ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 42(1): 137-158, March 2017

COMPARATIVE PROFITABILITY ANALYSIS OF SHIFTING LAND FROM FIELD CROPS TO MANGO CULTIVATION IN SELECTED AREAS OF BANGLADESH

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Abstract

Mango has emerged as an important area for diversification and as an alternative cropping pattern due to higher returns and productivity. The study was conducted in three mango growing districts, namely Chapai Nawabganj, Natore, and Rajshahi during 2014-2015 to estimate the financial benefit of shifting cereal lands to mango production, factors influencing shifting decision, and explore related problems of mango cultivation in the study areas. A total of 180 farmers taking 60 farmers from each district were selected through using multistage stratified random sampling for the study. About 49% lands were shifted to mango cultivation from cereal crops which was higher in Chapai Nawabganj (55%) followed by Natore (48%) district. The main reason of this shifting was reported to be higher profit compared to other crops. The average total cost of mango cultivation was Tk. 1, 33,889 per hectare. Higher cost was observed in the 16th-20th year of garden (Tk. 1, 52,010) followed by 11th -15th year (Tk. 1, 48,952). The average yield of mango was found to be the highest in 16th – 20th year (26.48 ton/ha) followed by 11-16th year (19.38 ton/ha). Per hectare net return from mango cultivation was Tk. 1, 75,244. Total cost of mango cultivation was 10% higher than Boro-Fallow-T.Aman cultivation. On the other hand, total cost was about 40% lower than Wheat- Jute- T.Aman, Wheat-Aus-T.Aman and Potato-Fallow-T.Aman. The net return from mango cultivation was 75% higher than other cropping patterns. The shifting of cereal lands to mango cultivation was found to be a profitable since the BCR (2.89), net present value (Tk. 33, 71,166) and internal rate of return (39%) were very high. Relative income, farm size and education turned out to be positively significant, whereas age was negatively significant for shifting decision from cereal crops to mango cultivation. Therefore, Farmers should be motivated to cultivate mango in the fallow lands or areas where other crops are not grown well.

Keywords: Financial impact, mango, cereal crops, relative profitability and factors responsible.

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1. Introduction

Farmers' crop diversification decision is considered as one of the important economic decisions which have strong influence on their welfare in terms of income level and returns. While taking decisions farmers make choices in the context of their production possibility frontier, their expectations of relative prices and their sense of risk from both an agronomic and market perspective for various alternatives. The first decision is about the choice of number of crops. While taking decision on number of crops and level of spread in the cropping pattern, farmers also take another critical decision as to which crops to produce and how much land to be allocated to that crop. Hence, the area substitution for crop decision comes from this concept.

The sustained economic growth, rising per capita income and growing urbanization have caused a shift in the consumption patterns in favour of high value crops like fruits and vegetables from staple food crops such as rice and wheat (Joshi, 2005). In recent years, demand for fruits has grown much faster than that of food grains. Fruits play a significant role in nutritional improvement, employment generation, food and financial security of the people of Bangladesh. The consumption pattern of people in Bangladesh shows that there has been a constant increase in demand for fruits as compared to other crops. In 2009-2010, the national production and area of fruits were 1.09 million MT and 2.42 lakh hectares respectively (BBS, 2010). Among the various fruits mango is one of the most important fruit crops in Bangladesh. Mango grows widely throughout the country and is raised mostly as homestead plantations. The soil and climatic conditions of Bangladesh especially northern regions are suitable for mango cultivation. Therefore, a large number of farmers in northern region namely Pabna, Natore, Rajshahi, Chapai Nawabganj, Naogaon and Dinajpur are preferred to cultivate mango in their field. Moreover, a huge portion of lands are now substituting to mango cultivation. In 2013-2014, the area under mango cultivation was about 34632 hectares with a total production of about 992296 metric tons (BBS, 2014). The area and production of mango is increasing day by day owing to its higher returns. The growth rates of area, production and yield of mango are 2.41%, 4.74% and 2.33%, respectively (Table 1). Due to higher returns and productivity, mango has emerged as an important area for diversification and as an alternative cropping pattern. With this backdrop, area shift in favour of fruits has been suggested as a viable option to stabilize and raise farm income, enhance agricultural growth and increase employment opportunities.

The shifting of land allocation decisions are generally analyzed at the macro level on the basis of distributive lag model that capture the role of several economic and non-economic factors in decision making. Nerlove (1958) was the first to initiate a study on this aspect where he endeavored to find the role of farmers'

expectation of future prices in shaping their decisions on the extent of land allocation of these crops. He devised a model relating the expected normal price to "past-observed" prices. Later on, many studies used the Nerlovian model, with some modifications also, to investigate the importance of price of crop in shaping farmer's supply response behaviour (Krishna, 1963; Behrman, 1968; Askari and Cummings, 1976; De, 2005; Mythili, 2006). Deshpande and Chandrashekar (1982) made an attempt to study the role of income in the farmers' decisions at the district level, but heterogeneity in the cost across farms made it more robust to study such decisions at the micro level, viz. farmers. However, studies relating to micro-level decision for area shifting in favour of high value crops such as fruits are very scanty. Therefore, an attempt was made to focus the profitability, factors responsible and the problem of shifting of lands from cereal crops to mango cultivation in Bangladesh.

