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ADOPTION AND PROFITABILITY OF BARI MALTA-1 IN SELECTED AREAS OF BANGLADESH

M. I. KAYSAR[1], M. A. M. MIAH[2], R. MIAH[3]
A. K. M. G. KAUSAR[4] AND N. BEGUM[5]

Abstract

The study was conducted in three malta growing districts namely Khagrachori, Pirojpur and Chapai Nawabganj during January-March 2018. An attempt was made to assess the adoption status of BARI Malta-1 (sweet orange), its farm level profitability, problems and the impacts of malta cultivation on the livelihood of farmers. A total of 180 farmers, 60 farmers from each district were randomly selected for this study. The study revealed that 91% farmers adopted BARI Malta-1 in their gardens. Higher yield, profitability, sweetness, and less insect-pests infestations were the major reasons for choosing BARI Malta-1 at farm level. Farmers did not follow the recommended doses of manures and fertilizers due to lack of adequate knowledge on recommended doses. The establishment cost of a malta garden was Tk. 7,02,650 per hectare. The highest yield (19.6 t/ha) and gross return (Tk. 15,68,000/ha) were obtained from 5th to 10th year gardens. The lowest return (Tk. 8,28,160/ha) was reported in the 3rd year garden. Scarcity of saplings, un-attractive colour, and lack of technical know-how were the major problems to BARI Malta-1 cultivation. The study suggested availability of saplings, hands-on training to the farmers, and affordable price of different input for higher adoption of this variety.

1. Introduction

Bangladesh is predominantly an agricultural country where agriculture sector plays a vital role in overall economic development of Bangladesh. This sector contributes a lot to the country's GDP (15%), provides employment for about 41% of the labour force and supplies raw materials to the agro-based industries (BBS, 2018). The climatic condition and ecological factors of Bangladesh is very much favorable for various fruits cultivation. Among various citrus fruits, malta (sweet orange) is a favorite fruit in Bangladesh. Orange market in Bangladesh consists almost entirely of imported products. The country imports a huge amount of mandarin and malta from China, India, Bhutan, Pakistan and many other countries for meeting its domestic demand. Available statistics shows that the share of imports in total orange consumption was 92.4% (43.6 thousand MT valuing 16.5 million USD) in 2010 (https://app.indexbox.io/report/ 080510/50/).

[1&2]Scientific Officer and Principal Scientific Officer respectively, Agricultural Economics Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur-1701, [3]Masters Student, Faculty of Agricultural Economics and Rural Sociology, Bangladesh Agricultural University (BAU), Mymensingh, [4]Senior Lecturer, Department of Agricultural Business and Management, Exim Bank Agricultural University, Bangladesh, Chapai Nawabganj, [5]Additional Director, Bangladesh Betar, Rajshahi-6200, Ministry of Information, Bangladesh.

Besides, Bangladesh also imported 30.92 thousand litre of orange juice valuing Tk. 6.521 million in 2018-19 (BBS, 2019).

In Bangladesh Sylhet, Hobiganj, Moulovibazar, Chottogram, Chottogram hill tract, Cox's Bazar, hilly and well drained areas of Panchagarh, Thakurgaon, Tangail, and Gazipur districts and some parts of Mymensingh, Narsingdi, Sherpur, Netrokona districts, and some southern and northern parts of the country have potential to bring under citrus fruit cultivation. It is possible to grow sweet orange and mandarin orange commercially to fulfill the national demand and save foreign exchange by eliminating the problems by developing suitable varieties and improved management techniques. Bangladesh Agricultural Research Institute (BARI) has developed a malta variety namely BARI Malta-1 since 2003. The Department of Agricultural Extension (DAE) has been involved in dissemination of this variety through its countrywide networks. Due to collaborative extension works with different agencies, BARI Malta-1 variety is cultivating all over the country.

The adequate farm level socioeconomic data and information and farmers' feedback about this variety are unknown to the researchers and policy makers. Kaysar et al., (2017) conducted a socioeconomic study on mandarin cultivation in selected areas of Bangladesh. Therefore, an attempt was made to assess the status of farm level adoption of BARI Malta-1 cultivation, its profitability, constraints to its cultivation and its adoption impacts on farmer's livelihood in Bangladesh. The specific objectives of this study were as follows.

a) To assess the adoption of BARI Malta-1 at the farm levels;
b) To find out the factors affecting their adoptions and sustainability;
c) To estimate the profitability of BARI Malta-1 cultivation; and
d) To find out the problems of BARI Malta-1 cultivation at farm level.

