Bangladesh Journal of Political Economy

Vol. 34, No. 2, December 2018, pp.273-294
Bangladesh Economic Association
(ISSN 2227-3182)

Economic Viability of Crop Diversification in Northern Bangladesh

Mohammad Monirul Islam*
Md. Elias Hossain**

Abstract: *The present study is an attempt to analyze whether practicing crop diversification is economically viable or not. Using farm level survey data, this study considers number of crops produced by a farm and proportion of rice crop area to gross crop area to observe whether the farm practices crop diversification or rice monoculture. Similarly, this study employed net return analysis and benefit cost ratio (BCR) analysis to investigate economic viability of crop diversification. The study is based on primary data collected from a total of 343 farmers taken from eight villages from four districts of northern Bangladesh randomly by using multi-stage random sampling procedure. It is found from the study that three fourths of the total farmers grow both rice and non-rice crops and only one fourth of the total farmers practice rice monoculture. It is also found that 63 percent of gross crop area under the study villages has been used to produce rice which is less than the national figure of 78.52 percent. A farm grows 4.46 crops, on the average, in a cropping year. It is found from the study that northern Bangladesh is a mediocre crop diversified area in Bangladesh and Rajshahi is the most crop diversified area among the sample districts. It is also found that vegetables, spices base cropping pattern offer more returns than that of rice based cropping pattern and non-rice crops especially vegetable, spices and jute create more employment generation than that of cereal, especially rice. Therefore, considering different aspects of crop production this study concludes that vegetables, spices, potato based cropping patterns are*

* Assistant Professor, Department of Economics, Nagarpur government college, Tangail
E-mail: rawnak_mahmud@yahoo.com
** Professor, Department of Economics, Rajshahi University, Rajshahi-6205
E-mail: eliaseco@ru.ac.bd

economically more viable than others. In conclusion, the study offers some suggestions to enhance practice of crop diversification. Firstly, Rabi season should be used to produce different types of non-rice crops, as higher numbers of crops grow in Rabi season than that of other seasons. In this season, various non-rice crops like vegetables, spices and other shorter duration crops should be grown in accordance with land quality. Secondly, farms should include at least one non-rice crop in their cropping pattern, as rice monoculture has many adverse effects on the environment. Similarly, some portion of cultivable land should be allocated for producing spices. Likewise, a shorter duration leguminous crop should be grown between early aman and late boro. Thirdly, proper facilities to non-rice crops production like supplying of quality seeds, supplying of fertilizer and insecticides, and also the irrigation equipments should be provided with reasonable subsidy by the relevant organizations of the government.

Keywords: *Crop diversification, Economic viability, Net Return, Benefit Cost Ratio (BCR).*

1. Introduction

Agriculture is the lifeblood of Bangladesh economy. It is also one of the major sources of livelihood of the people in Bangladesh. It employs almost 50 percent of labor force and contributes 19.41 percent to the Gross Domestic Product (GDP) of which 10.86 percent comes from crops and horticulture in the FY 2011-12 (GOB, 2013). Rice production dominates the farming activities of Bangladesh and it accounts for 75 percent of gross crop area (BBS, 2011). Apparently, there are basically two reasons for which farmers of Bangladesh concentrate on rice production. Firstly, rice provides the main source of food for the family throughout the year. To ensure food security for the family members, the farmers have a little option to grow crops other than rice. Secondly, *Green Revolution* technology such as HYV seeds, irrigation facility and fertilizer induced farmers to grow rice. As a result, production of major cereals especially rice has been increased enormously at the cost of minor crops. *Green Revolution* provides the country so called self-sufficiency in food crop production to some extent but creates many adverse effects, viz., it decline water table, reduces soil fertility, erodes biodiversity, creates nutritional imbalance in human food and snatches way diversity in crop production. Husain, Hossain and Janaiah (2001) and Rahman (2010) observed that intensive rice monoculture led to displacement of land under low productive non-rice crops such as pulses, oilseeds, spices and vegetables, erosion of crop diversity, thereby, endangering sustainability of crop-based agricultural production system.

In order to minimize the adverse effects of rice monoculture the government has launched crop diversification program (CDP) in 1990s and has been continuing the program in different regions of the country till today. It is said that crop diversification (CD) is an effective strategy to address the adverse effect of rice monoculture and make agriculture sustainable. It enhances food and nutrition security for the people and promotes agricultural and rural development (Acharya *et al*, 2011; Malik & Singh, 2002; Pattanayak & Nayak, 2003). Crop diversification also helps to utilize scarce land and valuable water resources effectively and make agriculture environment friendly (De & Chattopadhyay, 2010; Joshi *et al*, 2007; Kumari *et al*, 2010; Singh, 2001). In addition, by minimizing price and yield risk created by climatic variability and price volatility of agricultural production, it offers comparatively high return. Again, it offers higher labor productivity, maximizes use of resources and utilizes the land efficiently (Ashfaq *et al*, 2008; Mehta, 2009; Mukherjee, 2012). It also creates opportunities for more employment and higher income through efficient use of resources (World Bank, 1990). It is clear from the discussion that practice of crop diversification helps the farmers in different ways but yet we do not know what the level of crop diversification in Bangladesh is and how to measure the level of crop diversification. Thus, in spite of having such advantages of crop diversification, it is not clear yet about the actual situation of crop diversification in Bangladesh.

Similarly, there is a worldwide effort in favor of diversification in agriculture towards reducing various risks, as is evident in Bangladesh. Besides, practice of crop diversification reduces environmental risk; price and yield risk generated from rice monoculture are evident from different studies. Nonetheless, researcher's knowledge goes so far, there have been found no studies on profitability of crop diversification.

It is apparent that some farmers are commercializing agriculture to get more profit from their farm whereas some other produce different types of non-rice crops to make higher profit. In addition, it is found in many instances that farmers cannot off-set production cost of rice because of higher input cost and lower market price of rice. Siddique (2013) found farmers are losing interest in cultivating *boro* due to high production cost and low market price. Farmers are being forced to grow crops like maize. However, statistics show the different picture that is yet more than 70 percent of gross crop area is devoted to rice production in Bangladesh. Again, adding non-rice crops or multiple crops in the existing cropping pattern is comparatively profitable or not is unknown to all. Thus, it claims to explore

whether crop diversification is economically viable alternative to rice monoculture or not. In this backdrop, this study focuses on economic viability of crop diversification taking the special case study of northern Bangladesh.