Table 1. Area, production and yield of mango in Bangladesh

Year	Area (ha)	Production (M.tons)	Yield (M.tons/ha)
2004-2005	25055	662100	10.70
2005-2006	25972	639820	9.97
2006-2007	29109	766930	10.67
2007-2008	31658	802750	10.27
2008-2009	31059	828161	10.80
2009-2010	32011	842312	10.65
2010-2011	27466	889176	13.11
2011-2012	30680	945059	12.47
2012-2013	30804	956867	12.58
2013-2014	34632	992296	11.60
Growth rate	2.41	4.74	2.33

Source: BBS, 2011and 2014

1.1 Objectives

i. To estimate and compare relative profitability of mango production with its competitive cereal crops;

ii. To estimate the financial profitability of mango production through using investment analysis; and

iii. To identify the factors influencing the shift of land from cereal crops to mango cultivation; and

iv. To derive policy implications from the above.

2. Methodology

2.1 Area Selection

The study was conducted in three major mango growing areas, namely Chapai Nawabganj, Natore and Rajshahi. Nachol upazila from Chapai Nawabganj district, Lalpur upazila from Natore district and Poba upazila from Rajshahi district were selected for administering questionnaire survey.

2.2 Sampling Technique and Sample Size

A multistage stratified random sampling design was followed to collect sample farmers for this study. At first stage, three districts were selected according to the highest concentration of mango production. In the second stage, one upazila from each three districts and two blocks from each upazila were selected according to the above mentioned criteria. Finally, a total of 180 farmers taking 60 farmers from each district were randomly selected for interview. Because of common heterogeneity among agricultural household populations, it is necessary to undertake population stratification (Nyariki, 2009). Data were categorized according to year of mango cultivation. The ages of mango trees were classified as 1st year, 2nd year, 3rd year, 4th year, 5th year, 6-10th year, 11-15th year, 16-20th year and 20-25th year.

2.3 Method of Data Collection and Period of Study

The study was mainly based on primary data collected during the month of January to April 2015. Field investigators under the direct supervision of the researcher collected field level cross-sectional data using pre-tested interview schedule. Necessary information regarding this study was collected based on input costs, price, yields etc.

2.3 Analytical Techniques

a) Tabular Technique

Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. Descriptive statistics using different statistical tools like averages, percentages and ratios were used in presenting the results of the study. The profitability of mango production was examined on the basis of gross return, gross margin and benefit cost ratio analysis. Besides, the opportunity cost of family supplied labour was taken into consideration in estimating total cost. Land use cost was calculated on the basis of per year lease value of land. Project analysis and sensitivity analysis were done. Benefit Cost Ratio, Net Present Value and Internal Rate of Return were calculated (at 6.5% discount rate) with the following formulas:

Net Present Value (NPV): The NPV of an investment is the discounted value of all cash inflows and cash outflows of the project during its lifetime. It can be computed as

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

Benefit Cost Ratio (BCR): The BCR of an investment is the ratio of the discounted value of all cash inflows to the discounted value of all cash outflows during the life of the project. It can be estimated as follow:

$$BCR = \sum_{t=1}^{n} \frac{\frac{B_t}{(1+r)^t}}{\frac{C_t}{(1+r)^t}}$$

Internal Rate of Return (IRR): IRR is that rate of return at which the NPV is equal to zero. The IRR is computed as:

$$r = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t} = 0$$

Where,

B_t = Total benefit (Tk/ha) in time t

C_t = Total cost (Tk/ha) in time t

r = Rate of interest (discount rate)

t = Number of years (t = 1, 2, 3 …25)

Profitability analysis

Profitability of mango and crops was analyzed to compare the return received by the farmers.

Measurement of cost and return from crop cultivation

Equations for cost analysis are as follows

Variable Cost = $VC_{ij} = \sum_{l=1}^{n} (X_{ij} P_{ij})$

$TVC_{ij} = VC_{ij} + 10C_{ij}$

$TC_{ij} = TVC_{ij} + TFC_{ij}$

Where, TC_{ij} = Total cost (Tk/ha)

TVC_{ij} = Total variable cost (Tk/ha)

TFC_{ij} = Total fixed cost (Tk/ha)

VC_{ij} = Variable cost (Tk/ha)

IOC_{ij} = Interest of operating capital (Tk/ha)

X_{ij} = Quantity of inputs (kg)

P_{ij} = Price of inputs (Tk/kg)

j = Number of crops

i = Number of farmers (1.2.3……..n)

Equations for profitability analysis

Gross return + $GR_{ij} = Y_{ij}P_{ij}$

Net return = $GR_{ij} - TC_{ij}$

Gross margin = $GR_{ij} - VC_{ij}$

Where,

GR_{ij} = Gross return (Tk/ha)

P_{ij} = Price (Tk/ha) of *j* the crops received by *i*th farmer

Y_{ij} = Quantity (kg/ha) produced

b) Statistical Technique

Multiple Regression Model

The regression model was used to assess the factors affecting the extent of substitution by the farmers, while considering both the economic and non-economic factors as explanatory factors. The relative price and relative income were used as explanatory variables to test whether farmers cared for only price or also the income (included price and yield) in their crop substitution decisions. The following empirical multiple linear regression function was fitted in the study.

$$Y= a + b_1x_1+b_2x_2+b_3x_3 +b_4x_4 +b_5x_5 +b_6x_6+ b_7x_7+ b_8x_{8+}e$$

Where,

Y= Shift of area from cereal crops to mango cultivation (ha)

x_1= Relative price of the product (Tk/kg)

x_2= Relative income (Tk/year)

x_3= Yield (kg/ha)

x_4= Education level of the farmers (years of schooling)

x_5= Farm size (ha)

x_6= Age of the farmers (years)

x_7= Annual non-farm income (Tk)

x_8= Food crop (wheat/rice) requirements at home (Tk)

a= Intercept

b_1, b_2, b_3----------b_8= Coefficients of the respective variables to be estimated

e = Random error

3. Results and Discussion

This chapter captures amount of land shifted to mango cultivation, cost and return of mango, relative profitability of mango and cereal crops cultivation, factors affecting changing cropping pattern.

