natural capital was increased by 13.7, 33.3, and 33.3 percent for small, medium, and large farmers, respectively, due to the cultivation of BARI aam3. Some of the small farmers (25.8%) experienced constant change in natural capital. About half (45.5%) of the small farmers experienced constant change in pond (Rahman *et al*., 2019). Farmers' livelihoods were improved in terms of access to land due to their involvement with lemon production (Sarker *et al*., 2017).

Physical capital

The results presented in Table 5 indicate that 49.4 percent of the respondents' access to physical capital was increased after BARI Aam-3 cultivation. They experienced more increases or improvement in electricity use (93.7%), digital/electronic communication devices (82.0%), livelihood assets (74.8%), furniture (72.1%), agricultural tools (68.5%), toilet (53.2%), housing condition (52.3%), and personal vehicles (51.4%) compared to other physical capital. It is possible that the growers'

increased income from BARI aam3 made them more solvent than before, leading to more access to physical capital. About half (46.1%) of them experienced no change in different types of physical capital. The lack of change in the growers' housing condition, toilet, furniture, agricultural tools, cattle, poultry, personal vehicles, and livelihood materials like refrigerators, tube wells, etc., after BARI aam3 cultivation may be attributed to their perceived lack of necessity for upgrades or improvements of those. They had enough physical capital in suitable condition before BARI Aam-3 cultivation. After cultivation of this variety, they did not need to increase or improve those. Some of the respondents experienced a decrease in different types of physical capital, especially in agricultural tools (7.2%), jewelry (3.6%), and living assets like cattle (27.0%) and poultry (14.4%). Perhaps they were more involved in mango and crop cultivation and might not have had enough time for livestock rearing. Therefore, they sold their livestock, and thus their livestock decreased. Perhaps the respondents sold their jewelry for different purposes or gifted those to their daughters. They may have also sold their agricultural tools for different purposes.

Table 5. Perceived changes in the physical capital of respondents

Livelihood Assets	Degree of change		
	Increased/ Improved (%)	Decreased (%)	No change (%)
Housing condition	52.3	-	47.7
Toilet	53.2	-	46.8
Furniture	72.1	0.9	27.0
Agricultural tools	68.5	7.2	24.3
Cattle	42.3	27.0	30.6
Poultry	33.3	14.4	52.3
Personal vehicles	51.4	0.9	47.7
Digital/electronic communication devices	82.0	1.8	16.2
Livelihood assets	74.8	0.9	24.3
Jewelry	43.2	3.6	53.2
Electricity use	93.7	0.9	5.4
Shop	11.7	2.7	85.6
Market	3.6	0.9	95.5
Cattle/poultry farm	9.9	0.9	89.2
Average	49.4	4.4	46.1

Rahman *et al*. (2019) observed that BARI aam3 growers' physical capital was increased by 48.2, 58.0, and 50.0 percent for small, medium, and large farmers, respectively. Farmers also experienced improvement in household condition and access to safe drinking water, i.e., the presence of a tube well, electricity, and a sanitary toilet. Some small (10%) and medium (10%) farmers experienced constant change in their physical capital. Some small (18.2%), medium (20%), and large (43.2%) BARI aam3 farmers also experienced decrease in livestock. Sarker *et al*. (2017) found that farmers' livelihoods were improved in terms of well house due to getting engaged with lemon production. Most of the lemon growers (58.0%) were self-employed and had improved housing accommodation, sanitation, and better physical assets.

Financial capital

The results (Table 6) indicate that 52.8 percent of respondents' access to financial capital was increased after BARI aam3 cultivation. The majority of them experienced increases in annual agricultural income (97.3%), cash in hand (84.7%), and savings (55.0%) compared to other financial capital. The potential reason could be that the greater economic returns from BARI aam3 assisted the growers to increase their financial capital. About half (43.1%) of them experienced no change in different types of financial capital. The reason many growers reported no change in remittances from household members working outside the area (98.2%), annual non-agricultural income (50.5%), and business investment (50.5%) could be that they did not have any source of getting remittance or any means to earn non-agricultural income or invest in businesses. Perhaps some growers did not experience any change in their non-agricultural income because they had a small-scale non-agricultural income source. Some respondents also experienced decrease in annual non-agricultural income (6.3%), cash in hand (5.4%), savings (5.4%), and business investment (5.4%). The reason could be that they lacked a source of non-agricultural income after BARI Aam-3 cultivation for different reasons. Their cash in hand, savings and investment in business might have reduced after BARI aam3 cultivation due to their different socio-economic conditions. The cash in hand and savings usually fluctuate over time. Perhaps they experienced loss in mango cultivation, therefore, their cash in hand and savings decreased. Perhaps other social and economic factors might have had an influence on their decrease in cash in hand and savings. Rahman *et al*. (2019) revealed that financial capital increased by 20.5, 60.0, and 44.6 percent for small, medium, and large farmers, respectively, due to BARI aam3 cultivation. It was also observed in their study that the cash in hand increased by 36.4, 100.0, and 78.4 percent for small, medium, and large mango orchard owners, respectively. Their income and, thereby, their savings were also increased. Some large BARI aam3 mango orchard owners (24.3%) also experienced constant change in their financial capital. The majority of the small BARI aam3 orchard owners (63.6%) experienced decrease in cash in hand. The majority of the small BARI Aam-3 orchard owners (81.8%) and medium BARI aam3 orchard owners (60%) experienced decrease in bank/savings.