2. Materials and Methods

2.1 Sampling Technique and Sample Size

Purposive random sampling technique was used to select the sample respondents. In the first stage of sampling, three malta growing districts namely Khagrachori, Pirojpur and Chapai Nawabganj were selected purposively based on area coverage and production of malta. A total of 180 samples taking 60 farmers from each district were randomly selected for this study. Data were collected by the experienced field investigators with direct supervision of the researchers using a pre-tested interview schedule.

2.2 Analytical Techniques

Data were categorized according to the year of gardens like 1st year, 2nd year, 3rd year, 4th year, 5-10th year and above 10 years. Tabular methods of analysis using descriptive statistics were used in presenting the results of the study. The

following equations were used to calculate profitability of BARI Malta-1 cultivation:

Gross return = GRij = YijPij

Net return = GRij – TCij

Gross margin = GRij – VCij

Where,

GRij = Gross return (Tk./ha)

Pij = Price (Tk./ha of j^{th} crop received by i^{th} farmer)

Yij = Quantity produced (kg/ha)

TC_{ij} = Total cost of j^{th} crop for i^{th} farmer (Tk/ha)

VC_{ij} = Variable cost of j^{th} crop for i^{th} farmer (Tk/ha)

2.3 Analysis of Returns to Investment

The profitability of malta production was also measured by calculating net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR) of the malta orchard. The discount rate was specified by assuming the opportunity cost of capital which is 12% for most of the developing countries (Gittinger, 1982).

2.4 Factors of Adoption of BARI Malta-1 Technology

The following Probit model was used to determine the factors of adoption of BARI Malta-1 technology at farm level. The model was as follows:

$$Ai = a + \beta iXi + \ldots\ldots\ldots\ldots\ldots\ldots + Ui$$

Where,

Ai = Farmers adopting BARI Malta-1 (If adopt = 1; Otherwise = 0)

a = Intercept

Xi = Explanatory variables (socioeconomic characteristics)

Bi = Coefficients of the respective factors

Ui = Error term

The explanatory variables were as follows:

X_1 = Age of the respondent (year)

X_2 = Education (Year of schooling)

X_3 = Farm size (decimal)

X_4 = Family labour (No./ha)

X_5 = Training received on BARI Malta-1 (No. in lifetime)

X_6 = Training received on agriculture (No. in lifetime)

X_7 = Availability of saplings (Score)

X_8 = Availability of suitable land (Score)

X_9 = Influence of neighbouring farmers (Score)

X_{10}= Influence of extension personnel (Score)

X_{11}= Societal membership (Score)

3. Results and Discussion

3.1 Socio-economic Profile of the Farmers

Education: There is a positive relationship between education and agricultural productivity and technology adoption (Okpachu et al., 2014; Asfaw and Admassie, 2004; Appleton and Balihuta, 1996). So, farmer's education is expected to play crucial role in increasing farming output and adoption of new technologies. Adoption of new technology and efficiently use of farm resources to make maximum profit there is no alternative of farmers education. The farmers were categorized into (1) Can't read & write, (2) Primary, (3) Secondary, (4) Higher secondary, and (5) Degree & above groups (Table 1). It was observed that 8% of adopters and 20% of non-adopters did not have any formal education. The highest 45% of adopters have secondary level education followed by 23% have primary level, 15% have higher secondary level, and 7% have degree and above level education. On the other hand, 36% of non-adopters have primary level education followed by 30% secondary level, 11% higher secondary, and 4% have degree & above level education.

Table 1. Percent distribution of farmers by literacy levels

Literacy level	Khagrachori	Pirojpur	Chapai Nawabganj	All area
A. Adopter				
Can't read & write	12	5	8	8
Primary	31	14	25	23
Secondary	47	47	41	45
Higher secondary	8	22	16	15
Degree & above	2	12	8	7
B. Non-adopter				
Can't read & write	22	17	21	20
Primary	38	31	38	36
Secondary	34	31	24	30
Higher secondary	6	14	12	11
Degree & above	-	7	5	4

Source: Field survey 2018

Land holding: Farming activities mainly depend on land holding of the farmers. Table 2 reveals that farm size of adopters and non-adopters were 2.36 ha and 1.59 ha respectively. The land holdings of the adopting farmers of Khagrachori was higher than that of farmers of Pirojpur and Chapai Nawabganj districts.