3.1 Area Substitute to Mango Cultivation

3.1.1 Area shifted for mango cultivation: Responded farmers were asked how much land they shifted for mango cultivation from cereal crops. About 48% of their net cultivated land were shifted to mango cultivation which was higher in ChapaiNawabganj district (53%) followed by Natore district (48%) (Table 2). The farmers shifted 34% land of their farm size to mango cultivation. More than 50% of own cultivable land was shifted to mango cultivation. On an average, 49% lands were shifted for mango cultivation in the study areas which was the highest in Chapai Nawabganj district (55%) and the lowest in Rajshahi district (45%).

Table 2. Area shifted for cultivating mango

Particulars	Chapai Nawabganj	Natore	Rajshahi	All areas
Area shifted for mango (ha)	0.52	0.45	0.36	0.43
% of farm size	35	33	32	34
% of own cultivable land	68	49	54	57
% of net cultivated land	53	48	42	48
Average land shift (%)	55	48	45	49

3.1.2 Reasons for shifting land to mango cultivation: Farmers in the study areas were asked to mention the reasons behind mango cultivation in the crops land. Respondent farmers mentioned that higher profit compared to other crops

(73%) was the main reason for cultivating mango (Table 3). About 61% farmers mentioned the lower price of other crops as an important factor of shifting. Easy cultivation process (47%) was opined to be the third reasons. These responses were more or less similar in three districts. As Rajshahi and ChapaiNawabganj were in Barind region, farmers of these two districts reported that lack of irrigation facility for rice was the main reason. Some farmers (17%) preferred mango because they could cultivate more than one crop in mango field (intercropping) which also influenced them to cultivate mango. Suitability of land for mango rather than other crops (35%), not requiring extra care (22%), and the lower yield of other crops (25%) were mentioned as the reasons for cultivating mango.

Table 3. Reasons for shifting to mango cultivation

Reasons	% farmers responded			
	Chapai Nawabganj	Natore	Rajshahi	All areas
Higher profit	69	77	74	73
Lower price of other crops	63	59	61	61
Easy cultivation process	43	51	47	47
Lack of irrigation facility for rice	57	19	51	42
Non-suitable land for other crops	39	33	32	35
Lower yield of other crops	21	12	23	25
Not required extra care	23	14	28	22
Can cultivate two crops at a time (Intercropping)	14	21	16	17

3. 2 Source of Inspiration and Influence to Start Mango Cultivation for the First Time

The sample farmers mentioned various sources that influenced or inspired them to switch over from field crops to mango cultivation for the first time. The highly reported source was neighbouring farmers (37%) (Table 4). About 24% farmers opined that they were influenced by their relatives to cultivate mango. In contrast, some farmers (17%) reported that they were not influenced by anyone. They cultivated by their own experience and interest. Again, 14% farmers were inspired by the businessmen and 8% influenced by extension worker.

Table 4. Source of inspiration and influence to start mango cultivation for the first time

Items	% farmers responded			
	Chapai Nawabganj	Natore	Rajshahi	All areas
Neighbouring farmers	41	33	36	37
Relatives	23	29	21	24
Own experience	18	15	19	17
Businessman	11	14	16	14
Extension worker	7	9	8	8
Total	100	100	100	100

3.3 Farmers' Perception about Cost and Return of Mango Cultivation

The study found out farmers perception about cost of mango cultivation which is presented in Table 5. The highest percentage of farmers (56%) mentioned that cost of mango cultivation was almost similar than competitive crops. On the other hand, 30% farmers expressed their opinion that cost of mango cultivation was lower than other crops. Only 14% farmers said that cost of mango cultivation was higher than other crops. Farmers who said that mango cultivation required higher cost also mentioned that higher profit was the main reason for cultivating mango.

Table 5. Farmers' perception on cost of mango cultivation compare to other crops

Items	% farmers responded			
	Chapai Nawabganj	Natore	Rajshahi	All areas
Almost equal	56	59	53	56
Lower	33	28	30	30
Slightly higher	11	13	17	14
Total	100	100	100	100

As farmers in the study areas were much interested in mango cultivation, it is common perception that it is highly profitable crop. Although profitability of mango cultivation was measured in this study, farmers' perception about comparative profitability was also revealed in Table 6. A large portion of the respondent farmers (49%) told that mango was highly profitable crop compared to other crops. Besides, 41% farmers mentioned that profitability of mango cultivation was slightly higher than other crops. Very small percentage of farmers (10%) pointed out that profitability of mango cultivation was almost equal to other crops.

Table 6. Farmers' perception on profitability of mango cultivation compare to other crops

Items	% farmers responded			
	Chapai Nawabganj	Natore	Rajshahi	All areas
Much higher	46	49	51	49
Slightly higher	44	43	38	41
Almost equal	10	8	11	10
Total	100	100	100	100

3.4 Cost and Return of Mango Cultivation

3. 4. 1 Intercropping with mango

Most farmers (84%) in the study areas practiced intercropping with mango (Table 7). In Natore district more farmers cultivated intercrop than other districts. It was found that a large number of crops were grown as intercrops in the mango field. Among the intercrops, majority of the farmers (21%) preferred intercropping with sweet gourd followed by lentil (19%) in all areas (Table 8). Farmers in the Chapai Nawabganj district also cultivated guava (27%) with mango which was not found in other districts, whereas farmers in Rajshahi cultivated papaya (5%) as intercrop. The study revealed that 16% farmers did not adopt intercrop. The main reasons for not intercropping were the reduction of mango yield and poor yields of intercrops.

