Published with Open Access at Journal BiNET
Vol. 14, Issue 01: 1174-1182
Journal of Bioscience and Agriculture Research
Journal Home: www.journalbinet.com/jbar-journal.html

Productivity and profitability of mandarin cultivation in selected areas of Bangladesh

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ABSTRACT

The study was conducted in three districts namely Panchagarh, Bandarban and Moulovibazar to know the production technology of mandarin cultivation and to estimate profitability and identify the constraints of mandarin cultivation. A total of 99 farmers taking 33 from each district were selected randomly. Data were collected through a pre-tested schedule during January-March, 2016. Cost and return analysis revealed that mandarin cultivation was profitable in the study areas. The highest cost was estimated Tk. 215293/ha in 16-20th year garden and lowest cost Tk. 119993/ha in 2-4th year garden. Highest yield was found 16020 kg/ha at 11-15th year garden followed by 13800 kg/ha at 16-20th year garden and lowest yield 11100 kg/ha at 5-10th year garden. The highest gross return was found in Tk. 640800/ha at 11-15th year garden and lowest return was Tk. 444000 at 5-10th year garden. The highest amount of net return was found in the Tk. 435859/ha at 11-15th year garden and lowest return was Tk. 235286 in 5-10th year garden. The benefit cost ratio at 12% rate of interest was 1.68, NPV Tk. 920401 and IRR 30%. Sensitivity analysis implied that mandarin cultivation is profitable. Scarcity of irrigation in hill areas, acute problem of insect/pest infestation, lack of improved production technology, poor quality and scarcity of seedlings/saplings, lack of capital for initial investment and low yield of different varieties were found major constraints for mandarin cultivation in the study areas.

Key Words: *Mandarin, profitability, Socio-economic status, Constraints and Recommendation*

Cite Article: Kaysar, M. I. , khandoker, S., Islam, M. S., Mia, M. S. and Kausar, A. K. M. G. (2017). Productivity and profitability of mandarin cultivation in selected areas of Bangladesh. Journal of Bioscience and Agriculture Research, 14(01), 1174-1182.
Crossref: https://doi.org/10.18801/jbar.140117.144

I. Introduction

Mandarin (*Citrus reticulate*) is the most common citrus fruits grown in Bangladesh. Mandarin grows successfully in all frost free tropical and subtropical regions up to 1500m above from the sea level. Annual 100-120cm rainfall and temperature ranging from 10-35^{0}c are suitable for mandarin

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cultivation. Mandarin is rich in vitamin C, A, B and phosphorus. Mandarin is consumed fresh or in the form of juice, jam, squash and syrup. It is the main source of peel, oil, citric acid and cosmetics which have international value (Meena et al., 2014). Soil and temperature of Bangladesh is favorable for mandarin cultivation. But Bangladesh has not yet been given due attention for cultivation of this fruit. Bangladesh import huge amount of mandarin from china, India, Bhutan, Pakistan and other countriesevery year. The growth rates of importing orange and orange juice were about 4.1% and 1515.8% respectively during 1990-91 to 2009-10 (Hossain, 2014). Chittagong hill tract and Sylhet regions have the potentialities to bumper production of mandarin (BARI handbook 2014). Although a very small amount of the mandarin is produced there commercially. Most of the mandarins available in our market are from abroad. Recently some farmers, public sectors and NGO's have started cultivating mandarin in panchagarh district. This is another opportunities to mandarin cultivation in plain land. About 2998 MT of mandarin was grown annually in 853 hectares of land in Bangladesh (BBS, 2011). The present study was conducted to know the production practice, profitability and constraints of mandarin.