Table 6. Perceived changes in the financial capital of respondents

Livelihood Assets	Degree of change		
	Increased/ Improved (%)	Decreased (%)	No change (%)
Annual agricultural income	97.3	2.7	-
Annual non-agricultural income	43.2	6.3	50.5
Cash in hand	84.7	5.4	9.9
Savings	55.0	5.4	39.6
Business investment	44.1	5.4	50.5
Remittances from household members working outside the area	1.8	-	98.2
Average	52.8	4.1	43.1

However, all (100.0%) of the mango farmers mentioned that mango production was profitable in Dinajpur district (Alam *et al*., 2017). Farmers' livelihoods were improved in terms of income and savings patterns due to lemon production. The financial assets of lemon producers increased gradually (Sarker *et al*., 2017). Commercial pulse production increased the household farm income of the pulse farmers in rural China (Ji-liang *et al*., 2022). Cash crop cultivation had a positive and significant impact on household income. Their farm income was significantly increased due to cash crop cultivation (Meng *et al*., 2020).

Changes in participation in income-generating activities

The respondents' observed score of participation in income-generating activities before cultivation of BARI aam3 ranged from 0 to 20 with an average score of 7.6 and the observed score of participation in income-generating activities after cultivation of BARI aam3 ranged from 3 to 20 with an average score of 12.0. Findings presented in Table 7 indicate that the majority of the respondents had medium participation in income-generating activities before and after the cultivation of BARI aam3. The respondents' average score of participation in income generating activities after cultivation of BARI aam3 was higher than the average score of participation in income generating activities before cultivation of BARI aam3, and the change was significant at the 1.0% level of probability. It can be concluded that BARI aam3 cultivation significantly influenced on the respondents' increase in participation in income generating activities.

Table 7. Changes in participation in income generating activities of the respondents after cultivation of BARI aam3

Category	Before			Category	After			% Change	t-value (df=110)
	No.	%	Mean		No.	%	Mean		
Low (up to 4)	23	20.7	7.6	Low (up to 8)	16	14.4	12.0	57.9	10.724**
Medium (5-11)	66	59.5		Medium (9-16)	79	71.2			
High (>11)	22	19.8		High (>16)	16	14.4			

** Significant at 0.01 level

Conclusion

The respondent growers experienced a remarkable improvement in all of their livelihood assets due to the adoption of BARI aam3 mango variety. This improvement might be due to the increase of their household income. However, the highest improvement was observed in the social capital and the lowest improvement was observed in the physical capital. The growers experienced increases or improvement in knowledge, access to information, employment generation, decision-making, clothing, health care, quality of food intake, and dietary diversity after BARI aam3 cultivation. They also experienced improvement in attitude, social status and respect, involvement in social activities, social prestige, cooperation from others, management, networking, and leadership roles. Their forestry/trees, safe drinking water use, leased cultivable land, and availability of irrigation water were increased after BARI aam3 cultivation. Additionally, they noted increases or improvements in electricity use, digital/electronic communication devices, livelihood assets, furniture, agricultural tools, toilet, housing condition, and personal vehicles. The majority of growers reported an increase in annual agricultural income, cash in hand, and savings after BARI aam3 cultivation. BARI aam3 cultivation also significantly influenced the respondents' increase in participation in income-generating activities. BARI, Horticulture Wing of Department of Agricultural Extension (DAE), and Bangladesh Agricultural Development Corporation (BADC) may collaborate to raise and distribute saplings of BARI aam3 and organize campaigns to plant and maintain orchards of BARI aam3 in large scale to ensure availability of this delicious mango variety to consumers. The concerned authorities may also take necessary steps to bring the suitable fallow lands of Barind Tract, hill districts and other areas under cultivation of BARI aam3. The concerned authorities may encourage contract farming for exporting BARI aam3 to the overseas ethnic markets.

Acknowledgement

This research was funded by the National Science and Technology (NST) Fellowship, Ministry of Science and Technology.

Authors' contribution

The research was a collaborative effort by S. T. Jannat, M. S. I. Afrad, M. E. Haque, S. S. Hasan, and N. A. Ivy, who worked together on the conception, planning, design, and methodology aspects of the research. Data collection and analysis were carried out by S. T. Jannat. The interpretation of the results was a joint effort by S. T. Jannat, M. S. I. Afrad, M. E. Haque, and S. S. Hasan. All authors made more or less equal contributions to the manuscript writing.

Conflicts of interest

There are no conflicts of interest regarding the publication of this paper.

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