Table 2. Category of land and farm size (ha) of the respondent farmers

Land category	Khagrachori	Pirojpur	Chapai Nawabganj	All area
A. Adopter				
1. Own land	0.680	0.405	0.348	0.47
2. Rented in	0.243	0.138	0.162	0.18
3. Rented out	0.182	0.101	0.146	0.14
4. Mortgaged in	0.304	0.085	0.121	0.17
5. mortgaged out	0.227	0.093	0.097	0.13
6. Homestead	0.101	0.097	0.101	0.10
7. Malta orchard	0.445	0.202	0.223	0.29
8. Other orchard	1.065	0.482	0.429	0.65
9. Fallow land	0.243	0.109	0.081	0.14
10. Pond	0.000	0.081	0.097	0.05
Farm size (ha)	**3.490**	**1.794**	**1.806**	**2.36**
A. Non-adopter				
1. Own land	0.421	0.202	0.308	0.31
2. Rented in	0.162	0.085	0.142	0.13
3. Rented out	0.097	0.057	0.154	0.10
4. Mortgaged in	0.182	0.105	0.113	0.13
5. mortgaged out	0.158	0.097	0.138	0.13
6. Homestead	0.061	0.069	0.081	0.07
7. Malta orchard	0.121	0.000	0.000	0.04
8. Other orchard	0.745	0.271	0.324	0.44
9. Fallow land	0.198	0.182	0.142	0.17
10. Pond	0.000	0.093	0.061	0.05
Farm size (ha)	**2.146**	**1.162**	**1.462**	**1.59**

Source: Field survey 2018

Influencing persons in variety adoption: At the beginning stage of adopting of BARI Malta-1, most farmers were influenced by different persons at different levels. Table 3 shows that the overall influence of SAAO in adopting BARI

Malta-1 was higher than the influence of others. Akter et al. (2010) also found that the influence of SAAO in adopting BARI groundnut was highly significant. Neighboring farmers and AO also influenced farmers in adopting BARI Malta-1 in the study areas.

Table 3. Distribution of adopters by influencing persons

Persons	Level of influence (%)				
	Very high	High	Medium	Low	No influence
1. Family member	-	-	8	16	76
2. Neighboring farmer	15	41	27	5	12
3. SAAO	82	6	-	4	8
4. Agriculture Officer	13	18	13	42	16
5. IPM/ICM club			14	13	73
6. Scientists of OFRD	-	-	-	7	93

Source: Field survey 2018

Reasons for choosing BARI Malta-1: Respondent farmers adopted BARI Malta-1 for its numerous attributes such as higher yield, sweetness, higher demand in the market, highly profitable, availability of saplings, and less attack of insect-pests. Table 4 depicts that the higher yield of BARI Malta-1 was the first attribute that influenced farmers to adopt the variety.

Table 4. Reasons for choosing BARI Malta-1 variety adoption

Reasons	Rank order			
	Khagrachori	Pirojpur	Capai Nawabganj	All area
1. Higher yield	1	1	1	1
2. Highly profitable	2	3	2	2
3. Higher demand	4	2	4	3
4. Very tasty	3	4	3	4
5. Less attack of insects and pests	5	5	5	5
6. Attractive color	6	6	6	6

Source: Field survey 2018

Level of extension contact: Extension contact play significant role in improved technology adoption at farm level (Islam et al., 2013; Miah et al., 2015). DAE is the key agent of Bangladesh government to dissemination of crop related agricultural technologies from research organization to farmer's field. Table 5 reveals that the adopters of BARI Malta-1 had frequent contact with the extension personnel and neighboring farmers and their level of contacts were more than non-adopters in the study areas. It was opined that about 49% farmers

contacted with extension personnel regarding malta cultivation which was much higher than that of non-adopters. Contact with mass media (i.e. radio, television, newspaper) was also higher than non-adopters in the study areas.