Table 7. Percentage of farmers practiced intercropping in the mango field

Items	% farmers responded			
	Chapai Nawabganj	Natore	Rajshahi	All areas
Intercropping with mango	83	88	82	84
Not intercropping	17	12	18	16
Total	100	100	100	100

Table 8. Types of crop cultivated as intercrop

Types of crop	% farmers responded			
	Chapai Nawabganj	Natore	Rajshahi	All areas
Sweet gourd	36	6	24	21
Lentil	11	35	10	19
Turmeric	7	19	16	14
Black gram	13	13	16	14
Brinjal	-	21	10	11
Bitter gourd	7	6	12	8
Guava	27	-	-	8
Papaya	-	-	14	5
Total	100	100	100	100

3.4.2 Cost of mango cultivation (including intercrops)

The cost of production included different variable cost items like land preparation, human labour, sapling, manures, fertilizer, insecticides etc. Both cash expenditure and imputed value of family supplied inputs were included in the analysis. Besides, interest on operating capital was also considered for the estimation of cost of mango cultivation. Table 9 represents the cost of mango cultivation in different years in the study areas. The average total cost of mango cultivation in all years was found Tk. 1,33,889 per hectare of which 57% were variable cost and the rest 43% were fixed cost. Higher cost was observed in the 16th -20th year of garden (Tk. 1, 52,010) followed by 11th -15th year (Tk. 1, 48,952). It might be due to the cost of human labour, cost of intercrop and higher use of insecticides. The land preparation cost and saplings costs were 0.4% and 2% of the total cost. But this two cost items were incurred only in the 1st year. Land use cost occupied the largest share (32%) of the total cost. On an average, labour involvement incurred 31% of the total cost. Fertilizers cost shared only 4% of the total cost and 7% of the total variable cost. On the other hand, the cost of insecticides and irrigation occupied 10% and 6% of the total cost, respectively. Farmers in the study areas spent on an average Tk. 2,599 per hectare for manures. The cost of intercrop occupied 12% of the total cost in the study areas. On an average, farmers spent Tk. 15,840 per hectare for cultivating intercrop. In the first year, responded farmers did not cultivate other crops in the mango field. That's why the cost of intercrop was considered zero in the first year. The cost of supporting stick was Tk. 8,245 per hectare in mango cultivation.

3.4.3 Profitability of mango cultivation

The return from mango cultivation in different years is presented in Table 10. Farmers in the study areas obtained, on an average, 12.07 ton/ha yield. In the 1st year and 2nd year farmers did not find any yield. Farmers started getting yield from 3rd year garden. In the third year, they obtained 0.38 ton/ha yield. The yield had increasing trend from 4th year garden. The highest amount of yield was found in 16th – 20th year (26.48 ton/ha) old mango garden followed by 11-16th year (19.38 ton/ha). After 20 years, yield followed decreasing trend. The farmers in the study areas found on an average 16 ton/ha yield in 21-25th year. Likewise, the highest gross return of mango was found 16th-20th year (Tk. 7, 94,490/ha) and the lowest was found in 3rd year (Tk. 11,430/ha). They received on an average Tk. 3, 09,133 as gross return from mango per hectare. In the second year, the gross return of intercrop was Tk. 31,546 per hectare. Highest gross return from intercrop was found in 3rd year (Tk. 35,980/ha). The average gross return from intercrop was found Tk. 29,267 per hectare. Farmers received the highest amount of gross margin in the 16th-20th year (Tk. 7, 37,852/ha) followed by 11-15th year (Tk. 5, 24,325/ha). Similarly, the higher amount of net return was found in the 16th-20th year (Tk. 6, 75,465/ha) followed by 11th-16th year (4, 63,806/ha). Farmers gained negative gross margin and net return in the 1st, 2nd and 3rd year of mango field. They received on an average Tk. 1, 75,244 per hectare as net return and Tk. 2, 33,039 as gross margin from mango cultivation. Farmers in the study areas spent on an average Tk. 14 for producing 1 kg mango.

Table 9. Cost of mango cultivation with intercrops in the study areas (in Tk. /ha)