2. Literature Review

There have been several studies found on different aspect of crop diversification home and abroad. Most of the studies found on the concepts of crop diversification **(**Acharya *et al,* 2011; Akanda, 2010; Bhattacharyya, 2008; Joshi, 2011; Mukherjee, 2012), measurement index of crop diversification (Aneani *et al,* 2011; Ashfaq *et al,* 2008; Ghosh, 2010; Jha *et al,* 2009; Kumari *et al,* 2010; Mukherjee, 2012) and factors influencing crop diversification (Acharya *et al,* 2011; Bhattacharyya, 2008; Malik & Singh, 2002; Mesfin *et al,* 2011; Pingali *et al,* 1997; Rahman, 2009). So far, researcher knowledge goes, none of the studies found on the profitability of crop diversification. However, several recent studies have attempted to estimate profitability of crop production. They used various methods to analyze profitability. Mostly used methods are total cost and gross return (Π = TR- TC) analysis, benefit cost ratio (BCR), Gross Margin (GM) and Net Margin (NM) etc. There are host of studies where researchers have used cost benefit analysis (CBA) to measure the profitability of the crops. For example, Ahmed *et al* (2013), Haque *et al* (2013), Haque *et al* (2012), Hoq *et al* (2012), Kabir and Islam (2012), Karim *et al* (2009), Moniruzzaman *et al* (2009) and Mukul and Rahman (2013) have used benefit cost ratio (BCR) over total cost and total variable cost to analyze profitability of respective crops in their study**.**

Kabir and Islam (2012) did a comparative study on *Rabi* crops by using farm level primary data. They did cost benefit analysis by using net margin and gross margin approaches. They found that wheat is a more profitable *Rabi* crop than other crops like grass pea, mustard, lentil. Farmers earned the highest per hectare gross return (Tk.98,646) and gross margin (Tk.22,870) from the Wheat - *Aus* rice - T. *Aman* rice pattern whereas *Boro* rice - Fallow - T. *Aman* pattern produced the lowest gross return (Tk.65,918) and gross margin (Tk.10,134). Higher benefit was achieved from the pattern Wheat - *Aus* rice - T. *Aman* rice because of less production cost and high price of wheat grain, though three cereals crops could exhaust soil nutrient so that Mung-bean - *Aus* rice - T. *Aman* pattern may be alternate option to sustain soil health as well as productivity of the selected area.

Afroz and Islam (2012) estimated the relative profitability of growing *aus* rice and jute and to determine the resource use efficiency in the production of these crops by using primary data. They used benefit cost ratio and found that total costs for

producing jute and *aus* rice were Tk.50,254 and Tk.44,970 per hectare, respectively. The equivalent gross returns were Tk.83,717 and Tk.55,762, respectively. Accordingly, net return for jute was Tk.33,463, which was about three times higher than that for *aus* rice (Tk.10,792/hectare). Moreover, BCR of producing jute was about 30 percent higher (1.7) than that of *aus* rice (1.3). Cobb-Douglas production function was used to estimate specific effects of individual inputs on production of jute and *aus* rice. Resource use efficiency analysis showed that neither in jute nor in *aus* rice production farmers was found efficient enough to use various inputs. Therefore, it seems that efficient and judicious use of various resources would enable both jute and *aus* rice farmers to earn more profit.

Haque *et al* (2012) analyzed profitability of hybrid maize seed by using primary data collected from hybrid maize seed contract growers and 120 maize (non-seed) growers were selected randomly for the study. In this case, they used cost benefit ratio and found that the cost of production was higher for NGO (Tk.66,472/ha) than the public agency (Tk.64,836/ha) and private company (Tk.59,352/ha). The yield of hybrid seed was higher under NGO (3,780 kg/ha) than that of public agency and private company. Net return of hybrid seed production for contract growers was higher under public agency (Tk.78,204/ha) compared to private company (Tk.39,088/ha) and NGO (Tk.33,246/ha). Benefit cost ratio (BCR) was higher for the contract growers of public agency (2.21). Net return of hybrid maize seed production was 50 percent higher than that of non-seed production.

Mukul and Rahman (2013) estimated profitability of banana production by using primary data. In the study, they investigated total cost, profit and benefit cost ratio for different marketing channel like banana producers, wholesalers and retailers. They found that profit for producer was Tk.55,002.8 per hectare. Similarly, benefit cost ratio for producers was 1.40.

Haque *et al* (2013) studied the profitability of crop diversification by using data collected from randomly selected farmers. They used benefit cost ratio over variable cost as well as total cost. They found that the costs of rose cultivation were Tk.3,87,569 and Tk.2,75,214 per hectare on full cost and variable cost basis, respectively. The major share of full cost was incurred for human labor (30 percent), followed by land use (23 percent), fertilizer (17 percent), and irrigation (12 percent). The net return from rose cultivation was Tk.23,31,196 per hectare. The benefit cost ratios were 2.29 and 1.63 on variable cost and full cost basis, respectively. The highest profit was obtained from rose cultivation compared to its competitive crops like potato - jute, lentil - *teel* and mustard - *mung* - bean for Rose.

Moniruzzaman *et al* (2009) analyzed profitability level of maize production in Bangladesh. They collected data from 200 randomly selected maize growers using pre-designed interview schedule. To analyze profitability, they used net margin, gross margin and benefit cost ratio and found that the average cost of maize production were Tk.44,197, Tk.33,195 and Tk.24,441 per hectare on total cost, variable cost and cash cost basis, respectively and gross return was Tk.69,773 per hectare. The gross margin was Tk.36,578/ha on total variable cost (TVC) and Tk.45,332/ha on cash cost basis. The net return was observed to be Tk.25,575 per hectare. Benefit cost ratios were calculated as 1.58, 2.10 and 2.85 on total cost, variable cost and cash cost basis, respectively.

