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Measuring the Differences in Cost of Production: A Study on *Boro* Rice Farming in Bangladesh

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Abstract: *Rice farming is a critical issue in sustainable agriculture development in Bangladesh. It is well recognized that production cost has been a major constraint in the profitable farming practices by all types of farmers. The paper reports on an empirical study of the rice farmers' production phenomenon emphasizing on cost based on farm operation. The data stem from a survey of 95 farmers in Jessore District, Bangladesh. To investigate the significant difference of the inputs quantity, their prices and amount spent for necessary production elements, one-way ANOVA method was adopted. The results indicate that the nature of inputs and quantity of them are almost same for all types of farmers but the cost of production is gradually significantly lower for the large category of farmers because farming practices depend on the socio-economic status and purchasing nature of inputs used for cultivation. The small farmers usually use either borrowed money for cultivation or credit for purchasing inputs which leads to increase the cost of production while large farmers deploy their own funds and mainly purchase the inputs by cash which lead to reduction in the cost of production. It argues that for reducing the cost of production increased attention by both the government and non-government organizations are necessary.*

Keywords: *Rice; Farmer; Cost; production; Bangladesh*

Introduction

Despite steady progress towards industrialization, agriculture remains the most important sector in Bangladesh. The agriculture sector contributed 19.9 percent of total GDP in FY11 (BB, 2012). Besides, it has indirect contribution to the overall growth of GDP. Many sectors included in broad service sector such as wholesale and retail trade, hotel and restaurants, transport and communication are strongly supported by the agriculture sector. This sector also provides employment for around 30% of the total labor force and seems to have managed to feed around 160 million people of the country (BBS, 2011). During the last decade, significant changes took place in agriculture sector which includes, among others, new production structure, use of high yielding varieties supported by fertilizers, pesticides, mechanized cultivation, irrigation etc. All these changes have contributed much to the increased production of food grains. The output growth of agriculture sector eased down from the fiscal year 2010 high of 5.2 percent to lower but still strong and above trend of 5 percent growth in fiscal year 2011. This five percent growth was aided by continued policy support from the Government, including subsidy in input prices, adequate supply and timely distribution of key inputs, higher procurement prices of outputs, adequate access to credit and better delivery of extension services (BB, 2012; ADB, 2012).

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Crops dominate the agriculture sector, accounting for about 60% of sector value added. Average growth in the crop sub sector increased from 2% annually during the 1970s and 1980s, to about 3% during the 2000s. Cropping intensity increased from 148% to 181%, which is similar to other South Asian countries, but lower than countries like the People's Republic of China, the Philippines, Thailand and Viet Nam (ADB, 2012).

Rice accounts for about three-fourths of total cultivable land. Production rose more than three-fold from 11 million tons to 35 million tons during fiscal year 1972–2012. Average annual growth increased from 2.8% during the 1980s to 3.5% since fiscal year 1991, largely due to diversification into high-yielding variety rice production technologies (ADB, 2012). Supported by steady input supplies and price deregulation, incremental rice production was mostly driven by expanding irrigated *boro* rice in the dry season and partially displacing production of low yielding, rain-fed aus rice. Rice dominates the cropping pattern in most parts of the country and is grown in three different seasons aus[2], aman[3] and boro[4]. Figure 1 shows the percentages paddy land of local *boro*, HYV *boro* and hybrid *boro* are 3.03, 79.74 and 17.23, respectively.

The figure 2 shows the total cost involved in the cultivation of local *boro*, HYV *boro* and Hybrid *boro*, they were Tk. 19009, 26854 and 33440, respectively. The cost of production of HYV *boro* rice is rather high because of intensively used costly inputs such as irrigation and fertilizer. The constituent of cost of HYV *boro* paddy is shown in figure 3.

The importance of the paddy sector has been recognized by the Government of Bangladesh. Government has been launching a range of development projects and programs in the agriculture sector in the line of National Agriculture Policy (NAP) formulated in 1999 and its revised version in 2010. Also, an action plan is in place for achieving goals and objectives articulated in the NAP. This action plan will assist in building a sustainable food security system by achieving optimum growth in agriculture. The development of agriculture sector is very much urgent for poverty reduction, food security and sustainable development of our country (BBS, 2009; BB, 2012, BBS,

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[2] Premonsoon direct-seeded and transplanted rice crop generally planted in March-April and harvested in July-August. In many places, *aus* is cultivated before *aman* and is thus an alternative to *aman* in deep flood areas. Classifications of *aus*: Local broadcast *aus*, local transplanted *aus*, HYV aus and *pajam aus*.