Table 5. Level of extension contact of malta farmers with different extension medias

Extension medias	Farmer's responses (%)			
	Frequently	Often	Rarely	Never
A. Adopter				
Extension personnel	27	49	18	6
Neighbor farmer	23	58	17	2
Demonstration plot	3	7	14	76
Participating agril. fair	-	3	13	84
Television	-	2	4	94
Attend in the field day		8	18	74
Research organization visit	-	4	10	86
Radio	-	6	8	86
News paper	-	-	4	96
Agriculture booklet/leaflet	-	-	1	99
B. Non-adopter				
Extension personnel	18	34	23	25
Neighbor farmer	17	44	7	32
Demonstration plot	6	29	18	47
Participating agril. fair	2	3	11	84
Television	2	4	17	77
Attend in the field day	-	-	6	94
Research organization visit	--	12	17	71
Radio	-	-	-	100
News paper	-	-	-8	92
Agriculture booklet/leaflet	-	-	-	100

Training received: Technological knowledge dissemination training plays crucial role in increasing skills on production and related activities. Yokouchi and Saito (2016) found that training had significant influence on the adoption of NERICA upland rice varieties in Benin. Table 6 revealed that 40% BARI Malta-1 adopters and 91% non-adopters did not receive any training on malta cultivation. More than half of the adopters received 1-2 times training in their lifetime. DAE was the key agency to provide the training on malta cultivation at farmers level. More than two training was received by 9% non-adopters only.

Table 6. Training received by the farmers on malta cultivation

No. of training received	Farmer's responses (%)			
	Khagrachori	Pirojpur	Capai Nawabganj	All area
A. Adopter	n=40	n=40	n=40	n=120
No training	35	38	46	40
1-2 Nos.	42	56	54	51
3-4 Nos.	17	6	-	8
5-6 Nos.	6	-	-	2
Total	100	100	100	100
B. Non-adopter				
No training	84	94	96	91
1-2 Nos.	16	6	4	9
3-4 Nos.	-	-	-	-
5-6 Nos.	-	-	-	-
Total	100	100	100	100

Distribution of income from BARI Malta-1 production: Adopting farmers distributed their income from BARI Malta-1 cultivation in various way such as education of their children, daily food consumption, buying land, farm expenditure etc. Table 7 revealed that the highest (21%) income was spent on farm level expenditure. About 13% of income was spent on education of their children and 28% of income was spent on daily food consumption. They also used their income on purchase of furniture (6%), animal feed (10%), and savings at bank (5%), family recreation (2%), buying agricultural equipment (2%), and many other purposes (9%).

Table 7. Percent distribution of malta cultivation income on various household purposes

Item	Khagrachori	Pirojpur	Chapai Nawabganj	All areas
Education	15	12	11	13
Purchase of daily foods	32	24	28	28
Buying of land	2	6	4	4
Farm expenditure	18	24	21	21
Purchase of furniture	8	4	7	6
Purchase of agril. equipment	0	2	3	2
Family recreation	0	3	4	2
Purchase of animal feed	14	8	7	10
Savings at bank	3	7	6	5
Other purposes	8	10	10	9

3.2 Adoption of BARI Malta-1 Technology at Farm Level

The farm level adoption of BARI Malta-1 variety mainly depends on the collaborative dissemination technique used by BARI in Association with the DAE. Adoption of BARI Malta-1 is very glowing all over Bangladesh since its development in 2003 by BARI. Almost 100% farmers used BARI Malta-1 variety. Some local and exotics varieties were also used by the farmers in the study areas. The main reasons of this high adoption were availability of saplings, higher yield, and sweetness of the variety (Table 8).

Table 8. Percent of adoption of BARI Malta-1 variety at farm level

Variety	Khagrachori *(n=40)*	Pirojpur *(n=40)*	Chapai Nawabganj *(n=40)*	All areas *(n=120)*
BARI Malta-1	80 (32)	95 (38)	100 (40)	92 (110)
Other varieties	20 (8)	5 (2)	--	8 (10)

Note: Figures in the parentheses are number of respondents

Adoption of BARI Malta-1 management technologies: BARI has recommended different improved management practices likes tillage operations, time and method of seedlings, fertilizer dose, weed management, irrigation and insect-pest control. The recommended number of saplings ranged from 950 to 1050 nos. per hectare, but most of the farmers used above number of saplings except Khagrachori district. The recommended period of planting time is May to August. In that case, adoptions level was high because majority of the farmers in all areas planted their saplings within recommended period of time. It is noted that 28% farmers kept recommended plant to plant distance (4m), but 42% and 30% farmers followed below and above recommended plant to plant distance respectively. The highest percentage (56%) of farmers in all areas followed the recommended depth (75cm) of pit. Half of the respondent farmers irrigated their garden on regular basis, but in Khagrachori district 30% famers irrigated their garden. The highest percentage (75%) of farmers in all areas followed the recommended number of weeding (2 times) and 65% farmers used pesticides in their gardens (Table 9).