Although there are several research works on profitability of various issues, very few of them were focused on crop diversification. To analyze the profitability most of them use conventional profit determining model, i.e. total costs and total returns analysis. To find out profit, total costs are deducted from total returns. Zahir (1993) observed that vegetables, spices and modern variety of potatoes are much more profitable than modern variety of *boro* rice. He also found that vegetables-based cropping pattern on irrigated high land was much more remunerative than *boro*-based cropping pattern. The results of financial and economic analyses had shown that a number of crops such as potato, vegetables, onion and cotton have high financial and economic return which were significantly higher than those of rice. On the other hand, wheat, sugarcane and oilseeds had a very low economic return although private return from sugarcane was quite high (Mahamud *et al*, 1994). Alam (2009) studied on the comparative cost and return of the various crops and found diversified crops were more profitable than rice and it had a positive impact on reducing poverty through consuming nutritional food. Alam also concluded diversified agriculture might be a leader of uplifting socio economic condition through effective and pragmatic planning on income and nutrition.

3. Methodology

The objective of this study is to investigate whether diversified cropping practice is economically viable to the farmers. Thus, this study used primary data from farm households to observe whether the farm practices crop diversification or rice monoculture and to analyze economic viability of crop diversification in the study area. To observe whether the farm practices crop diversification or rice monoculture, this study considers number of crops produced by a farm and proportion of rice crop area to gross crop area. Economic viability basically refers to profitability and this study employed net return analysis and benefit cost ratio

(BCR) analysis to investigate the economic viability of crop diversification. Computation procedures under these techniques are provided below:

3.1 Net Return Analysis

Net return analysis is the most common approach for determining and comparing profitability of different crops. Profit is defined as the difference between the gross return and total cost. Thus, to analyze profitability, gross return and total cost of the crops were considered. Total cost includes all types of costs which are paid from farmers' pocket and imputed cost of family labor and other factors of production. All types of imputed costs were converted according to the market price. Even land and other agricultural implements of the owner farmers were treated as rented one. Total return includes return from main product and by-products. Farmers' actual cost and returns of production have been calculated in this research. Where farmers buy inputs of production at retail price and sell their product at wholesale price. The following conventional profit determining model, which is the simplest procedure to determine profitability and commonly used, were employed to analyze farmers' profitability in producing crops.

$$GM = (GR - TVC) \quad \text{..... (1)}$$

$$NR = (GR - TC) \quad \text{..... (2)}$$

Where,

$$GR = \sum_{i=1}^{n} P_{q_i} Q_i \quad \text{.....(3)}$$

$$TC = TFC + TVC \quad \text{.....(4)}$$

GM = Gross Margin (profit) from i^{th} crop per *bigha* (33 decimal) of land

NR = Net Return (profit) from i^{th} crop

GR = Gross return from i^{th} crop

TC = Total cost of i^{th} crop

TVC = Total cost except land cost (summation of labor cost, tillage cost, seed cost, fertilizer cost, pesticide cost and irrigation cost)

TFC = Total fixed cost (land rent)

P_{qi} = Unit price of i^{th} main crop and related by-products (if any)

Q_i = Quantity of i^{th} main crop and related by-products (if any)

3.2 Benefit Cost Ratio (BCR) Analysis

Undiscounted BCR is another technique of profitability analysis. BCR analysis is an important tool to assess economic viability of farming. It is the ratio of total cost to total return (gross return). If BCR is greater than one, the farm is considered as profitable. This study has used undiscounted BCR to compare profitability of monoculture and diversification. The formula is stated as:

$$BCR = \frac{TR}{TC} \quad \text{..... (5)}$$

The farm is treated as a profitable farm if the value of BCR is greater than one (BCR>1).

3.3 Sample Selection and Data Collection

The present study is mainly based on primary data collected from sample households. In this purpose, eight villages from four districts under northern Bangladesh, which is comprised of Rajshahi and Rangpur divisions, have been selected. The sample farmers are chosen randomly using multi-stage random sampling method. For conducting the present study, the researcher selected the study area with great care so that the estimated results become representative. The rationale behind selecting northern Bangladesh for the present study is that this area is an agriculture-based area. Although rice is the dominant crop in northern Bangladesh, it also produces several other minor crops such as wheat, potato, vegetables, jute, maize, oilseeds, pulse, onion, garlic etc. In northern Bangladesh, farming is the principal occupation of most of the population and their livelihood mostly depend on agricultural activities. The selection of sample for this study involves the selection of districts, upazila and villages. The first step was to select four districts out of sixteen districts from northern Bangladesh. Four districts that are chosen purposively are Thakurgaon and Kurigram from Rangpur division and Rajshahi and Naogaon from Rajshahi division. The districts have been selected purposively on the basis of consultation with regional office of DAE. In the next step, one upazila from each district has been selected randomly. Thus, Pirgonj upazila of Thakurgaon district, Rajarhat upazila of Kurigram district, Paba upazila of Rajshahi district and Mohadebpur upazila of Naogaon district have been selected for the survey. From each of the selected upazila, two villages have been selected randomly. After that farm households have been listed from the records available to the Sub Assistant Agriculture Officer (SAAO) of the respective villages and then sample households are chosen by using random sampling

method. A total number of 343 farm households, using statistical formula proposed by Arkin and Colton (1963), are selected for this study. Finally, these data have been collected from head of the each sample household.

4. Result and Discussion

4.1 Level of Crop Diversification

Table 4.1 presents existing cropping practice and level of crop diversification amongst the sample households in each district. It is clear from Table 4.1 that there are distinct variations among the regions with respect to each of the aspects considered.

Table 4.1: Extent of Crop Diversity among Sample Farmers

Variables	Rajshahi	Naogaon	Kurigram	Thakurgaon	All
Only rice growers	2%	34.34%	42.85%	18.07%	24%
Only non-rice growers	3%	0%	0%	1%	1%
Both rice and non-rice crops	95%	65.66%	57.15%	80.93%	75%
Average number of crops grown	6.26	3.56	2.58	4.46	4.46
Maximum number of crops grown	17	10	7	14	17
Proportion of rice crops area	31%	68%	70%	66%	63%
Number of observations	91	99	70	83	343

Source: Field Survey, 2013.

Source: Field Survey, 2013.Twenty four percent of the total farmers adopted rice monoculture and 75 percent of the total farmers adopted both rice and non rice crops in the sample districts. In terms of area allocated to crops, the rice cover 63 percent of gross crop area which is less than the national level of 78.52 percent (BBS, 2011). It is found from the study that 31 percent of gross crop area in Rajshahi has been used to produce rice during the survey year, 68 percent in Naogaon, 70 percent in Kurigram and 66 percent in Thakurgaon. It is also found that a farm grows 4.46 crops in a year. Thus, the study indicates that cropping system in the study area is relatively diverse.