Items	1st year	2nd year	3rd year	4th year	5thyear	6th-10th year	11th-15th year	16th-20th year	21th-25th year	All years
Observations	n=15	n=15	n=15	n=15	n=15	n=30	n=30	n=30	n=15	n=180
A. Variable Cost	88681	47255	57807	65323	81897	86506	88433	89623	79319	76095 (57)
Hired labour	13916	9876	13452	17678	31456	33678	34187	39054	31345	24960 (19)
Land preparation	4901	0	0	0	0	0	0	0	0	545 (0.41)
Saplings	20081	0	0	0	0	0	0	0	0	2231 (2)
Manures	9691	0	4689	4325	0	2345	2341	0	0	2599 (2)
Fertilizers										
Urea	1831	1649	1275	1326	1513	1292	1003	1139	1224	1361 (1)
TSP	4145	4080	3146	2834	2262	2028	2470	1768	1976	2745 (2)
MoP	1544	1072	1216	944	1152	992	1392	1216	864	1155 (1)
Gypsum	197	150	0	165	115	160	0	110	185	120 (0.09)
Insecticides	13998	6750	7546	8787	17769	14414	19453	14861	15908	13276 (10)
Irrigation	7103	6541	5632	8425	9876	7675	9345	10453	9214	8252 (6)
Stick	8245	0	0	0	0	0	0	0	0	916 (1)
Intercrop	0	15586	19258	18936	15326	21569	16136	18964	16782	15840 (12)
Interest on operating capital	3029	1551	1593	1903	2428	2353	2106	2058	18215	2094 (1)
B. Fixed cost	54282	50514	55641	56079	61630	59110	60519	62387	59994	57795 (43)
Family labour	11628	7860	12987	13425	18976	16456	17865	19733	17340	15141 (11)
Land use cost	42654	42654	42654	42654	42654	42654	42654	42654	42654	42654 (32)
C. Total Cost (A+B)	142963	97769	113448	121402	143527	145616	148952	152010	139313	133889 (100)

Note: Figures in the parentheses indicate percentage of total cost.

Table 10. Profitability of mango cultivation with intercrops in the study areas

Items	1st year	2nd year	3rd year	4th year	5thyear	6th-10th year	11th-15th year	16th-20th year	21th-25th year	All years
Sample	n=15	n=15	n=15	n=15	n=15	n=30	n=30	n=30	n=15	n=180
A. Total cost (Tk/ha)	142963	97769	113448	121402	143527	145616	148952	152010	139313	133889
Variable cost	88681	47255	57807	65323	81897	86506	88433	89623	79319	76094
Fixed cost	54282	50514	55641	56079	61630	59110	60519	62387	59994	57795
Cost of intercrops	0	15586	19258	18936	15326	21569	16136	18964	16782	15840 (12)
B. Yield of mango (kg/ha)	0	0	381	1271	6848	13629	19382	26483	15966	9329
C. Price (Tk/kg)	30	30	30	30	30	30	30	30	30	30
D. Gross return of mango (Tk/ha)	0	0	11430	38130	205440	408870	581460	794490	478980	279867
E. Gross return of intercrop (Tk/ha)	0	31546	35980	31546	35674	28970	31298	32985	35400	29267
F. Total gross return (Tk/ha)	0	31546	47410	69676	241114	437840	612758	827475	514380	309133
G. Gross margin (Tk/ha)	-88681	-15709	-10397	4353	159217	351334	524325	737852	435061	233039
H. Net return (Tk/ha)	-142963	-66223	-66038	-51726	97587	292224	463806	675465	375067	175244
I. Benefit Ratio (Undiscounted)	0.00	0.32	0.42	0.57	1.68	3.01	4.11	5.44	3.69	2.31
J. Per unit production cost (Tk/kg)	-	-	298	96	21	11	8	6	9	14

3.4.4 Returns to investment in mango cultivation

The results of project analysis are shown in Table 11 and 12. Normally the best discount rate to use is the "opportunity cost of capital"- i.e., the profitability of the last possible investment in an economy given the total available capital (Islam etl, 2014). To calculate benefit-cost ratio (BCR) and net present worth (NPV) the cost and returns were discounted at 6.5% rate of interest.

Table 11. Financial analysis of mango cultivation

Year	Gross cost (Tk)	Gross benefit (Tk)	Discount factor at 6.5%	PW of cost at 6.5%	PW of benefit at 6.5%
1	142963	0	0.943396226	134870.7547	0
2	97769	31546	0.88999644	87014.06194	28075.8277
3	113448	47410	0.839619283	95253.12842	39806.35021
4	121402	69676	0.792093663	96161.7549	55189.91808
5	143527	241114	0.747258173	107251.7238	180174.4071
6	145616	437830	0.70496054	102653.5341	308652.8734
7	145616	437830	0.665057114	96842.95666	291181.9561
8	145616	437830	0.627412371	91361.27987	274699.9585
9	145616	437830	0.591898464	86189.88667	259150.9043
10	145616	437830	0.558394777	81311.21384	244481.9852
11	148952	612768	0.526787525	78466.05548	270968.9673
12	148952	612768	0.496969364	74024.58064	255631.1012
13	148952	612768	0.468839022	69834.51004	241161.4163
14	148952	612768	0.442300964	65881.61325	227510.7701
15	148952	612768	0.417265061	62152.46533	214632.8019
16	152010	827485	0.393646284	59838.17159	325736.3951
17	152010	827485	0.371364419	56451.10527	307298.4859
18	152010	827485	0.350343791	53255.75969	289904.232
19	152010	827485	0.33051301	50241.28273	273494.5585
20	152010	827485	0.311804727	47397.43653	258013.7344
21	139313	514380	0.294155403	40979.67162	180249.0178
22	139313	514380	0.277505097	38660.06757	170046.2432
23	139313	514380	0.261797261	36471.76185	160420.9842
24	139313	514380	0.246978548	34407.3225	151340.5511
25	139313	514380	0.232998631	32459.73821	142774.1048
Total	3548564	9780161	11.46992122	1779431.837	5150597.544

Firstly, the cost and benefit streams of mango garden were discounted to find out their present worth. Dividing the present worth of the gross benefits by the present worth of the gross cost, the benefit cost ratio was found. In the study areas BCR was found 2.89 at 6.5% 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 project was Tk. 33, 71,166 per hectare which indicates that mango 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 represents the average earning power of the money used in the project over the project life. The IRR was found to be 39%. It is highly acceptable because it is much higher than the opportunity cost of capital.