The recommended fertilizer doses varied according to the age of malta gardens. The use of manures and fertilizers by sample farmers varied from location to location (Table 10). Table shows that famers often do not follow recommendation for applying manure and fertilizers. Adoption status of cow dung applied in different year's garden was low since majority of the famers applied below the recommended doses. Urea applied in different years of garden was also below the recommended doses per tree. Adoption status of TSP applied in different years garden was medium, majority of the famers applied below the recommended doses. Almost all the respondent farmers applied urea, TSP, MoP, zinc oxide and boron in lower quantity compared to recommended doses in different years of garden. However, the levels of adoption of using manure and fertilizers were found to be low as they did not use recommended dose.

Table 9. Percent of adoption of crop management technologies used in malta cultivation

Particular	Khagrachori *(n=40)*	Pirojpur *(n=40)*	Chapai Nawbganj *(n=40)*	All areas *(n=120)*	Adoption level
Saplings (No./ha)					
Recommended (950-1050)	25 (10)	20 (8)	18 (7)	21 (25)	Low
Below recommendation	75 (30)	10 (4)	8 (3)	31 (37)	
Above recommendation	-	70 (28)	75 (30)	49 (58)	
Time of planting					
Recommended (May-August)	85 (34)	95 (38)	90 (36)	90 (108)	High
Non-recommended period	15 (6)	5 (2)	10 (4)	10 (12)	
Plant to plant distance					
Recommended **(4m)**	23 (9)	33 (13)	30 (12)	28 (34)	Low
Below recommendation	-	60 (24)	65 (26)	42 (50)	
Above recommendation	78 (31)	8 (3)	5 (2)	30 (36)	
Deepness of pit					
Recommended **(75cm)**	48 (19)	63 (25)	58 (23)	56 (67)	Medium
Below recommendation	35 (14)	28 (11)	13 (5)	25 (30)	
Above recommendation	18 (7)	10 (4)	30 (12)	20 (23)	
No. of irrigation					
Regular irrigation	35 (14)	70 (28)	45 (18)	50 (60)	Medium
Not regular irrigation	65 (26)	30 (12)	55 (22)	50 (60)	
No. of weeding					
Recommended (2 times)	70 (28)	78 (31)	80 (32)	75 (91)	High
Below recommendation	20 (8)	10 (4)	10 (4)	13 (16)	
Above recommendation	10 (4)	13 (5)	10 (4)	11 (13)	
Non-users					
Insect-pest control					
Do not used pesticide	58 (23)	28 (11)	20 (8)	35 (42)	
Used pesticide	43 (17)	73 (29)	80 (32)	65 (78)	
Pruning					
Regular pruning	60 (24)	73 (29)	68 (27)	67 (80)	
Never pruning	40 (16)	28 (11)	33 (13)	33 (40)	

Note: Figures in the parentheses are number of respondent farmers.

Table 10. Percent of farmers used manures and fertilizers in different ages of malta gardens

Particular	Age of the garden (year)					Adoption level
	1-2 *(n=24)*	3-4 *(n=24)*	5-7 *(n=24)*	8-10 *(n=24)*	10 & above *(n=24)*	
Cowdung (kg/tree)	10-12	12-15	15-18	18-20	20-25	
*Recommended	45.83 (11)	25.00 (6)	16.67 (4)	20.83 (5)	25.00 (6)	Low
Below recommendation	25.00 (6)	58.33 (14)	54.17(13)	70.83 (17)	66.67 (16)	
Above recommendation	8.33 (2)	-	-	-	-	
Not applied	20.83 (5)	16.67 (4)	25.00 (6)	8.33 (2)	8.33 (2)	
Urea (gm/tree)	250	400	500	650	750	
*Recommended	16.67 (4)	25.00 (6)	20.83 (50)	25.00 (6)	33.33 (8)	Low
Below recommendation	41.67 (1)	33.33 (8)	58.33 (14)	58.33 (14)	41.67 (10)	
Above recommendation	16.67 (4)	29.17 (7)	4.16 (1)	-	-	
Not applied	25.00 (6)	12.50 (3)	16.67 (4)	16.67 (4)	25.00 (6)	
TSP (gm/ha)	150	200	300	400	500	
*Recommended	54.17 (13)	62.50 (15)	33.33 (8)	29.17 (7)	45.83 (11)	Medium
Below recommendation	12.50 (3)	16.67 (4)	29.17 (7)	33.33 (8)	20.83 (5)	
Above recommendation	29.17 (7)	12.50 (3)	16.17 (4)	12.50 (3)	8.33 (2)	
Not applied	16.67 (4)	20.83 (5)	16.67 (4)	25.00 (6)	25.00 (6)	
MoP (kg/ha)	150	200	250	300	450	
*Recommended	12.50 (3)	16.67 (4)	25.00 (6)	20.83 (5)	20.83 (5)	Low
Below recommendation	--	4.17 (1)	12.50 (3)	16.67 (4)	12.50 (3)	
Above recommendation	50.00 (12)	33.33 (8)	33.33 (80)	29.17 (7)	25.00 (6)	