4.2 Average Yield of Different Crops in the Study Area

Yield, output price and production cost of different crops are important indicators in economic return analysis of the crops. It is observed that in Bangladesh, there is higher yield gap between expected yield and actual yield of the crops which is attributable to climatic variations, soil structure, and some socio-economic and demographic characteristics of the farms and farmers.

Similarly, same crops do not grow across all the regions in the country. Agro-climatic conditions influence crop choice by the farms in different areas. Moreover, yield of different crops is also not same in all the areas. Putting it differently, some areas are specialized for production of some crops rendering higher yield rate of those crops while the other areas good for other crops. Table 4.2 shows average yields of different crops in the sample districts in northern Bangladesh. It is clear from the table that there are clear variations in crops under choice and yields across the sample districts. As is found from the table, average yield per *bigha aus* rice is 570 kg*, aman* 640 kg, *boro* 962 kg, wheat 573 kg, maize 1,067 kg, *musur* 195 kg, mustard 192 kg, jute 327 kg, chili 1,738 kg, potato 3,292 kg and yield of different vegetables per bigha ranges between 2,500 kg to 4,000 kg. Yield of different crops per bigha in Bangladesh is still considered very low in comparison to that in many other countries of the world.

Table 4.2: Average Yield of Different Crops by Districts (Kg/ bigha)

Crops	Rajshahi	Naogaon	Kurigram	Thakurgaon	All
Aus	540	536	--	619	570
Aman	673	655	594	640	640
Boro	943	954	942	1,003	962
Wheat	579	550	525	582	573
Maize	1,044	1,130	993	1,104	1,067
Musur	220	-	-	180	195
Mustard	193	191	191	190	192
Jute	346	314	353	271	327
Chili	1,797	1,638	1,665	1,697	1,738
Onion	1,603	1,388	-	1,457	1,520
Garlic	1,024	1,004	-	830	983
Potato	3,672	3,266	3,163	3,081	3,292
Brinjal	4,527	3,311	3,172	3,109	3,482
Bot. gourd	2,786	3,400	2,820	-	2,868
Ash gourd	3,400	3,284	3,040	-	3,274
Point gourd	2,377	2,314	1,860	2,300	2,272
Yard long been	2,749	2,114	2,100	-	2,429
Cucumber	2,498	2,442	2,100	-	2,376
Bitter gourd	2,461	2,145	1,600	2,240	2,309
Tomato	4,695	3,275	-	3,343	4,023
Cauliflower	-	2,500	3,111	2,767	2,838
Cabbage	3,200	3,233	3,400	4,260	3,734

Sources: Author' calculation

In disaggregated analysis, average yield of *aus, boro* and wheat grown in Thakurgaon is the highest among the sample districts. Similarly, average yield of *boro* rice in Thakurgaon is 1,003 kg per *bigha* followed by Naogaon 954 kg, Rajshahi 943 kg and Kurigram 942 kg. Average yield of T. *aman* in Rajshahi is

higher than that of other districts in the study area. It is 673 kg in Rajshahi, 655 kg in Naogaon, 640 kg in Thakurgaon and 594 kg in Kurigram. In Naogaon district, the average yield of maize is 1,130 kg per *bigha* followed by Thakurgaon 1,104 kg, Rajshahi 1,044 kg and Kurigram 993 kg per *bigha*. It is clear from the table that only the sample farms of Rajshahi and Thakurgaon districts were found to grow pulses and yield of pulses is higher in Rajshahi than that in Thakurgaon. Average yield of mustard is almost the same across the sample districts. The highest yield of jute is found in Kurigram. The table also shows that yield of spices in Rajshahi districts is the highest. In Rajshahi, average yield of chili, onion and garlic is 1,797 kg, 1,606 kg and 1,024 kg per *bigha*, respectively. It is 1,638 kg, 1,388 kg and 1,004 kg respectively, in Naogaon and 1,697 kg, 1,457 kg and 830 kg, respectively in Thakurgaon district. Sample farms Kurigram district were not found to cultivate onion and garlic. In case of potato, the highest yield is 3,672 kg per *bigha* found in Rajshahi followed by 3,266 kg in Naogaon, 3,163 kg in Kurigram and 3,081 kg in Thakurgaon districts. It is apparent from the table that yield rate of major vegetables grown in Rajshahi district is higher than those of others.

The table clearly presents that Rajshahi district grows the highest number of crops amongst the sample districts. Besides, most of the non-cereal crops' yield is also higher in Rajshahi than that of other districts. The reasons behind growing the highest number of crops and obtaining higher yield in Rajshahi district is the farmers' motivation for profit, fertile soil, infrastructural facilities, available irrigation facilities, vicinity to urban centre etc. It is opined by many people that huge demand for different crop by the people of the metropolis, marketing facility in and from the city and irrigation facility provided by the BMDA are some of the reasons behind growing different crops and the comparatively high yield in Rajshahi district. One thing is also clear from the above discussion suitability of soil also influence the choice of crops by the farms. It is found during the data collection that soil of Rajshahi district is fertile and conducive for various crops to grow while the soil of Naogaon district although fertile is mostly conducive to grow rice only.

Because of the variation in yields and condition of soil fertility along with climate variability, farms of different sizes and different districts obtained different level of returns for different crops. Table 4.3 presents gross returns of different crops. It is found from the table that price of per 40 kg *aus* paddy is Tk.562, *aman* paddy is Tk.656 and *boro* paddy is Tk.558. Similarly, per 40 kg *musur* at prices Tk.2,138. Again, price of per 40 kg jute is Tk.1,306, chili Tk.711, onion Tk.694 and garlic Tk.1,433. Likewise, per 40 kg potato, cucumber, tomato, cabbage

prices are Tk.369, Tk.529, Tk.464 and Tk.445, respectively. Thus, a farm obtained a gross return (value of total product) is Tk.8,702 from cultivation of *aus* paddy per *bigha* land. *Aman* Tk.11,510 *boro* Tk.14,410, wheat, Tk.13,100 and maize Tk.12,888. Similarly, gross return is Tk.46, 673 from per *bigha* tomato cultivation. Cabbage Tk.41,562, cauliflower Tk.33,174, brinjal Tk.38,685, yard long bean Tk.35,037, potato Tk. 30,351, chili Tk.30,893, onion Tk.26,354, garlic Tk. 35,202, jute Tk.12,187, etc.