Table 12. Financial analysis of mango cultivation

Year	Incremental benefit	Discount factor at 35%	PW of benefit at 35%	Discount factor at 40%	PW of benefit at 40%
1	-142963	0.714286	-102116	0.689655	-98595.2
2	-66223	0.548697	-36336.4	0.510204	-33787.2
3	-66038	0.406442	-26840.6	0.364431	-24066.3
4	-51726	0.301068	-15573.1	0.260308	-13464.7
5	97587	0.223014	21763.22	0.185934	18144.78
6	292214	0.165195	48272.35	0.13281	38809.03
7	292214	0.122367	35757.29	0.094865	27720.74
8	292214	0.090642	26486.88	0.06776	19800.53
9	292214	0.067142	19619.91	0.0484	14143.23
10	292214	0.049735	14533.27	0.034572	10102.31
11	365428	0.036841	13462.64	0.024694	9023.882
12	365428	0.027289	9972.329	0.017639	6445.63
13	365428	0.020214	7386.91	0.012599	4604.022
14	365428	0.014974	5471.785	0.008999	3288.587
15	365428	0.011092	4053.174	0.006428	2348.991
16	675475	0.008216	5549.693	0.004591	3101.421
17	675475	0.006086	4110.884	0.00328	2215.301
18	675475	0.004508	3045.099	0.002343	1582.358
19	675475	0.003339	2255.629	0.001673	1130.255
20	675475	0.002474	1670.836	0.001195	807.3253
21	473455	0.001832	867.5002	0.000854	404.1941
22	473455	0.001357	642.5927	0.00061	288.7101
23	473455	0.001005	475.9946	0.000436	206.2215
24	473455	0.000745	352.5886	0.000311	147.3011
25	473455	0.000552	261.1767	0.000222	105.215
Total			45145.31	2.474814	-5493.41

3.4.5 Sensitivity analysis

Sensitivity analysis is a technique to assess the effects of adverse changes in the project. For making a valid generalization about mango cultivation sensitivity analysis was necessary. For doing this, all cost of mango cultivation were considered constant while benefit decreases at the rate of 10% or if benefit of mango remains the same but all cost increase at the rate of 10% and if benefit decrease and cost increase at the rate of 10%. The results of sensitivity analysis considering the above mentioned situation is presented in Table 13. BCR of mango cultivation was found greater than one. NPV was positive at 6.5% discount rate and IRR was also higher than the opportunity cost of capital. This indicates that if the returns decrease at 10% while the cost of mango remains unchanged investment in mango is profitable from the point of view of the owner. On the other hand, if gross cost increase at 10% and returns decrease at 10%, BCR>1, NPV was positive and IRR was higher than the opportunity cost of capital which implies that mango cultivation is profitable.

Table 13. Result of sensitivity analysis of mango cultivation in the study areas

Situation	BCR at 6.5%	NPW at 6.5% (Tk.)	IRR (%)
Current situation	2.89	3371166	39
Increase cost 10% but return constant	2.68	3295411	36
Decrease return 10% but cost constant	2.54	2493533	36
Increase cost and decrease return 10%	2.31	2331941	35

3.5 Profitability of Cereal Crops Cultivation

3.5.1 Cropping pattern before shifting land to mango cultivation

Respondent farmers in the study areas mostly cultivated two crops in a year. Some farmers cultivated three crops per year. Before shifting land to mango cultivation, they cultivated Boro, wheat, T. Aman, jute, sesame, aus, lentil, potato and some short duration vegetables. Variations found among the farmers in case of cropping pattern. A total of 19 types of cropping patterns were found in the study areas which were shifted by the 180 farmers. Major 11 cropping patterns are presented in Table 14.The highest percentage (25%) of farmers mentioned that they followed Wheat- Jute-T.Aman cropping pattern before shifting land. The second highest percentage (18%) of farmers followed Boro-Aus-Fallow cropping pattern which was high in Rajshahi district and low in Natore district. About 14% farmers cultivated Boro-Fallow-T.Aman before cultivation of mango. Farmers in the Natore district mentioned that they cultivated sesame and lentil before cultivating mango which was not found in other districts. A good number of farmers in Rajshahi district cultivated potato and some short duration

vegetables. In all areas, 13% farmers cultivated Boro-Jute-Fallow and 12% farmers cultivated Wheat-Aus-T.Aman in their field before cultivating mango.

Table 14. Types of cropping pattern followed by the farmers before cultivating mango

Types of Cropping pattern	% farmers responded			
	Chapai Nawabganj	Natore	Rajshahi	All areas
Wheat-Jute –T.Aman	11	28	31	25
Boro-Aus-Fallow	22	9	23	18
Boro-Fallow-T.Aman	30	9	8	14
Boro-Jute –Fallow	19	9	11	13
Wheat-Aus-T.Aman	14	17	7	12
Wheat-Fallow-T.Aman	5	2	8	5
Boro-Sesame-T.Aman	-	11	0	4
Wheat-Jute-vegetables	-	-	8	3
Lentil-Jute-T.Aman	-	9	-	3
Wheat-Sesame-T.Aman	-	34	-	1
Potato-Fallow-T.Aman	-	-	3	1
Total	100	100	100	100