Particular	Age of the garden (year)					Adoption level
	1-2 *(n=24)*	3-4 *(n=24)*	5-7 *(n=24)*	8-10 *(n=24)*	10 & above *(n=24)*	
Not applied	37.50 (9)	29.17 (7)	29.17 (7)	33.33 (8)	25.00 (6)	
Zinc(kg/ha)	10	15	20	25	30	
*Recommended	25.00 (6)	20.83 (5)	29.17 (7)	25.00 (6)	16.67 (4)	Low
Below recommendation	33.33 (8)	37.50 (9)	25.00 (6)	25.00 (6)	33.33 (8)	
Above recommendation	16.67(4)	25.00 (6)	29.17 (7)	29.17 (7)	33.33 (8)	
Not applied	25.00 (6)	16.67 (4)	20.83 (5)	25.00 (6)	16.67 (4)	
Boron (kg/ha)	5	8	10	12	15	
*Recommended	33.33 (8)	25.00 (6)	37.50 (9)	37.50 (9)	33.33 (8)	Low
Below recommendation	25.00 (6)	33.33 (8)	12.50 (3)	16.67 (4)	12.50 (3)	
Above recommendation	29.17 (7)	20.83 (5)	25.00 (6)	20.83 (5)	45.83 (11)	
Not applied	16.67 (4)	20.83 (5)	25.00 (6)	25.00 (6)	12.50 (3)	

Note: Figures in the parentheses are No. of respondent farmers

*****Recommended dose of fertilizers (FRG, 2005)

3.3 Determinates of Adoption of BARI Malta-1

The adoption of BARI Malta-1 at farm level were influenced by farmer's age, education, family labour, experience, training, farm size, influence of SAAO, and extension contact. The coefficients of farmer's education, training, farm size, availability of suitable land, availability of quality saplings, influence of SAAO, and extension contact had positive and significant influence on the adoption of BARI Malta-1 in the study areas. Marginal effects of different variables indicate that if these factors are increased 100% the probability of adopting BARI Malta-1 would be increased by 4.0%, 12.4%, 23.9%, 5.3%, 1.5%, 8.6%, 9.6% and 1.2% respectively (Table 12)

Table 11. Maximum likelihood estimates of variable determining adoption of BARI Malta-1 variety among respondent farmers

Explanatory variable	Coefficient	Standard Error	Z-statistic	Probability p>z
Constant	-11.2893***	1.9823	-7.08	0.000
Farmers' age (year)	0.0258	0.0235	2.64	0.003
Education (year of schooling)	0.10498 **	0.0062	1.47	0.136
Training on malta (No. of life time)	0.18925 **	0.0560	1.89	0.016
Farm size (decimal)	0.12652 **	0.1256	2.36	0.036
Family labour (No./year)	0.45784**	0.0654	1.84	0.012
Availability of suitable land (Scale,0-4;0=not available 4= plenty)	0.21354	0.0456	2.38	0.006
Availability of quality saplings (Scale,0-4;0=not available 4= plenty)	1.49253 ***	0.1352	4.36	0.038
Influence of neighbor (score) (Scale,0-4;0=not influence 4= high influence)	0.08920	0.0254	3.12	0.632
Influence of SAAO (score) (Scale,0-4;0=not influence 4= high influence)	0.39320**	0.0638	4.23	0.002
Extension contact (score) (Scale,0-4;0=no contact 4=regular contact)	0.02935**	0.0937	2.65	0.005

Table 12. Marginal effect of the variables determining adoption of BARI Malta-1 variety among respondent farmers