Thus, it is found that gross returns from vegetables, spices, jute and oilseed etc. are higher than rice, wheat, maize etc. In short, gross returns from non-rice crops are comparatively high. This is because of the higher yields and prices of different vegetables than that of rice.

Table 4.3: Gross Returns from Different Crops (per bigha)

Crops	Yield (Kg)	Unit Price (Tk./40kg)	Main crop (Tk.)	By product	GR (Tk.)
Aus	570	562	8,002	700	8,702
Aman	640	656	10,510	1,000	11,510
Boro	962	558	13,410	1,000	14,410
Wheat	573	901	12,900	200	13,100
Maize	1,067	543	14,488	400	14,888
Musur	195	2,138	10,431	-	10,431
Mustard	192	1,792	9,604	-	9,604
Jute	327	1,306	10,687	1,500	12,187
Chili	1,738	711	30,893	-	30,893
Onion	1,520	694	26,354	-	26,354
Garlic	983	1,433	35,202	-	35,202
Potato	3,292	369	30,351	-	30,351
Brinjal	3,482	444	38,685	-	38,685
Bot. gourd	2,868	398	28,544	-	28,544
Ash gourd	3,274	368	30,121	-	30,121
point gourd	2,272	533	30,276	-	30,276
Yard long been	2,376	577	35,037	-	35,037
Cucumber	2,309	529	31,420	-	31,420
Tomato	4,023	464	46,673	-	46,673
Cauliflower	2,838	468	33,174	-	33,174
Cabbage	3,734	445	41,562	-	41,562

Sources: Author's calculation.

4.3 Production Cost of Growing Different Crops

Not only gross returns but also input cost is also important for analyzing economic viability of any crop. Higher production cost reduces profit margin of the farms. Input cost, particularly, is a significant determinant of choice of crops. Generally, farmers are reluctant to grow those crops that incurs higher input cost and comparatively low output price. Inputs are not used equally in growing different

crops. Some crops need higher amount of some inputs and some crops need lower amount. For example, *boro* needs higher degree of irrigation whereas wheat and maize need less irrigation and pulses necessitate no irrigation. Similarly, some crops require more fertilizer and pesticides compared to others.

Production cost of a farm for different crops constitute the total cost of producing those crops which include fixed cost (land rent), labor cost, tilling cost, seed cost, fertilizer cost, pesticide cost and irrigation cost. Table 4.4 presents production cost of different crops in the study area. In aggregated analysis, it is evident from the table that production costs of potato, vegetables, spice are higher than those of other crops and production cost of other crops. It is found that total cost of potato cultivation per *bigha* is Tk.20,305. It is Tk.10,266 for jute, Tk.16,876 for spices, Tk.18,082 for vegetables, Tk.10,843 for maize and Tk.11,763 for *boro* paddy production. In disaggregated analysis, it is found from the table that in spices production the major share of total cost is labor cost. Labor cost of spices

Table 4.4: Production Cost of Different Crops in the Study Area (Tk./bigha)

Crops	TC	TFC	TVC and % of Total cost					
			Labor	Tilling	Seed	Fertilizer	Pesticide	Irrigation
Aus	7,939	1,819	2,758 (35)	847 (11)	456 (6)	1,092 (14)	492 (6)	475 (6)
Aman	8,967	2,205	3,153 (35)	930 (10)	502 (6)	1,268 (14)	476 (5)	433 (5)
Boro	11,763	2,390	3,655 (31)	1,007 (9)	736 (6)	1,865 (16)	615 (5)	1,495 (13)
Wheat	9,991	2,615	2,841 (28)	1,020 (10)	767 (8)	2,058 (21)	--	690 (7)
Maize	10,843	1,994	3,724 (34)	968 (9)	572 (5)	2,369 (22)	548 (5)	668 (6)
Pulse	5,700	1,422	1,798 (32)	638 (11)	355 (6)	1,251 (22)	236 (4)	--
Mustard	5,966	1,335	1,679 (28)	837 (14)	345 (6)	1,285 (22)	265 (4)	220 (4)
Vegetables	18,082	2,830	5,922 (33)	1,030 (6)	2,499 (14)	3,142 (17)	1,568 (9)	1,091 (6)
Spices	16,876	2,707	6,519 (39)	1,059 (6)	1,392 (8)	3,178 (19)	1,216 (7)	805 (5)
Jute	10,266	2,477	4,098 (40)	982 (10)	383 (4)	1,470 (14)	428 (4)	428 (4)
Potato	20,305	2,435	5,219 (26)	1,027 (5)	5,873 (29)	3,276 (16)	1,692 (8)	783 (4)

Source: Author's calculation (.) indicates % of total cost

production is Tk.6,519 followed by vegetables Tk.5,922, potato Tk.5,219, jute Tk.4,098, maize Tk.3,724 and *boro* Tk.3,655. If it is analyzed in terms of percentage, it is found that share of labor cost of the total cost varies among different crops, e.g., labor cost of cereals ranges from 28 percent to 35 percent of total cost. Labor cost of wheat is 28 percent of the total cost whereas it is 35 percent for *aus* and *aman* paddy, 31 percent for *boro* and 34 percent for maize production. Share of labor cost of jute production is the highest among the crops, which is 40 percent of total cost. It is 39 percent for spices and 34 percent for vegetables.

In the study area, tillage cost of mustard is 14 percent of the total cost and it is the highest among different crops. Tillage cost of cereals, pulses and jute differ from 9 percent to 11 percent of total cost, and it is 6 percent for vegetables and 5 percent for potato. Share of seed cost to the total cost is the highest for potato production which is 29 percent of total cost. Seed cost of vegetables is also comparatively high. It is 17 percent of total cost. Seed cost of cereals, pulses, mustard and others is almost same.

Fertilizer cost of wheat, maize, pulses and mustard are 21 percent to 22 percent of total cost and it is 14 percent to 16 percent for paddy, potato and jute. Vegetables and spices need 17percent and 19 percent of total cost respectively as fertilizer cost. Wheat does not require any pesticide cost whereas in vegetables, pesticide cost is the highest proportion to the total cost. It is 9 percent of total cost. Cereal, jute and mustard need 4 percent to 6 percent of total cost as pesticide cost. *Boro* paddy needs the highest proportion of irrigation cost to the total cost and it is 13 percent of the total cost. Pulses necessitate no irrigation cost and other crops need 4 percent to 7 percent cost of total cost as irrigation cost.