3.5. 2 Profitability of cereal crops cultivation

Data in Table 15 shows the profitability of cereal crops. Total cost for Wheat-Fallow-T.Aman cultivation was Tk. 1, 19,155 and net return was Tk. 24,983 per hectare. Per hectare total cost for Wheat-Jute-T.Aman cultivation was Tk. 1, 81,007 whereas it was Tk. 1, 64,335 for Wheat-Sesame-T.Aman cultivation. Among the cropping patterns, total cost and total variable cost for Potato-Fallow-T.Aman was higher than other cropping patterns which was Tk. 1, 82,735 and Tk. 1, 34,130 per hectare, respectively. Total cost and total variable cost of Wheat-Aus-T.Aman was higher than Lentil-Jute-T.Aman and Wheat-Jute-Vegetables. Boro- Fallow-T.Aman cultivation required Tk. 1, 13,336 as total cost which was lower than Boro-Aus-Fallow (Tk. 1, 15,593) per hectare. Highest gross return and net return was found for the cropping pattern Potato-Fallow-T.Aman cultivation which were Tk. 2,45,407 and Tk. 62,672 per hectare respectively. In contrast, lowest gross return and net return was found in the cropping pattern Boro-Fallow-T. Aman. On an average net return of different cropping pattern varies from Tk. 13,668 (Boro-Fallow-T.Aman) to Tk. 62,672 (Potato-Fallow-T.Aman). Highest gross margin was found for Potato-Fallow-T.Aman cultivation (Tk. 1, 11,277) followed by Wheat-Sesame-T.Aman (Tk. 93,976) and Wheat-Jute-T.Aman (Tk. 83,245). Return per taka invested on total

cost and on variable cost was estimated higher in the case of Potato-Fallow-T.Aman which was 1.34 and 1.83, respectively. BCR on total cost for different cropping pattern varies from 1.12 to 1.34, whereas it was 1.36 to 1.83 on variable cost.

Table 15. Profitability of cereal crops cultivation

Items	Total Cost (Tk/ha)	Total variable Cost (Tk/ha)	Gross Return (Tk/ha)	Net Return (Tk/ha)	Gross Margin (Tk/ha)	Return per Tk. invested as TC	Return per Tk. invested as TVC
Potato-Fallow-T.Aman	182735	134130	245407	62672	111277	1.34	1.83
Wheat-Sesame-T.Aman	164335	115621	209597	45262	93976	1.27	1.81
Wheat-Jute-vegetables	143257	102978	178867	35610	75889	1.24	1.73
Boro-Sesame-T.Aman	158516	117801	192463	33947	74662	1.21	1.63
Wheat-Fallow-T.Aman	119155	86163	144138	24983	57975	1.20	1.67
Wheat-Jute - T.Aman	181007	133453	216698	35691	83245	1.19	1.62
Wheat-Aus-T.Aman	179058	135115	211901	32843	76786	1.18	1.56
Lentil-Jute-T.Aman	176188	128535	202099	25911	73564	1.14	1.57
Boro-Jute -Fallow	117542	93688	134657	17115	40969	1.14	1.43
Boro-Fallow-T.Aman	113336	88343	127004	13668	38661	1.12	1.43
Boro-Aus-Fallow	115593	95350	129860	14267	34510	1.12	1.36

3.6 Relative Profitability of Mango Cultivation

Table 16 and 17 depicted the relative profitability of mango cultivation. Total cost (TC) and total variable cost (TVC) of mango were higher than Wheat-Fallow-T.Aman, Boro-Jute-Fallow, Boro-Fallow-T.Aman and Boro-Aus-Fallow whereas TC and TVC of mango were lower than cost incurred for other seven cropping patterns. Total cost of mango cultivation was 10% higher than Boro-Fallow-T.Aman cultivation whereas it was on an average 40% lower than Potato-Fallow-T.Aman and Wheat-Jute-T.Aman cultivation. Moreover, mango cultivation required Tk. 13,915 more as total cost instead of cultivating Boro-Fallow-T.Aman (Table 26 and Table 27). For maintaining cropping pattern Wheat-Jute-T.Aman farmers required Tk. 63,997 more than mango cultivation per hectares as total variable cost. Total variable cost of mango cultivation was 34% and 32% higher than the cost incurred for Boro-Aus-Fallow and Boro-

Jute-Fallow cropping pattern cultivation whereas it was 84% lower than Wheat-Jute-T.Aman and Potato-Fallow-T.Aman cultivation. The gross return, gross margin and net return from mango cultivation were also higher than any of the eleven cropping patterns. Mango farmers got 59% higher gross return compared to Boro-Fallow-T.Aman cultivation. The gross margin of mango was 85% higher than Boro-Aus-Fallow which amounted Tk. 1, 98,529 per hectare. The average net return was on an average more than 75% higher than the eleven cropping pattern. The net return of mango was 85% higher than Lentil-Jute-T.Aman whereas it was 64% higher than Potato-Fallow-T.Aman. Likewise, the gross margin of mango was 68% higher than Lentil-Jute-T.Aman whereas it was 52% higher than Potato-Fallow-T.Aman. BCR on total cost and variable cost were also higher in mango cultivation then this eleven studied cropping patterns.