Explanatory variable	dy/dx	Std. Error	Z-statistic	Probability
Farmers' age (year)	0.00004	0.0235	2.34	0.009
Education (year of schooling)	0.04003**	0.0062	1.29	0.141
Training on malta (No. of life time)	0.12426**	0.0560	1.67	0.021
Farm size (decimal)	0.23892**	0.1256	2.89	0.034
Family labour (No./year)	0.05325**	0.0654	1.78	0.017
Availability of suitable land (score)	0.01532	0.0456	2.37	0.007
Availability of quality saplings (score)	0.08624***	0.1352	3.98	0.045
Influence of neighbor (score)	0.00364	0.0254	2.89	0.664
Influence of SAAO (score)	0.09604**	0.0638	4.47	0.009
Extension contact (score)	0.01243**	0.0937	2.62	0.008

Note: **'**'** and **'***'** indicate 5% and 1% level of significance respectively

3.4 Profitability of BARI Malta-1 Cultivation

Cost and return of BARI Malta-1 production: Planting materials, land preparation, input cost (FYM, fertilizers, plant growth regulators, plant protection chemicals etc.), labour cost, power cost, harvesting, packing and transportation charges were the main cost components for BARI Malta-1 cultivation. The rental value of land was treated as fixed cost and interest on operating capital was also considered for the estimation of cultivation cost. Land development and saplings costs were involved only for the first year.

The highest cost was estimated at Tk. 7,02,650/ha for BARI Malta-1 cultivation was found in the 1st year garden and the lowest cost was Tk.3,94,315/ha in the 2nd year garden. Among cost items, human labour cost was the highest (Tk.4,50,000/ha.) for first year garden. Average wage rate in the study areas was Tk. 300/days. Total variable cost was the highest (Tk. 6,02,090/ha) in the 1st year garden and the lowest (Tk. 3,16,594/ha) in the 2nd year garden. The rental value of BARI Malta-1 garden was Tk. 52,393/ha. Interest on operating capital was calculated at 8% interest rate (Table 13).

Table 13. Per hectare cost of malta cultivation in the study areas

Items	Period of cultivation (year)					
	1st	2nd	3rd	4th	5-10th	11-15th
Human labour	450000	235000	279000	297400	309500	309500
Saplings	80000	-	-	-	-	-
Cow dung	12000	8300	16500	18586	19457	24000
Urea	3650	6823	6478	7036	7231	17690
TSP	5320	5783	8560	10500	11500	19800
MP	4500	4832	7456	9864	10035	12500
Zinc	1560	2320	2450	2450	2458	3560
Boric acid	500	700	900	1350	1452	2431
Insecticides	5000	12450	12360	9548	15483	18750
Pesticides	12560	12650	13500	14560	18230	23450
Irrigation	15000	14236	14560	12540	12550	15600
Bamboo	12000	13500	13500	13500	13500	18902
Total variable cost (TVC)	602090	316594	375264	397334	421396	466183
Interest on opt. capital	48167	25328	30021	31787	33712	37295
Rental value of land	52393	52393	52393	52393	52393	52393
Total fixed cost (TFC)	100560	77721	82414	84180	86105	89688
Total cost (TVC+TFC)	702650	394315	457678	481514	507501	555871

Source: Authors' calculation based on field survey, 2018.

The return from BARI Malta-1 cultivation in different years is presented in Table 14. After two years, saplings starts producing fruits and continue up to 10-15th years. Price varied based on quality of BARI Malta-1. In the last year, farmers got an average price of Tk.80 per kg. The highest yield was found to be 19.6 t/ha at the 5-10th year garden followed by 18.00 t/ha at above 10th year old garden, and the lowest yield was 10 t/ha at the 3rd year garden. The highest gross return was estimated at Tk. 15,68,000 at the 5-10th years garden and the lowest return was Tk. 8,28,160 at the 3rd year garden. The highest gross margin was found to be Tk. 11,46,604/ha at the 5-10th year garden and the lowest Tk. 4,52,896/ha in the 3rd year garden. Similarly, the highest net return was found to be Tk. 10,60,499/ha at the 5-10th year garden and the lowest return was Tk. 3,70,481 in the 3rd year garden. Net return was negative in the 1st and 2nd year garden because production was zero.

Returns to investment of BARI Malta-1 cultivation: The profitability of malta production was also measured by estimating the benefit-cost ratio (BCR), net present value (NPV), and internal rate of return (IRR) of the investment on establishing malta orchard. The BCR of the investment was found to be 1.89 at 12% discount rate which is greater than unity and acceptable. Again, the estimated NPV was Tk. 27,06,658 per hectare which indicates that the investment on BARI Malta-1 cultivation was highly profitable. The IRR was found to be 50% which is highly acceptable because it is much higher than the opportunity cost of capital (Table 14). The above estimates (BCR, NPV & IRR) were much higher than the estimates generated for mandarin cultivation (Gangawar and Singh, 1998) and Kinnow mandarin cultivation (Gangawar et al., 2005) in India.