From the discussion it is found that major share of total cost is calculated for human labor to produce most of the crops. In the case of potato production major share of total cost is incurred for purchasing of seed as potato requires higher amount of seed compared to other crops. It is also found that human labor cost of major non-cereal crops is higher than that of cereal which indicates non-cereal crops generate more employment for agriculture laborer.

4.4 Net Return and Benefit Cost Ratio Analysis of Different Crops in the Study Area

Table 4.5 presents cost-benefit scenario of various crops grown in the study area. The study analyzes net returns and BCR to explore economically viable cropping patterns. It is found from the table that higher gross return is generated from

vegetables production such as gross return from tomato is Tk.46,673 per *bigha* followed by cabbage Tk.41,562, brinjal Tk.38,685 and garlic Tk.35,202. Similarly, it is Tk.30,893 for chili, Tk.30,351 for potato, Tk.14,410 for *bor*o, Tk.10,431 for *masur* and Tk.9,604 for mustard. Comparatively high yields and prices inflate the gross returns of these crops. Thus, it is clear that majority of higher return offering crops are vegetables. It is also found that gross return from rice is comparatively very low. However, higher gross return does not necessarily mean higher profit. It needs to analyze net return and BCR to find out the profitable ones. Net return and BCR analysis includes Total cost incurred and gross return obtained from the crops. Higher gross return and lower total cost increases net return and BCR of the crops. From the analysis highest net return is found from cabbage and it is Tk.26,453 per *bigha* followed by tomato Tk.22,167, brinjal Tk.21,192, yard long bean Tk.19,658, cauliflower Tk.18,319 and garlic Tk.17,653. When rice is considered, it is found that net return is Tk.764 for *aus*, Tk.2,582 from *aman*, and Tk.2,646 from *boro*. The highest BCR is found from turmeric. The BCR of turmeric is 2.84 followed by cabbage (2.75), yard long bean (2.28), cauliflower (2.23), brinjal (2.21), ash gourd (2.03), garlic (2.01), tomato (1.9) and chili (1.85). Similarly, BCR of *aus* is 1.1, jute (1.18), *boro* (1.22), *aman* (1.28), wheat (1.31), maize (1.37) and potato (1.45).

Table 4.5: Net Return and BCR of Crops in the Study Area(Tk./bigha)

Crops	A GR	B TVC	C TC	D GM (A-B)	E NR (A-C)	F BCR (A/C)
Aus	8,702	6,119	7,939	2,583	764	1.10
Aman	11,510	6,584	8,967	4,926	2,542	1.28
Boro	14,410	9,375	11,765	5,036	2,646	1.22
Wheat	13,100	7,376	9,991	5,725	3,109	1.31
Maize	14,888	8,843	10,855	6,045	4,034	1.37
Musur	10,431	4,825	6,138	5,606	4,294	1.70
Mustard	9,604	4,466	6,315	5,138	3,289	1.52
Jute	12,187	7,655	10,296	4,532	1,892	1.18
Chili	30,893	13,924	16,727	16,969	14,166	1.85
Onion	26,354	15,097	18,044	11,257	8,310	1.46
Garlic	35,202	14,875	17,549	20,327	17,653	2.01
Potato	30,351	17,871	20,863	12,480	9,487	1.45
Brinjal	38,685	14,897	17,493	23,788	21,192	2.21
Ash gourd	30,121	10,725	14,827	19,396	15,294	2.03
point gourd	30,276	15,355	19,632	14,920	10,644	1.54
Yard long bean	35,037	11,340	15,379	23,697	19,658	2.28
Cucumber	31,420	14,033	18,238	17,387	13,182	1.72
Tomato	46,673	20,094	24,507	26,580	22,167	1.90
Cauliflower	33,174	12,421	14,855	20,753	18,319	2.23
Cabbage	41,562	12,757	15,110	28,806	26,453	2.75

Source: Author's calculation

It is clear from the table that farmers earn higher returns from the production of vegetables and lower returns from the cereal crops. It is also apparent from the table that the lowest returns come from paddy. Mustard, pulses and spices provide comparatively high returns. Reasons behind higher returns from vegetables, spices and pulses production are higher yield, higher market price and comparative low input cost. However, causes of comparatively low returns from cereals are higher input cost and lower market price.

Rapid urbanization, change of taste, infrastructural development and economic growth change the food habit of the people and accordingly demand for vegetables, pulses and spices is also increasing gradually. Increasing demand of vegetables, pulses and spices pushes the price of these crops upward. Moreover, because of higher yield and facilities of quick transportation of vegetables to town area, farms receive higher returns. Although returns from pulse is comparatively low, its input cost is also lower but higher demand makes the price go up and ultimately farms get higher returns. Furthermore, theses crops are labor intensive and in most cases, farms use their family labor to produce them. This is another advantage of these crops.

It is stated earlier that net returns from cereals are lower than those of all other crops grown in the sample area. Because yield of *aus* and *aman* paddy and wheat is comparatively low and so is the market price of output, consequently net returns are low from the crops. Yield of *boro* and maize is comparatively high and their input cost is also higher with lower market price of output, as a result, returns are lower. Distorted and defective market system deprives the farmers from getting

Table 4.6: Net Return and BCR by Group of Crops (Tk./bigha)

Crops	A GR	B TVC	C TC	D G M (A-B)	E NR (A-C)	F BCR (A/C)
Paddy	12,465	7,745	10,070	2,395	2,395	1.24
Wheat	13,100	7,376	9,991	5,725	3,109	1.31
Maize	14,888	8,843	10,855	6,045	4,034	1.37
Pulses	8,748	4,466	5,553	3,195	3,195	1.58
Oilseed (Mustard)	9,604	4,466	6,315	5,138	3,289	1.52
Spices	30,045	14,282	17,090	15,763	12,955	1.76
Vegetables	32,177	14,926	17,857	17,251	14,320	1.80
Cash crop (jute)	12,187	7,655	10,296	4,532	1,892	1.18

Source: Author's calculation

fair returns from their products. Indebtedness and lack of the storage facility compel the farmers to sell their crops especially paddy during the harvesting time. Infestation of intermediaries, government's untimely procurement of rice and the farmers' urgent need for cash eat up the major portion of the returns from the crops (Bayes, 2012).