[3]Generally planted before or during the monsoon season and is either broadcast or transplanted. Broadcast *aman* is direct-seeded, normally in March and transplanted *aman* is generally planted in June-August and harvested in November-January. **Classifications of *aman*:** Local broadcast *aman*, local transplanted *aman*, HYV transplanted *aman* and HYV broadcast *aman*.

[4] The paddy which is planted in mid November to February and reaped in the month of April to June is called *Boro*. There are three types of *Boro* namely-Local *Boro*, High Yielding Variety (HYV) *Boro* and Hybred *Boro*. Presently *Boro* tops the list of paddy production.

Local *Boro* : From time immemorial this type of paddy has been cultivating in our country and is said to be local variety *Boro*. Planting time of this variety is mid November to December and harvesting time is April to May. It gives relatively lower yield rate.

HYV *Boro*: The name HYV has been originated for its high yielding capacity. In the decade of 1960, HYV was introduced and through the pass of time this HYV has been extended very rapidly to meet the demand of the cereals in the market. Time of transplantation of HYV is January to February and reaping time is April to May. It demands adequate irrigation, fertilizer, insecticides and intercultural practices and farmers have to invest more money for the application of these inputs.

Hybred *Boro*: This variety has brought revolutionary change in respect of yield rate. The sowing and harvesting time of Hybred *Boro* is the same as that of HYV. The seeds are very much environment sensitive and farmers cannot preserve the seeds domestically. These are preserved in seeds producing institutions. And farmers have to procure seeds from these institutions.

2012). Despite notable progress, agriculture sector especially in paddy is still characterized by low yields per acre and low labor productivity due to increasing cost of production which is one of the most important concerns of the farmers and government as well (BB, 2012; ADB, 2012). After the green revolution, High Yielding Variety (HYV) boro rice has gained importance, because of its higher yields. The production system dominated by a single crop (i.e. rice) is not scientific from an economic point of view.

Due to conventional cultivation practices in agriculture and rising the price of agricultural inputs increases the cost of production on the one hand and lower prices of the output on the other, many farmers have abandoned paddy cultivation and started cultivating diversified crops rather than rice (BBS, 2009; Rahman, 2012, BBS, 2012). During last few years farmers of Bangladesh have been presuming that cultivation of rice is a losing concern. Farmers engaged in cultivating rice because many of them have not substantial alternative way to subsistence. They can only deploy their own physical labor to their own land which can not be utilized in any other fields of agriculture due to lack of opportunity to use or social status. Even the persons who have small parcel of land think selling physical labor as a disgraceful work especially in agricultural field in Bangladesh which hampers their social status. Another presumption of farmers for the cultivation of rice is they are facing difficulties during the current year and these difficulties will be removed by next year by the favorable cultivation and marketing practices. Production of crops, cost of production of crops and market price of crops are directly interrelated. If selling price is lower than the production cost, producers get loser and discouraged to produce more crops and if procurement price is higher than the production cost, producers get profit and encouragement. This type of loss and profit influences positively or negatively on the cultivation of next year's crops. In case of Bangladesh agriculture, especially rice farmers are passing their rainy days due to not recovering their cost of production. As a result many of the farmers are abandoning paddy cultivation or trending to cultivate cash crops which may cause a great threat to staple food and food security. It is, therefore, necessary to recognize the problem facing by the rural farmer especially in terms of cost of production of rice with a view to ensuring food security, sustainable and balanced development of the nation.

Literature Review

The ownership of agricultural land remains as one of the most difficult problems in the rural economy in Bangladesh. In most villages, few families have enough land to live comfortably, while a large number of families have either no land, or not enough land to support their families (Rahman and Takeda, 2004). It is well recognized that fragmented holdings have been a major constraint in the implementation of improved farming practices by small-scale farmers. A small parcel of land not only acts as a constraint to profitable investment, but also deprives farmers of access to production inputs, formal credit and other institutional services required for improved agricultural practices. As a result, farmers are often forced to continue traditional agricultural practices, which lead to lower productivity (Devendra and Thomas, 2002; Golam and Gopal, 2004; Rahman and Takeda, 2007). Rahman, 2012 states, 'Small farmers are unable to use modern variety efficiently since financial constraints make it difficult for them to purchase inputs such as

fertilizers, pesticides etc. by cash. In Bangladesh, land ownership serves as a surrogate for a large number of factors, as it is a major source of wealth and influences crop production (Rahman, 2000).