4. Problems of Malta Cultivation

Table 15 revealed that the highest 78% farmers opined that green color of BARI Malta-1 is the main constraints to adoption but situation is changing rapidly. About 77% farmers claimed that high saplings price and the scarcity of saplings of BARI Malta-1 in all study areas. As a result farmers cannot establish their garden. Nearly 56% farmers have not sufficient knowledge of technical aspects. Lack of suitable land, lack of marketing facilities, problem of insect/pest infestation and some others problems faced by farmers in the study areas.

Table 14. Profitability of malta cultivation in the study areas

Items	Period of cultivation (year)					
	1st	2nd	3rd	4th	5-10th	11-15th
Total cost	702650	394315	457678	481514	507501	555871
Variable cost	602090	316594	375264	397334	421396	466183
Fixed cost	52393	52393	52393	52393	52393	52393
Yield (kg/ha)	0	0	10352	13560	19600	18000
Unit price (Tk./kg)	80	80	80	80	80	80
Gross return (Tk./ha)	0	0	828160	1084800	1568000	1440000
Gross margin (Tk./ha)	-602090	-316594	452896	687466	1146604	973817
Net return (Tk./ha)	-702650	-394314	370481	603286	1060499	884129
BCR	1.89					
NPV	Tk. 27,06,658					
IRR	50%					

Table 15. Problems of BARI Malta-1 cultivation in the study areas

Problems	Farmer's responses (%)			
	Khagrachori	Pirojpur	Chapai Nawabganj	All area
Lack of suitable land	16	26	21	21
Scarcity of saplings	32	41	48	40
Higher price of sapling	72	76	83	77
Colour not attractive	84	72	79	78
Lack of technical knowledge	63	46	58	56
Less tasty	12	14	11	12
Insect-pest infestation	16	8	7	10
Lack of marketing facilities	38	32	16	29
Others	9	10	14	11

Facilities needed by the farmers: The availability of quality saplings at local level is the primary need of farmers to expand BARI Malta-1 production. Eighteen percent farmers mentioned that training on BARI Malta-1 cultivation is essential for improve production practice. About 14% of farmers demanded suitable land to cultivate BARI Malta-1. Input price of BARI Malta-1 cultivation should be reasonable as a new crop to expand farmer's field. They also demanded yellow malta varieties (6%), credit facility with low interest rate (8%), and ensuring fair price of their produces (Table 16).

Table 16. Facilities needed to increase BARI Malta-1 cultivation in different locations

Type of facility	Farmer's response (%)			
	Khagrachori	Pirojpur	Chapai Nawabganj	All area
Availability of quality saplings	28	26	31	28
Hands-on training on malta cultivation	14	18	20	18
Availability of suitable land	7	20	16	14
Ensuring low price of inputs	20	6	8	12
Credit facility with low interest	6	10	5	8
Yellow color malta varieties	8	5	4	6
Ensuring fair price of produces	7	6	6	6

5. Conclusions and Recommendations

Most of the farmers adopt BARI Malta-1 variety in their gardens. Adoption status of management technology is low in most of the cases. Farmers apply

different doses of manures and fertilizers according to plant age, but it is below the recommended doses in almost all the study areas. The cost of human labour, saplings, fertilizers, and hiring of land are the major cost items of BARI Malta-1 cultivation. The benefit cost ratio, net present value and internal rate of return indicate that farmers are benefited from BARI Malta-1 cultivation in both hill regions and plain lands. Although BARI Malta-1 is a profitable crop, respondent farmers face various problems during its cultivation.

Based on the findings of the study, the following recommendations are suggested for expanding the cultivation of BARI Malta-1 throughout the country.

- The saplings of BARI Malta-1 variety should be made available to the other parts of the country through DAE, BADC and nursery owners to produce sufficient BARI Malta-1 saplings and supply to the farmers at reasonable price.
- Regular training program should be arranged for the farmers to enhance their knowledge about improved cultivation practices.
- Present green malta variety needs publicity through mass media for its higher popularity.
- The scientists should develop yellow colored malta variety.
- Respective departments may take immediate steps to control insect-pest infestation.
- Government should ensure credit facilities with minimum interest for the farmers for expanding BARI Malta-1 cultivation.

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