Table 4.7: Net Return and Benefit Cost Ratio Analysis of Different Cropping Patterns in the Study Area (Tk./bigha)

Cropping Pattern	A GR	B T VC	C TC	D G M (A-B)	E NR (A-C)	F BCR (A/C)
Aus - T. *Aman* - *Boro*	34,622	22,078	28,671	12,544	5,952	1.21
Aus - T. *Aman*- Potato	50,563	30,574	37,769	19,988	12,793	1.34
Aus- T. *Aman* – Mustard	29,816	17,170	23,221	12,647	6,595	1.28
Jute - Vegetables - Wheat	57,465	29,956	38,144	27,508	19,321	1.51
Maize - T. *Aman* – Potato	56,748	33,298	40,685	23,450	16,063	1.39
Jute - T. *Aman* – Wheat	36,797	21,614	29,254	15,183	7,543	1.26
Jute - T. *Aman* – Potato	54,047	32,110	40,126	21,938	13,921	1.35
Vegetables - T. *Aman*- Spices	73,732	35,792	43,915	37,940	29,817	1.68
Vegetables -T. *Aman*-Vegetables	75,864	36,436	44,682	39,428	31,182	1.70

Source: Author's calculation

4.5 Net Return and Benefit Cost Ratio Analysis of Groups of Crops

Table 4.6 presents net return and BCR of groups of crops in the study area. It is found that net returns of non-rice crops are higher than that of cereal crops. Net return of vegetables is higher which is Tk.14,320 followed by spices Tk.12,955, maize Tk.4,034, oilseed Tk.3,289 whereas net return of paddy is Tk.2,395. Similarly, BCR of vegetables is higher than that of.

4.6 Net Return and Benefit Cost Ratio Analysis of Different Cropping Patterns in the Study Area

Different farms include different crops in their cropping patterns and returns from the different patterns are different. By calculating net return and BCR of different cropping patterns, comparisons are made among the patterns towards the economic viability of them.

5. Conclusion

It is found from the study that most of the farmers in the study area grow different types of crops. In the study area, proportion of rice crops area to gross crop area is less than that of national level. This indicates that the area is mediocre crop

diversified area. Among the sample districts, Rajshahi is the most crop diversified area and grows the highest number of crops. Similarly, on average, yield of vegetables is higher in Rajshahi whereas yield of rice is higher in Thakurgaon in the study areas. Average yield of spices in Rajshahi is the highest in the study area. In farming activities, labor cost of a farm is considered as income of the family. Labor cost of crop production is the highest amongst the inputs costs. On average, labor cost of a crop is one fifth to two fifths of the total cost. Average labor cost for growing vegetables, spices and jute is higher than that of other crops. These indicate that these types of crops generate more employment than that of other crops. Net return of vegetables and spices are significantly higher than those of rice wheat and maize. In terms of cropping pattern, vegetables, spices base cropping pattern offer more returns than that of rice based cropping pattern. Again, non-rice crops especially vegetable, spices and jute create more employment generation than that of cereal, especially rice. Therefore, considering different aspects of crop production, this study concludes that vegetables, spices, potato based cropping patterns are economically more viable than others. As growing non-rice crops are more profitable than that of rice, this study offers following recommendations to promote practice of crop diversification in Bangladesh.

1. As higher numbers of crops grow in *Rabi* season than that of other seasons, *Rabi* season should be used to produce different types of non-rice crops. In *Rabi* season, various non-rice crops like vegetables, spices and other shorter duration crops should be grown in accordance with land quality.
2. As rice monoculture has many adverse effects on the environment, farms should include at least one non-rice crop in their cropping pattern. Similarly, some portion of cultivable land should be allocated for producing spices. Likewise, a shorter duration leguminous crop should be grown between early *aman* and late *boro*.
3. Proper facilities to non-rice crops production like supplying of quality seeds, supplying of fertilizer and insecticides, and also the irrigation equipments should be provided with reasonable subsidy by the relevant organizations of the government.

References

Acharya, S. P., Basavaraja, H., Kunnal, L. B., Mahajanashetti, S. B. & Bhat, A. R. S. (2011). Crop diversification in Karnataka: An economic analysis. *Agricultural Economics Research Review, 24* (July – December), 351 – 357.

Afroze, S. & Islam, M. S. (2012). Economics of *aus* rice (oryza sativa) and jute (corchorus olitorius) cultivation in some selected areas of Narsingdi district of Bangladesh. *The agriculturists 10* (2), 90-97.

Ahmed, F., Islam, M. N., Alom, M. S., Sarker, M. A. I. & Mannaf, A. (2013). Study on intercropping leafy vegetables with okra (*Abelmoschus esculentus L.*). *Bangladesh Journal of Agricultural Research, 38*(1), 137 – 143.

Akanda, A. I. (2010). Rethinking crop diversification under changing climate, hydrology and food habit in Bangladesh. *Journal of Agriculture and Environment for International Development, 104* (1 – 2), 3 – 23.

Alam, M. J. (2009). *Impact of diversified agriculture on the socio economic upliftment of the rural people of Bangladesh*. Bangladesh Academy for Rural development (BARD), Kotbari, Comilla, Bangladesh.

Aneani, F., Anchirinah, V. M., Owusu-Ansah, F., & Asamoah, M. (2011). An analysis of the extent and determinants of crop diversification by cocoa (*Theobroma cacao*) farmers in Ghana. A*frican Journal of Agricultural Research, 6*(18), 4277-4287.

Arkin, H., and Colton, R. R. (1963). *Tables for Statisticians.* 2nd Ed. New York, NY: Harper and Row Publishers.

Ashfaq, M., Hassan. S., Naseer, M. Z., Baig, I. A., & Asma, J. (2008). Factors affecting farm diversification in rice-wheat. *Pakistan Journal of Agriculture and Science, 45*(3), 91-94.

BBS (2011). 2011 Y*earbook of agricultural statistics of Bangladesh*. Dhaka: Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

Bayes, A. (2012, March 7). *Formal and informal sources of rural credit*. The Financial Express. Dhaka, Bangladesh.