In general, pecuniary economies are said to exist when larger farms pay lower prices for their inputs due to lower transaction costs and/or stronger bargaining power, thus lowering their average production cost. And for similar reasons, large farms may receive higher prices for their outputs (Rahman and Takeda, 2006). Large farmers mainly deploy their own money and have easier access to the credit market for cultivation than those of small and medium farmers. Soil Research Development Institute (SRDI), Bangladesh conducted a survey on fertilizer uses and the quality of the fertilizer available in market in 2011-12. The survey found that 40% of the fertilizers are adulterated having lower nutrient elements, for the reason it needs more in quantity for cultivation which increases the cost of production on the one hand and decreases the productivity on the other (Mahmud, 2014). The guideline of Bangladesh Bank (Central Bank) regarding loan disbursement, all the private and nationalized banks are instructed to disburse at least 5% loan to agricultural sector in total loan. But this instruction is not implemented properly, especially private banks are not so much interested to disburse agricultural loan.

For the development of standard of living, creating employment facilities, controlling the price level of daily commodities especially for food items and overall development of agriculture, the government has special attention to agricultural sector and included it in vision 2021 formulated in 2009. As per goals of vision 2021 the government has taken seventeen steps for the development of agriculture, some of the important steps are as follows: (a) reducing the price of fertilizer three times lower than before; (b) introducing rebate for electricity used in irrigation devices; (c) introducing subsidy for purchasing diesel used in irrigation devices; (d) by the 'Farm Mechanization Project', farmers are provided agricultural machineries such as, power tiller, tractor, thresher, weedier etc at 25% reduced rate; (e) ensuring timely distribution of agricultural inputs; (f) innovating agricultural technology and extension etc (Vision 2021).

Since independence in 1971, the government has introduced a revised agricultural policy in varying degrees. As a result, the quantity of production increased regardless of the sizes of land operation. But farmers still have a serious problem, especially regarding the increasing cost involved in production (Azad and Mustafi, 2004; ADB, 2012). Although agricultural mechanization is emerged and government subsidy is increased gradually, production cost has not been reduced compared to earlier period due to unstable price of inputs and output. Seeds, fertilizers, irrigation and labor are the four major inputs that are essential in producing any crop and contribute significantly to the total cost of production. As rice is the main crop, the conditions of production cost incurred in different inputs, the purchasing nature of inputs and sources of production elements influence the cost of production, which has a direct effect on rural subsistence. For example, lower cost of production ensures higher returns thus influencing total income. Rahman (2007, 2012) reports that the rural economy of Bangladesh mostly depends on the farmers' profitability i.e., costs incurred and return earned from rice production. Thus, it is

necessary to recognize the problems exist in current agricultural practices and minimize the constraints for the betterment of vast population.

Objective

The name HYV has been originated for its high yielding capacity. In the decade of 1960, HYV was introduced and through the pass of time this HYV has been extended very rapidly to meet the demand of the cereals in the market (BBS, 2010). It demands adequate irrigation, fertilizer, insecticides and intercultural practices and farmers have to invest more money for the application of these inputs. The vast majority of the studies on agriculture especially rice are associated with biological aspect rather than socio-economic aspects in Bangladesh. However, the need to examine the cost of production within different land operators has been identified (Rahman and Takeda, 2007; Rahman, 2012). Yet, no study has examined the cost of production among farmers in Jessore district. As an attempt to fill this gap, the present study was conducted on farmers operating different size of lands to examine the production cost experienced by the farmers. More specially, the objective of this study is to measure the differences in the costs of production of HYV *boro* rice (HYV *boro* paddy) among farmers' on the basis of the size of land operation in the surveyed area (Jessore district) by considering the nature of inputs purchased, inputs quantity and production elements used.

Study Area, Sample and Methodology

Study Area: Jessore district was established in 1781. The district is situated between 22º48′ and 23º22′ north latitudes and between 88º51′ and 89º34′ east longitudes. The district is bounded on the north by Jhenaidah district, on the east by Magura and Narail district, on the west by India, and on the south by Khulna and Satkhira district. The total area of the district in 2567 squire kilometers of which 23.39 squire kilometers is riverine area. Jessore district constitutes 1.74% of the total area of the country. In respect of area, it ranks 4th among the ten districts of Khulna division and 24th among the 64 districts of the country. The economy of Jessore is predominantly agriculture. Most of farmers in the surveyed area are marginal and in small category, they grow HYV *boro* rice as one of the most important crops shown in the appendix 1. Out of the total 591030 holdings of the district, 63.38% holding are farms that produce varieties of crops, namely rice, wheat, jute, spices, pulses, oilseeds, sugarcane, 35 types of vegetables and other (BBS, 2011).