Table 16. Relative profitability of mango cultivation with other competing crops

Items	Wheat-Fallow-T.Aman	Boro-Jute-Fallow	Boro-Fallow-T.Aman	Boro-Aus-Fallow
Total cost lower than mango (Tk)	8096	9709	13915	11658
Total cost lower than mango (%)	6	7	10	9
Total variable cost lower than mango (Tk)	16707	24232	18887	5894
Total variable cost lower than mango (%)	22	32	25	34
Gross return lower than mango (Tk)	164995	174476	182129	179273
Gross return lower than mango (%)	53	56	59	58
Gross margin lower than mango (Tk)	175064	169108	194378	198529
Gross margin lower than mango (%)	75	82	83	85
Net return lower than mango (Tk)	150261	158129	161576	160977
Net return lower than mango (%)	86	90	92	92

3.7 Impact of Mango Cultivation on Income and Livelihood Pattern

Mango cultivation has created tremendous impact to many of the respondent farmers in the study areas. Survey results exposed that 83% respondent farmers opined that switching from cereal crops to mango cultivation brought them positive impacts to some extent on household income, food intake, and livelihood improvement (Table 18).

Table 17. Relative profitability of mango cultivation with other competing crops

Items	Wheat-Jute T.Aman	Wheat-Seasame-T.Aman	Wheat-Jute-vegetables	Wheat-Aus-T.Aman	Lentil-Jute-T.Aman	Potato-Fallow-T.Aman	Boro-Sesame-T.Aman
Total cost higher than mango (Tk)	53756	37084	16006	51807	48937	55484	41299
Total cost higher than mango (%)	40	28	12	39	37	41	31
Total variable cost higher than mango (Tk)	63997	46165	33522	65659	59079	64674	59539
Total variable cost higher than mango (%)	84	61	44	86	78	85	78
Gross return lower than mango (Tk)	92435	99536	130266	97232	107034	63726	116670
Gross return lower than mango (%)	30	32	42	31	35	21	38
Gross margin lower than mango (Tk)	149794	139063	157150	156253	15946875	121762	158377
Gross margin lower than mango (%)	64	60	67	67	68	52	68
Net return lower than mango (Tk)	139553	129982	139634	142401	149333	112572	141297
Net return lower than mango (%)	80	74	80	81	85	64	81

Table 18. Impact of mango cultivation to farmers

Impact	% farmers responded			
	Chapai Nawabganj	Natore	Rajshahi	All areas
Positive impact	68	93	87	83
No impact	32	7	13	17
Total	100	100	100	100

3.10 Factors Influence Decision for Shifting Area in Favour of Mango Cultivation

A multiple linear regression analysis was carried out for studying the influence of different factors that affect farmers to substitute their land to mango cultivation. The estimated regression coefficients and related statistics are presented in Table 19. The variations in eight independent variables included in the regression model explained nearly 80% variations in the crop substitution of mango. The F value was significant indicating thereby the good fit of the regression model.

The results revealed that the relative income from the crop was positive and significant in explaining the crop substitution decisions of farmers. The relative price variable came out to be insignificant. This showed that farmers, generally,

calculate the aggregate gain from the crop in their decision rather referring to only the price of the crop. The variables age turned out to be negatively significant for shifting decision to mango cultivation. It indicated that older farmers are less likely to be interested for shifting their land as compared to young farmers. Education had positive and significant effect implying that educated farmers were more concerned about profit and income and hence they preferred to have a higher level of substitution in their cropping pattern. Farm size was positively significant which indicated that farmers with large farm size were more interested for altering their land to mango cultivation.

Table 19. Factors influencing decision for area shift in favour of mango cultivation

Regression variable	Regression co-efficient	t-value	Standard error	P- value
Constant	-0.762***	2.978	0.256	0.003
Relative price (Tk/kg)	0.018	1.374	0.013	0.172
Relative income (Tk/farm/year)	0.445***	2.981	0.149	0.002
Yield (kg/ha)	0.020	1.623	0.012	0.107
Age (year)	-0.028**	2.215	0.013	0.031
Education (year of schooling)	0.034**	2.045	0.017	0.043
Farm size (ha)	0.946*	1.935	0.489	0.055
Non-farm income (Tk/farm/year)	0.318	0.648	0.491	0.518
Food crop requirements at home (Tk)	-0.168	0.345	0.486	0.731
R squire	80%			
F-values	1.871***			

Note: '***', '**' and '*' indicates 1%, 5%, and 10% level of significance

4. Conclusions and Recommendations

The study assessed the profitability of mango cultivation in comparison of cereal crops cultivation. Respondent farmers shifted about half of their total land to mango cultivation. Although mango cultivation required slightly higher cost it received the higher net return compared to other crops. This was the main reason behind the shifting of crop land to mango cultivation. The rate of returns (i.e. BCR, NPV and IRR) indicated that mango cultivation was highly profitable for the farmers. Mango cultivation also had positive impact to household income and livelihood pattern. There was concern for household food security could hinder shift in the cropping pattern from food crop to mango. Regarding food security, majority of the farmers mentioned that they were food-self-sufficient along with increased consumption level after cultivating mango. Moreover, as the net income from mango was high so it could cover the expenditure of farm families. Farmers mentioned that as the prices of food crop were not much high so they had never faced any problem in obtaining food crops from the market. Farmers in the study areas reported some sources from which they were motivated to mango cultivation rather than cereal crops. Among them neighbouring farmers were

opined to be as an important source of influence. This study also found out the factors that influence farmer's decision to shift from cereal crops to mango cultivation. Income, education and farm size had positive effect whereas age had negative effect to substitute their land from cereal crops to mango cultivation.The following recommendations are put forwarded for mango cultivation.

- Farmers should be motivated to cultivate mango in the fallow lands or areas where other crops are not grown well.
- As mango cultivation was highly profitable in the study areas, there is a tendency in the study areas to reduce crop land. Therefore, scientists should develop new cropping pattern with mango so that farmers can cultivate different food crops with mango.

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