II. Materials and Methods

The study was conducted in three mandarin growing districts Panchagarh, Bandarban and Moulovibazar during January-March, 2016. Sadar upazilla from Panchagarh district, juriupazilla from Moulovibazar district and ruma upazilla from Bandarban district were selected for the study. Purposive random sampling technique was followed for the study. A total of 99 samples, 33from each district were randomly selected for interview. Data were collected by the experienced field investigators with direct supervision of the researchers using pre-tested interview schedule. Data were categorized according to the year of cultivation like 1st year, 2-4th year, 5-10th year, 11-15th year and 16-20th year. Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. Tabular methods of analysis using descriptive statistics were used in presenting the results of the study. Benefit-Cost Analysis is a technique for evaluating a project or investment by comparing the economic benefits with the economic costs of the activity. BCA can be used to evaluate the economic merit of a project. The results from a series of benefit-cost analysis can be used to compare competing projects. BCA can be used to assess business decision, examine the worth public investments, or assess the wisdom of using natural resources or altering environmental conditions. Ultimately, BCA aims to examine potential actions with the objective of increasing social welfare (Gittinger, 1982).

NPV: The net present value (NPV) is the current value of all project net benefits. Net benefits are simply the sum of benefits minus costs. The sum is discounted at the discount rate. Using this method, if the project has a NPV greater than zero then it appears to be a good candidate for implementation. The formula used to calculate at NPV:

$$Netpresentvalue = \sum_{t=1}^{t=n} \frac{B_t - C_t}{(1+i)^t}$$

IRR: The internal rate of return (IRR) is the maximum interest that could be paid for the project resources, leaving enough money to cover investment and operating to break even. In other words, the IRR is the discount rate for which the present of total benefits equal the present value of total cost. In generally the IRR should be greater than the discount rate for a project to be accepted.

$$Internalrateofreturn = \sum_{t=1}^{t=n} \frac{B_t - C}{(1+i)^t}$$

Where,

Bt= Total benefit (Tk./ha) in tth year
Ct = Total cost (Tk./ha) in tth year
t = Number of year
i = Interest (discount) rate

III. Results and Discussion

Socio-economic profile of the respondent farmers

Socio-economic profile of the respondent farmers is very important part of social science research because it gives clear picture about the present farm activities, different type of cultivation in hill regions and plain land, pattern of input use, possible development opportunities and constraints faced by the farmers during the production process. Therefore, information regarding respondent's age, education, occupation, family size, land ownership, sources of income and land use pattern were recorded for the study.

Family size: The composition of family members in the study areas included the number of adult male, adult female and children of the respondent households. The average family size was found 6.03 persons per family whereas the national average was 4.44 persons/family (BBS, 2013). Among family members of sample household it was found that 40% male, 36% female and 23% children in all areas. It was also found that dependency ratio on an average almost 3 in the study areas (Table 01).

Table 01. Family size (no./farm) of the respondent farmers

Family size	% farmers responded			
	Panchagarh	Bandarban	Moulavibazar	All average
Male	2.62	2.32	2.35	2.43(40)
Female	2.37	1.94	2.26	2.19(36)
Children	1.86	1.02	1.35	1.41(23)
Total	6.85	5.28	5.96	6.03
Effective member	2.21	1.98	1.86	2.02(33)
Dependency ratio	3.10	2.67	3.20	2.99(49)

Figures in the parentheses indicate percentage of total.

Education level of farmers: Education plays a vital role for modern agricultural practices. It is recorded that 21% of the farmers were illiterate that means 79% of the farmers were literate in the study areas which was higher than national average. It was found that average 30.67% farmers only can sign, 23.33% having primary education 14.67% junior level, 7.33% SSC level and only few farmers (2.68) HSC and above level of education (Table 02).

Table 02. Education level (%) of the respondent farmers

Education level	% farmers responded			
	Panchagarh	Bandarban	Moulavibazar	All average
Illiterate	15	28	20	21
Can sign	25	32	35	30.67
Primary	30	22	18	23.33
Junior	20	10	14	14.67
SSC	6	6	10	7.33
HSC	3	2	3	2.68
Bachelor and above	1	-	-	1
Total	100	100	100	100

Occupational status of the sample farmers: It was found that in study areas sample farmers have both main occupation and subsidiary occupations. The farmers of the study areas involved in various occupations such as agriculture, business, service and others for their livelihood. The major occupation of the sample farmers were on farm agriculture which accounted for about 59% in all locations. In addition, 21.67% household were involved in business, followed by 1.5% household in service and 18.66% household in others occupation. It also found that 31% farmers not involved any subsidiary occupation. Among sample farmers it was found that agriculture is the subsidiary occupation 28.66% farmers, 15% has business, 2% involved in service and 24% farmers has different occupation (Table 03).