The study was based on interview of farmers during November to December 2012 for the production in the year of 2012 in Jhikargacha Upazila in the district of Jessore in Bangladesh of HYV *boro* rice (HYV *boro* paddy) cultivation, which started in January/February 2012 and ended in April/May 2012. The study site was 276 kilometers south west of Dhaka and 15 kilometers west of the Jessore district headquarters. The area was selected for study for two major reasons. First, the area bears the common characteristics of the Jessore district comprising different types of farmers producing rice as main crop. Second, so far no attempt has been made to evaluate whether

there exists any difference in the costs of production on the basis of sizes of the farm operation of the various farmers.

Sample Size and Methodology

A total of 95 households shown in Table 1, have been selected randomly from 32729[5] Farmers from Jhikargacha Upazila. The farm household having minimum 0.05 acre of land for HYV boro rice was considered as sample. Data collection has been taken place at the homestead of the household. Usually the respondents are the head of household. Microsoft Office Excel 2003 and SPSS 16.0 version have been used for processing the survey data.

The calculation of the cost of production, i.e., the cost of seeds, fertilizer, pesticide, labor, irrigation, interest on borrowed money and land rental, were calculated using the measurement provided by the Bangladesh Bureau of Statistics (2010). Although depreciation on the fixed assets and maintenance costs are essential for the calculation of the cost of production, they were not mentioned in the BBS calculation. However, in the present study, depreciation and maintenance expenses were considered as per the practical situation in the surveyed area. The price of home made seeds, home made organic fertilizer, family labor, land irrigated by own device and own land used for cultivation have been evaluated as per the local rate and considered in the calculation of the cost of production included with other expenses. To investigate the significant difference of the inputs quantity, their prices and amount spent for necessary production elements, one-way ANOVA method was adopted.

Result and Discussion

General characteristics and land operation: Most of the people of Bangladesh are directly and indirectly involved in agricultural activities for their livelihood. At the very beginning of its independence more than 50% of GDP came from this sector. When industrialization started the activities of the population diversified towards different sectors. As a result, the contribution of the agriculture sector is slowly reducing but till today it plays vital role and is known as the most important sector of the economy. Its importance in poverty reduction is evident from the fact that agriculture is primarily a rural activity and 83% of the country's poor live in rural areas. The rural poverty level cannot be reduced to a desired level excepting increasing productivity of agriculture sector and at the same time it is to be assured that farmers get fair price of the crops. Natural calamity like draught, flood, cyclone, tornado etc. is a very regular phenomenon which hinders the production of agriculture at a great extent. Cultivable land is being decreased by 1% of total land per year due to the pressure of massive population, industrialization, river erosion, and salinity intrusion. As a result, self sufficiency of rice is being threatened and the risk of poor people is getting increased.

[5]According to Agricultural Census 2008 (2011) in Jessore district conducted by BBS, the total number of holdings in Jhikargacha upazila was 48752 in which farm households were 32729. The number of small, medium and large farm households were 25625, 6270 and 834.

In the surveyed area, only males were engaged in farming activities and no group farming/farmers' associations were found in farming activities. In the NAP, government repeatedly emphasizes the importance of farmers' cooperative which has great impact on reducing cost of production, enhancing bargaining power, increasing mutual cooperation and flowing information but no cooperative association or group farming activities are found in the area i.e. individual farming activities among all categories of farmers for purchasing inputs, accumulation of production elements and cultivation practice were the principal characteristic in the area. Rapid population growth and a tradition of bequeathing land to all heirs have led to the fragmentation of holdings. Three types of rice farmers were found in the surveyed villages: own land cultivators, tenant cultivators and owner-cum-tenant cultivators. Share cropping farming system is found, when the land owner bears the cost of irrigation for the cultivation gets half of the production and when the land owner bears no expenses gets one third of the production from the tenant farmers. Both family labor and haired labor are used in cultivation. The emergence of opportunity to become migrant labor in the area causes severe agricultural labor shortage during last ten years. Cultivation is mainly dominated by male; females are somewhat found but they are usually engaged in post harvesting activities. The conventional tools for cultivation such as bull and plough are used but in recently, farmers in Jessore district are gradually applying mechanical tools for cultivation leaving conventional ways. Farmers are using the agricultural inputs on the basis of their previous experience, no standard or guideline is followed here.