Bhattacharyya, R. (2008). *Crop diversification: A search for an alternative income of the farmers in the state of West Bengal in India*. Paper presented in International Conference on Applied Economics (ICOAE). http://kastoria.teikoz.gr/icoae2/wordpress/wp-content/uploads/articles/2011/10/012-2008.pdf. html (accessed October 01, 2012).

De, U. K. & Chattopadhyay, M. (2010). Crop diversification by poor peasants and role of infrastructure: Evidence from West Bengal. *Journal of Development and Agricultural Economics, 2*(10), 340-350.

Ghosh, B. K. (2010). Essence of crop diversification: A study of West Bengal agriculture during 1970 – 1971 to 2004 – 2005. *Journal of Development and Agricultural Economics, 2*(11), 368 – 381.

GoB (2013). *Bangladesh economic review* (BER). Economic Adviser's Wing, Finance Divisiona ministry of Finance, Government of the People's Republic of Bangladesh.

Haque, M. A., Miah, M. A. M., Hossain, S. & Alam, M. (2013). Profitability of rose cultivation in some selected areas of Jessore district. *Bangladesh Journal of Agricultural Research. 38*(1), 165 – 174.

Haque, M. A., Moniruzzaman, Rahman, M. S. & Alam, Q. M. (2012). Profitability of hybrid maize (zeamaysl.) seed production under contract farming in Bangladesh: A farm level study. *Bangladesh Journal of Agricultural Research. 37*(2), 327 – 334.

Hoq, M. S., Raha, S. K. & Sultan, N. (2012). Value addition in vegetables production, processing and export from Bangladesh. *Bangladesh Journal of Agricultural Research. 37*(3), 377 – 388.

Husain, A.M.M., Hossain, M., & Janaiah, A., (2001). *Hybrid rice adoption in Bangladesh: Socio-economic assessment of farmers' experiences*. BRAC Research Monograph Series No. 18. BRAC, Dhaka, Bangladesh.

Jha, B., Kumar, N., & Mohanty, B. (2009). *Pattern of agricultural diversification in India.* Working Paper Series No. E/302/2009. Institute of Economic Growth, University of Delhi Enclave North Campus, India .

Joshi , P. K. (2011). *Crop diversification in India: Nature, pattern and drivers.* ADB, Oxford University Press, New Delhi, India, 184 – 217.

Joshi, P. K., Gulati, A. & Cumming Jr. R. (Eds.). (2007). *Agricultural diversification and smallholders in South Asia.* Academic Foundation, New Delhi.

Kabir, M. J. & Islam, M. M. (2012). Study on agronomically and economically dominant cropping patterns in some selected areas of Barisal district. *Bangladesh Journal of Agricultural Research. 37*(1), 55 – 65.

Karim, M. R., Rahman, M. S. & Alam, M. S. (2009). Profitability of summer BARI hybrid tomato cultivation in Jessore district of Bangladesh. *Journal of Agriculture and Rural Development, 7*(1&2), 73 – 79.

Kumari, B.A.P., Thiruchelvam, S. Dissanayake, H.M.H., & Lasantha, T. (2010). Crop diversification and income inequality in irrigation systems: The case of Minipe. *Tropical Agricultural Research, 21*(3), 308 – 320.

Mahmud, W., Rahman, S. S., & Zohir, S. (1994). *Agricultural growth through crop diversification in Bangladesh*. Food Policy in Bangladesh Working Paper No. 7, IFPRI, Washington DC.

Malik, D. P. & Singh, I. J.(2002). Crop diversification - An economic analysis. *Indian Journal of Agricultural Research, 36* (1), 61 – 64.

Mehta, P. K. (2009). *Diversification and horticultural crops: A case of Himachal Pradesh*. Unpublished Phd thesis. Department of economics, university of Mysore, Karnataka, India.

Mesfin, W., Fufa, B. & Haji, J. (2011). Pattern, trend and determinants of crop diversification: Empirical evidence from smallholders in Eastern Ethiopia. *Journal of Economics and Sustainable Development, 2,* (8), 78-89.

Moniruzzaman, Rahman, M. S. Karim M. K. & Alam, Q. M. (2009). Agro-Economic analysis of maize production in Bangladesh: A farm level study. *Bangladesh Journal of Agricultural Research, 34*(1), 15 – 24.

Mukherjee, S. (2012). *Crop diversification and risk: An empirical analysis of Indian states*. http://mpra.ub.uni-muenchen.de/35947/1/MPRA_paper_35947.pdf. html (accessed October 01, 2012).

Mukul, A. Z. A. and Rahman, M. A. (2013). Production and profitability of banana in Bangladesh—an economic analysis. *International Journal of Economics, Finance and Management Sciences, 1*(3), 159 – 165.

Pattanayak, M. & Nayak, B. P. (2003). *Crop diversification in Orissa: A spatio-temporal analysis*. International Economics Division, SIS, Jawaharlal Nehru University Working Paper Series. New Delhi, India. Available at SSRN:http://ssrn.com/abstract=671585

Pingali, P.L., Hossain, M. & Gerpacio, R.V. (1997). *Asian rice bowls— The returning crisis?* CAB International. Wallingford

Rahman, A. (2010). *Promoting financial inclusion for poverty reduction with inclusive growth.* Bazlur Rahman Memorial Lecture, presented at the 17th biennial conference on 'The economy at the golden jubilee of war of liberation: what type of Bangladesh we would like to see?' organized by Bangladesh Economic Association held on 8-10 April at Osmani Memorial Auditorium and Institution of Engineers, Bangladesh Dhaka.

Rahman, S. (2009). The economic determinants of crop diversity on farms in rural Bangladesh. *Journal of International Agricultural Trade and Development, 5*, 51–70.

Siddique, A. B. (2013). *Farmers losing interest in boro*. Dhaka Tribune. 30th July.

Singh, R. B. (2001). *Crop diversification in the Asia-Pacific region*. Address at FAO-RAP seminar, Bangkok, Thailand.

World Bank. (1990). *Agricultural diversification and policies and issues from East Asian Experiences.* Policy and Research Series, Agriculture and rural development department, The World Bank, Washington, DC.

Zohir, S. (1993). Problems and prospects of crop diversification in Bangladesh. *The Bangladesh Development Studies XXII* (3), 73 – 90.