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Table 03. Occupation status (%) of the respondent farmers

Main occupation	% farmers responded			
	Panchagarh	Bandarban	Moulavibazar	All average
Agriculture	60	65	52	59
Business	18	15	32	21.67
Service	2		1	1.5
others	20	20	15	18.33
Subsidiary occupation				
No subsidiary occupation	35	24	34	31
Agriculture	30	30	26	28.66
Business	15	12	18	15
Service	3	-	1	2
others	17	34	21	24

Land ownership and utilization pattern: Land ownership plays an important role for providing food security at household level. It was estimated that the average land owned by the farmers was 2.11 ha/farm for all locations. Farmers in the study areas utilized their land on various purposes. Among land utilization pattern it was found that highest (39.81%) land allocated for crop cultivation followed by 34.12% garden, 10.90% mandarin garden, 3.31% homestead and 11.37% others (Table 04).

Table 04. Land ownership and utilization pattern (ha/farm) of the respondent farmers

Item	Land(ha/farm)			
	Panchagarh	Bandarban	Moulavibazar	All areas
Total crop land	0.61	0.92	1.02	0.85(39.81)
Total garden	0.31	1.22	0.62	0.72(34.12)
Mandarin garden	0.18	0.34	0.19	0.23(10.9)
Homestead area	0.07	0.04	0.12	0.07(3.31)
others	0.07	0.44	0.2	0.24(11.37)
Total land	1.24	2.96	2.15	2.11(100)

Figures in the parentheses indicate percentage of total

Annual income: Annual income which included on-farm, off farm and non-farm activities (Table 05). The average annual income per farm of all locations of study areas were Tk. 364294.3. Lowest (Tk. 303258) annual income was found in Bandarban district and highest (Tk. 419726) income found in panchagor district. Among different sources of income highest income was obtained from agriculture (32%), followed by service (23%), business (22%), mandarin garden (16%), day lobour (3%) and others(4%).

Table 05. Annual income (Tk.) per farm different sources in the study areas

Source	Annual income/locations			
	Panchagarh	Bandarban	Moulavibazar	All average
Agriculture	105697(25)	128000(42)	112516(30)	115404(32)
Mandarin garden	85559(20)	67240(22)	24948(7)	59249(16)
Service	116000(28)		140000(38)	85333(23)
Business	95714(23)	90000(30)	51571(14)	79095(22)
Day lobour	8526(2)	12328(4)	15236(4)	12030(3)
Others	8230(2)	5690(2)	25630(7)	13183(4)
Annual income per farm(Tk.)	419726(100)	303258(100)	369901(100)	364294.3(100)

Figures in the parentheses indicate percentage of total

Production technology of mandarin cultivation

This study was done Panchagarh, Banderban and Moulovibazar district having found Khasia and indian varieties of mandarin in farmers field. Different types of land category farmers cultivating

mandarin. The maximum garden (60%) established on high land in all areas. Considering soil type, 70% sandy loamy and 30% loamy soil considered mandarin garden. Most of the farmers purchase saplings from market and neighbor garden. The best planting time of mandarin garden was end of the rainy season whereas the farmers in the study areas planted generally during June to July. Farmers used one year aged saplings in their garden. The average plant to plant and line to line spacing were found to be 3.33 meter and 3.33 meter respectively and average deepness of pit 30cm. The average number of saplings for mandarin was found to be 760/ha. On an average 2-4 times weeding and 3 times spraying was done. Only the farmers of Panchagarh area used 2 times of irrigation during dry season. October was the first harvest and December was the last harvest in the study areas (Table 06).