Before and after independence, the custom of *Dadon* was found in the area. In this practice marginal and poor farmers used to borrow money for cultivation from the solvent persons/businessmen in exchange of selling all of his products at a predetermined price to the lender soon after harvesting. Farmers knew that the price of product during harvesting period was lower than lean period but they could not keep the product for future market because the farmers who borrowed money had oral commitment to the lender to sell his product to him. During *Dadon* era cost of production was comparatively lower than present days but farmers were suffered by lower price selling the product soon after their harvesting at predetermined price to the money lenders. The custom of *Dadon* is now-a-days rarely found because of government and non-government initiatives. Marginal and poor farmers are facing different types of problems for example, due to having economic constrains these types of farmers usually purchase the agricultural inputs for production by credit rather than cash. Input traders impose higher prices for credit selling which causes increasing the cost of production. Another problem is, these types of farmers are committed to pay the debt to the input traders soon after harvesting. In fact, they are bound to sell their product by lesser prices for mitigating the debt. The marginal and poor farmers are suffering increasing cost of production on the one hand and getting lower prices on the other. But the large and solvent farmers are getting advantages by lowering cost of production on the one hand and having higher prices on the other. Most of the large and solvent farmers are using their own fund by purchasing input in cash which causes lowering the cost of production and these types of farmers are not bound to sell their product immediately after harvesting, keeping the product for the lean period for higher prices.

Appendix 1 shows that number of total holding are 591030, in which farm holdings are 376423 (64%). Most of the farmers (85.79%) in the area have a small parcel of land; they are cultivating both their own land and or tenant land. 9.56% households have no land. HYV *boro* is the main temporary crop in the area.

Different inputs used and their costs: Per acre seeds quantity by farm size of *boro* rice are presented in Table 2. The lowest mean seeds requirement for per acre plantation for 1.00 – 1.49 acre of farm size is found 16.0238 Kilogram and highest mean seeds requirement for per acre for 5.00 – 7.49 acre of farm size is found 18.2222 Kilogram, there are significant differences in using the seeds. In case of chemical fertilizer, significant differences are found in using the TSP and DAP. The Table 2 shows no significant differences in the using of Urea, MoP, Zinc, Gypsum, organic fertilizer, pesticide, labor and irrigation. The minimum, maximum and standard deviation of quantities are shown in Appendix 2 and 3.

Table 3 shows the differences of cost of inputs by farm size. No significant differences are found in case of gypsum, organic fertilizer and pesticide but there are significant differences in the costs of seeds, urea, TSP, MoP, Zinc, DAP, labour and irrigation. Here in most cases, cost gradually decreased for the larger farmers i.e. farm size and costs of input have negative correlation. The costs of inputs for small farmers are higher than those of large farmers. Obviously purchasing nature of the inputs influences the cost of each element. Most of the small farmers used credit purchasing inputs rather than cash purchasing inputs which directly increase their unit prices. In the surveyed area inputs are being sold either by cash or credit or both. Credit purchasing price is higher than cash price because sellers argue that there are risks associated with this types of selling. But the farmers who have substantial portion of lands have easier access to credit market and these types of farmers invest their own money for purchasing the inputs which reduces the cost of each input. Another feature of the reduced costs of inputs for the large farmers is, they mainly purchase the inputs at a large quantity at a time gaining wholesaling rate. It is common phenomenon that wholesaling price is lower than retailing price. The Table 2 shows subtle significant differences in some cases in the use of inputs but Table 3 shows in most cases, costs of these inputs are significantly differed. The minimum, maximum and standard deviation of costs are shown in Appendix 4 and 5.

Cost of land preparation, land rental, transportation and miscellaneous: In the surveyed area, contractual power tiller and tractor are mainly used for land preparation. Conventional plough and ox are also used for cultivation but it is more costly than power tiller/tractor. Here miscellaneous cost includes the cost for cleaning of paddy after thrashing and any other related cost not included in planting, weeding, harvesting thrashing etc. and interest on working capital. Table 4 shows no significant differences among the different landholders in case of transportation cost but there are significant differences in case of land preparation, land rental and miscellaneous cost. The table shows that in most cases large farm holders paid less money compared to small land holders. This scenario is must be stated as a reason of higher bargaining capacity and deploying own money by the large farmers compared to the small farmers. The minimum, maximum and standard deviation of costs are shown in Appendix 6.

Total Cost of Production: Total cost of production comprises the cost of seeds, Urea, TSP, MoP, Zinc, DAP, Gypsum, Organic fertilizer, pesticide, labor, irrigation, land preparation, land rental, transportation and miscellaneous. Table 5 shows the cost of production of HYV *boro* rice is gradually lower from small land holders to large holders (0.05 – 0.49, X = 43536; 0.50 – 0.99, X = 45067; 1.00 – 1.49, X = 44826; 1.50 – 2.49, X = 43038; 2.50 – 4.99, X = 41255; 5.00 – 7.49, X = 40563; ≥7.50, X = 39490). The significant differences of the cost of production among the land holders is due to purchasing nature of inputs and deploying the nature of fund for the cultivation. The minimum, maximum and standard deviation of costs are shown in Appendix 7.

Conclusion

Bangladesh has achieved self-sufficiency in rice production in spite of its very high population density, very meager land-man ratio and a process of shrinkage of cultivable land. In Bangladesh rice production in 1972 was only 11 million tons and it has increased more than threefold to about 35 million tons in 2012. The alarming situation is existed in production especially higher cost incurred. The cost of production is gradually increasing every year but farmers are not getting fair prices from their product. The prices of fertilizers and fuel have risen continuously and steeply in recent years, but the prices of farm products have not kept pace. This deteriorating input-to-output ratio for all crops decreases farmers' profitability. As a result, for next season, farmers cannot afford to use fertilizers and improved hybrid quality seeds to increase yield. As most of the farmers in the areas are marginal and small category, their existence in the economy is one of the most burning questions. The following measures might be taken for the farmers which can ultimately affect food security and sustainable development.

Although Government of Bangladesh is extending the subsidy programs for the betterment of the marginal and poor farmers by agricultural inputs, monitoring activities should be emphasized whether the real needy farmers is getting the subsidy. Cooperative society plays a vital role for the development of agriculture, in this perspective cooperative society might be formed by the initiative of GO and NGO where farmers' leadership should be ensured. GO and NGO might take initiative for the marginal and small farmers to access the institutional agricultural credit market with easier terms and conditions. Agricultural extension activities should be enhanced where farmers would be introduced with the new technology and proper use of inputs.

Scope for further study

Despite notable progress, agriculture sector is still characterized by low yields per hectare and low labor productivity. The main challenges of Bangladesh agriculture are: intrusion of salinity, land erosion, depletion of land to river/sea, lack of crops diversification, decreasing land by the emergence of high population growth, urbanization and industrialization, conventional agricultural practices, adulteration of fertilizer and seeds, inadequate extension activities, lack of cooperative or group farming activity, marketing problems etc. This study only highlights the cost of production of only one crop, *boro* rice. It is important to know the returns of the farmers by their cultivation. Therefore, to know in depth about the profitability of the farmer, not only production aspect but also marketing phenomenon of produced goods should also be studied intensively.

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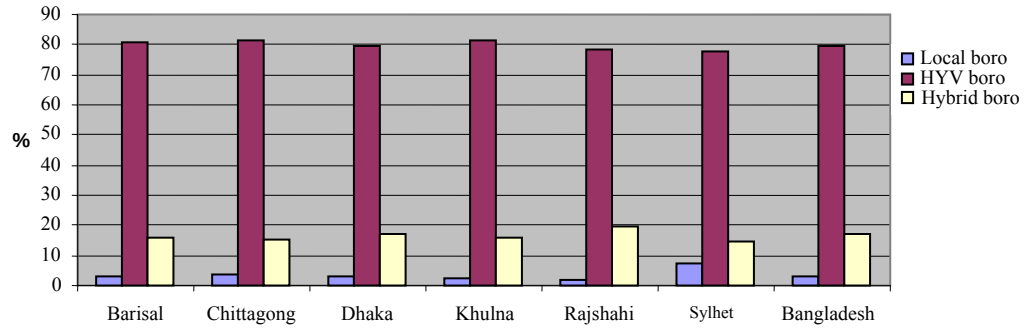
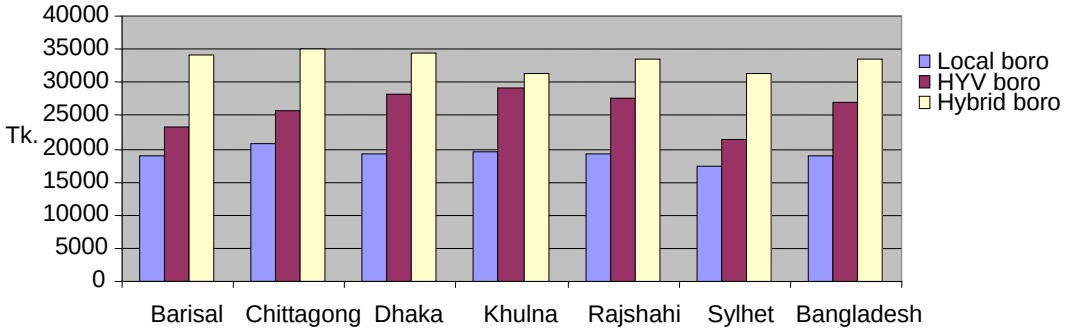
Figure 1: Percentage of area of boro cultivation