Table 06. Production practices followed by farmers at different locations

Production practice	Locations			
	Panchagarh	Bandarban	Moulovibazar	All areas
1. Varity used	Khasia	Khasia Indian	Khasia	Khasia Indian
2. Types of land: (%)				
High land		100	70	60
Medium high land	20		20	13
Plain land	80		10	30
3. Types of soil: (%)				
Sandy soil				
Loamy soil	30	20	40	30
Sandy loamy soil	70	80	60	70
4. Sources of seedling: (%)				
Own garden		20	30	16
Market/neighbor	40	30	70	46
BADC/Others	60	50		38
5. Planting time	June-July	June-July	June-July	June-July
6. No. of saplings /ha	530	830	920	760
7. Age of saplings (months)	1	1	1	1
8. Plant to plant distance (meters)	4	3	3	3.33
9. Deepness of pit (cm)	30	30	30	30
10. No. of weeding (No./year)	(2-3) times	2-4	2-3	2-4
11. No. of spraying (times)	2.5	3.6	3.4	3.1
12. No. of irrigation (No./year)	2 times	-	-	-
13. Time of harvest				
Time of 1st harvest	October	October	October	October
Time of last harvest	November	December	December	December

Manures and fertilizer application: Farmers applied different types of manures and fertilizers in their mandarin garden. Farmers applied cowdung, urea, TSP, MoP and gypsum according to the year. For first year they used 5 kg cowdung, 300 gm urea, 150 gm TSP, 100 gm MoP and 120 gm gypsum per plant. Similarly for different years they used different doses of manures and fertilizer per plant which is shown in Table 07. Generally farmers in the study areas applied manures and fertilizer in the month of February and October.

Table 07: Average manures and fertilizer application per plant in all areas

Plant age (year)	Cowdung (kg)	Urea(gm)	TSP (gm)	MoP(gm)	Gypsum(gm)
1	5	300	150	100	120
2-4	8	350	180	150	160
5-10	10	400	230	180	150
11-15	11	480	230	180	130
16-20	10	510	200	200	130

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Level of input use

Different types of input used for mandarin cultivation which is presented in Table 08. Human labour was required for land development, plantation of sapling, application of manures and fertilizers, spraying, weeding, irrigation and harvesting. On an average 215 man days of human labour was required for mandarin cultivation which was 60% family supplied and 40% hired labour. The number of human labour varied from one year to another year due to change in number of weeding, spraying, pesticides, irrigation and harvesting. Use of human labour was highest in 1st year garden because land development, land preparation and garden establishment required more labour. In the study areas farmer used on average 630 piece of sapling per hectare. Highest 5430 kg/ha was used cowdung in first year garden and lowest 2326 kg/ha was used in 16-20th year garden. On an average mandarin farmers applied TSP 194kg/ha, urea 191kg/ha, MoP 197kg/ha, gypsum 300kg/ha and calcium carbonate ($CaCO_3$) 630 kg/ha (Table 08).

Table 08. Per hectare input used for Mandarin cultivation in study areas

Parameters	Period of cultivation(year)					
	1	2-4	5-10	11-15	16 -20	All years
Human labour (man days)	302	186	286	278	274	215
Own	190	124	190	170	185	137
Higher	112	62	95	108	89	78
Saplings	735	-	-	-	-	630
Cow dung(kg)	5430	2563	3240	2964	2326	3336
Urea(kg)	157	141	77	85	202	191
TSP(kg)	195	93	152	136	190	194
MP(kg)	152	138	173	175	156	197
Gypsum	-	290	331	-	-	300
$CaCO_3$	-		446	350	520	630
Bamboo (no of stick)	-	180	245	230	130	152

Table 09. Per hectare cost of production for mandarin cultivation in the study areas