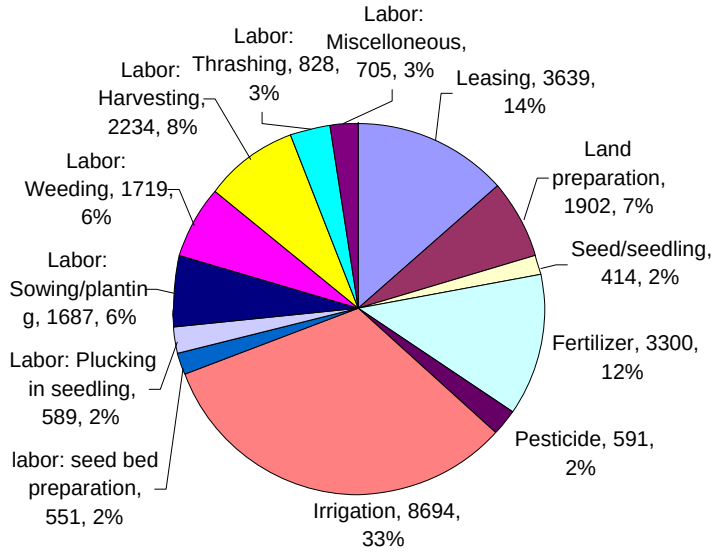


Source: Report on the cost of production of boro 2008-09 (2010)

Figure 2: Per arce production cost of boro paddy



Source: Report on the cost of production of boro 2008-09 (2010)



Source: Report on the cost of production of boro 2008-09 (2010)

Table 1. Numbers and Percentages of Usable Respondents

Farm Size (Acre)	Number	Percentage
0.05 – 0.49	7	7.37
0.50 – 0.99	12	12.63
1.00 – 1.49	21	22.11
1.50 – 2.49	24	25.26
2.50 – 4.99	17	17.89
5.00 – 7.49	9	9.47
≥7.50	5	5.26

Source: Field survey, September – October, 2012

Total farmer – 95. Farmers having cultivated area up to 0.04 acre are considered non-farm holdings. According to BBS, farmers having 0.05 – 2.49, 2.50 – 7.49 and ≥7.50 acre of land are in the category of small, medium and large farmers respectively.

Table 2. Differences of Inputs (Quantity) Used for One Acre of Land Based on Farm Size (One-way ANOVA)

Inputs	Farm Size (Acre)							*P*
	0.05 – 0.49 n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5	
Seeds (Kg)	16.4286	17.2500	16.0238	17.7500	16.4118	18.2222	17.6000	0.002[a]
Chemical Fertilizer (Kg):								
Urea	85.7143	85.4167	88.1905	83.8750	82.9412	86.7778	84.2000	0.117
TSP	31.8571	28.2500	33.6667	29.3333	31.5882	34.5556	34.0000	0.001[a]
MoP	27.5714	29.8333	29.3333	29.0417	29.2941	29.0000	30.8000	0.196
Zinc	4.1429	3.9167	3.8810	3.6417	3.7647	4.2222	4.0000	0.774
DAP	67.1429	69.5833	62.8571	70.0833	71.8824	66.5556	62.2000	0.001[a]
Gypsum	33.2857	33.5000	30.5238	33.7500	35.5294	36.4444	34.4000	0.151
Organic Fertilizer (Kg)	568.7512 (4)	587.5547 (8)	569.1222 (16)	616.6793 (12)	550.0678 (13)	572.2245	600.4576	0.728
Pesticide (Kg)	3.9286	4.1250	4.1952	4.0792	4.1765	4.0000	3.9000	0.971
Labor (Man day)	72.5714	74.3333	76.5238	73.7917	72.6471	72.4444	71.2000	0.114
Irrigation (Hour)	131.7113	127.8343	132.5256	126.6766	126.2444	131.2278	133.2006	0.488

Source: Field survey, September – October, 2012.