Parameters	Period of cultivation (year)					
	1	2-4	5-10	11-15	16-20	All years
Human labour (man days)	112302	76536	140230	155171	158693	128586
Saplings	22230	-	-	-	-	22230
Cowdung (TK.)	5630	1362	1965	1245	1964	2433
Urea	2520	2256	4500	1365	3236	2775
TSP	4698	2248	3652	3286	4580	3693
MP	2587	2361	2350	2986	2354	2528
Gypsum		2324	2650			2487
$Caco_3$	-		2519			2519
Insecticides	-	2254	8630	3598	5230	4928
Pesticides	-	1657	3652	2356	2405	2518
Irrigation			-			0
Bamboo	2260	1589	4587	1235	2365	2407
Interest on opt. capital	12180	7407	13979	13699	14466	14466
Total Variable cost	164407	99994	188714	184941	195293	191570
Rental value of land	20000	20000	20000	20000	20000	20000
Total cost(Tk.)	184407	119994	208714	204941	215293	211570

Cost of mandarin 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 mandarin cultivation. Rental value of land was treated as fixed cost and interest on operating capital was also considered for the estimation of mandarin cultivation cost. Land development and saplings costs were involved only for first year.

The highest cost was estimated Tk. 215293/ha for mandarin cultivation which was found in 16-20th year garden and lowest cost was Tk119993/ha in 2-4th year garden. Among various cost items human lobour (Tk. 128586/ha)cost was the highest cost items for mandarin cultivation. Average wage rate in the study areas were Tk. 250-350 per man-days. Total variable cost was Tk. 164407/ha which was highest (Tk.195293/ha) in 16-20th years of garden and lowest (Tk. 99994/ha) in 2-4th years of garden. On an average total cost of production of mandarin cultivation was Tk. 211570/ha which was Tk. 191570/ha was variable cost and only Tk. 20000/ha was fixed cost (Table 09).

Profitability of mandarin cultivation

The return from mandarin cultivation in different years is presented in Table 10. After four years of saplings plantation, garden start production and continue up to 16-20thyears. Price varied quality of mandarin. Average price of mandarin was Tk.40/ kgin last year. Highest yield was found 16020 kg/ha at 11-15th year garden followed by 13800 kg/ha at 16-20th year garden and lowest yield was 11100 kg/ha at 5-10th year garden. The highest net return was found Tk 435859/ha at 11-15th years garden and lowest return was Tk. 235286 in 5-10th years' gardens. Net return was negative in 1st and 2-4th year garden because production was zero.

Table 10. Profitability of Mandarin cultivation in the study areas

Item	Period of cultivation(year)				
	1	2-4	5-10	11-15	16-20
A. Total cost (a+b)	184407	119994	208714	204941	215293
a. T. Variable cost	164407	99994	188714	184941	195293
b. Fixed cost	20000	20000	20000	20000	20000
Yield (kg/ha)	0	0	11100	16020	13800
Unit price (Tk./kg)	0	0	40	40	40
Gross return (Tk./ha)	0	0	444000	640800	552000
Gross margin (Tk./ha)	-164407	-99994	255286	455859	356707
Net return (Tk./ha)	-184407	-119994	235286	435859	336707

Table 11. Summary of original BCR, NPV, IRR and sensitivity analysis for Mandarin production

Criteria	BCR at 12%	NPV at 12%	IRR at 12%
Base parameter	1.68	920401	30
Increase cost 15% but benefit constant	1.46	718352	25
Cost constant but benefit decrease 15%	1.43	580292	25
Cost increase 15% but benefit decrease 15%	1.24	378244	20
Cost decrease 15%, but benefit increase 15%	2.28	1462558	41

Returns to investment in mandarin cultivation

Discounting is a technique that converts all benefits and costs into their value in the present. The rate at which a future value is discounted is closely related to the rate at which present values are compounded, namely interest rate whenever the benefits and costs used in a benefit-cost analysis occur in the future, it is important to discount these future values to account for their present value. To calculate benefit-cost ratio (BCR), net present worth (NPV) and internal rate of return (IRR), the cost and returns was discounted at 12% rate of interest. Firstly, the cost and benefit streams are discounted in order to find their present worth. Dividing the present worth of the gross benefits by the present worth of the gross cost, we found the benefit cost ratio. In the study areas BCR was found 1.68 at 12% discount rate which is greater than unity and acceptable. The most straightforward discounted cash flow measures of the project worth are the net present worth. It is the difference between the present worth of benefits and present worth of costs. The estimated NPV of the mandarin garden was Tk. 920401 per hectare which indicates that mandarin cultivation was profitable in the study areas. The internal rate of return (IRR) for the investment is that discount rate which nullifies the present worth of cash flows and outflows. It presents the average earning power of the money used in the

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project over the project life. The IRR was found to be 30% whichis highly acceptable because it is much higher than the opportunity cost of capital.

Sensitivity analysis

To make a valid generalization it is necessary to conduct sensitivity analysis. By doing sensitivity analysis under different conditions tell us what happens profitability of mandarin. It is done in three condition: (1) if cost of mandarin cultivation in all areas increases at the rate 15% but benefit decrease at the rate 15% (2) if cost constant but benefit decrease 15%, cost increase 15% but benefit decrease 15% and (3) if cost decrease at the rate 15% but benefit increases at the rate 15%. The results of sensitivity analysis considering the above mentioned situation is presented in Table 11. BCR of mandarin cultivation was found greater than one. NPV was positive at 12% discount rate and IRR also higher than the opportunity cost of capital. This implied that under changing situation mandarin cultivation is a profitable business.

Constraints of mandarin cultivation

Although mandarin is profitable crop, farmers in the study areas encountered various constraints during production. All these constraints were ranked according to the frequencies of responses. The first and foremost constrains of mandarin production in insect/pest infestation like Gummosis, leaf minor and dieback were found different garden. On an average 56% farmers reported that scarcity of irrigation. 48% farmers reported that non availability of quality seedlings/saplings at farm level, and 46% claimed that lack of cash money as the major problem for initial establishment of lemon garden. About 45% farmers claimed that not getting proper suggestion from the researcher and extension personnel. About 27% farmers believed that low yield of different varieties was the another constraints for mandarin cultivation (Table 12).

Table 12. Constraints faced by the Mandarin growers at different locations

Constraints	% farmers responded			
	Panchagarh	Bandarban	Moulovibazar	All areas
Acute problem of insect/ pest infestation	53	64	62	60
Scarcity of irrigation	20	70	80	56
Lack of improved production technology	42	60	46	49
Poor quality and scarcity of seedlings/ saplings	45	52	48	48
Lack of capital for initial investment	40	56	42	46
Not getting proper suggestion	24	60	50	45
Low yield of different varieties	20	32	28	27

IV. Conclusion

Farmers in the study areas used one year aged saplings, planting time June and July, average plant to plant distance 3.33 meters. Farmers applied different doses of manures and fertilizers according to plant age but it is below the recommendation doses in all study areas. Main cost items was found human lobour cost but maximum labour supplied from own family. The benefit cost ratio, net present value and internal rate of return indicate that farmers were benefited for cultivation of mandarin in both hill regions and plain land. By doing sensitivity analysis it is clear that mandarin growers can make profit under changing situations. The saplings of mandarin should be made locally available to the farmers. So, Government should encourage BADC and nursery owners to produce mandarin sapling locally and supply to the farmers at reasonable price. BARI should develop improved location specific varieties and advance production technology of mandarin so that government should take initiatives to disseminate it to the farmers. Insect/pest infestation should be controlled through proper management. Government should ensure credit facilities through both institutional and non-institutional sources for mandarin cultivation. Regular training should be arranged to the farmers for the development of their knowledge about improved cultivation practices and adopted new technology.

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HOW TO CITE THIS ARTICLE?

Crossref: https://doi.org/10.18801/jbar.140117.144

APA (American Psychological Association)

Kaysar, M. I. , khandoker, S., Islam, M. S., Mia, M. S. and Kausar, A. K. M. G. (2017). Productivity and profitability of mandarin cultivation in selected areas of Bangladesh. Journal of Bioscience and Agriculture Research, 14(01), 1174-1182.

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