[a] Denotes mean difference is significant at the 0.05 level.

In case of organic fertilizer, the figures inside the bracket indicate the number of farmers used that fertilizer to their cultivated land.

In the first part of the crop season weather remains dry and at the growing stage of the plants seldom rain fall occurs. So, surface or under ground water is applied to the paddy plants by mechanical system which are run by electricity or diesel.

Table 3. Differences of Cost of Inputs (Tk) for One Acre of Land Based on Farm Size (One-way ANOVA)

Inputs	Farm Size (Acre)							*P*
	0.05 – 0.49 n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5	
Seeds	738.8634	774.1721	714.0067	789.7176	712.1245	732.4493	701.0012	0.002 [a]
Chemical Fertilizer:								
Urea	1891.3223	1841.7411	1898.0946	1812.6562	1759.6468	1686.2708	1619.0903	0.000 [a]
TSP	793.1434	689.8333	822.8605	719.1274	731.7116	719.4402	701.0068	0.012 [a]
MoP	420.7113	444.6716	458.1076	460.2145	428.1887	392.4480	397.2004	0.002 [a]
Zinc	570.5712	486.0887	557.7122	518.6224	431.0066	361.3358	325.8017	0.001 [a]
DAP	2031.3356	2142.1007	1926.5906	2137.2347	2113.9194	1816.1653	1699.2458	0.000 [a]
Gypsum	256.7132	225.5885	224.0506	228.2945	208.4163	191.3333	173.8009	0.124
Organic Fertilizer	1849.5307 (4)	1748.5453 (8)	1899.0305 (16)	2150.0069 (12)	1887.4110 (13)	1895.6334	2073.4344	0.322
Pesticide	607.5734	630.1716	546.7118	582.2167	573.4749	555.8903	513.6002	0.411
Labor	11308.0012	11954.1256	12320.7564	11795.3460	11897.3461	11708.6340	11268.2373	0.055 [a]
Irrigation	11931.2357	12127.4444	11782.0980	10605.0336	9357.6712	9188.3003	8744.6305	0.000 [a]

Source: Field survey, September – October, 2012.

[a] Denotes mean difference is significant at the 0.05 level.

In case of organic fertilizer, the figures inside the bracket indicate the number of farmers used that fertilizer to their cultivated land.

Table 4. Differences of Cost (Tk.) of Land Preparation, Land Rental, Transportation and Miscellaneous for One Acre of Land Based on Farm Size (One-way ANOVA)

Items	Farm Size (Acre)							*P*
	0.05 – 0.49 n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5	
Land preparation	2224.3345	2154.3871	2128.8123	2202.1543	2158.4098	2121.7044	2100.0764	0.004 [a]
Land rental	8642.9346	9391.7907	8931.2875	8912.5642	8458.6678	8144.4123	8034.0546	0.000 [a]
Transportation	339.5712	313.9207	385.2434	351.1276	295.3535	324.8909	292.2007	0.123
Miscellaneous	723.4313	727.0055	683.9004	849.9668	686.2913	725.7843	847.4037	0.032 [a]

Source: Field survey, September – October, 2012.

[a] Denotes mean difference is significant at the 0.05 level. Contractual Power tiller and tractor are mainly used for land preparation. Conventional plough and ox are also used for cultivation but it is more costly than power tiller/tractor.

Here miscellaneous cost includes the cost for cleaning of paddy after thrashing and any other related cost not included in planting, weeding, harvesting thrashing etc. and interest on working capital.

Table 5. Differences of Total Cost of Production (Tk.) for One Acre of Land Based on Farm Size (One-way ANOVA)

Item	Farm Size (Acre)							*P*
	0.05 – 0.49 n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5	
Total Cost of Production	43536.00	45067.00	44826.00	43038.00	41255.00	40563.00	39490.00	0.000 [a]

Source: Field survey, September – October 2012.

[a] Denotes mean difference is significant at the 0.05 level.

Appindix 1: Basic Information of Jessore District

	Area in Acres		
Particulars	**Total**	**Rural**	**Urban**
Number of holdings:			
Total	591030	551280	39750
Non-farm	216407	179156	37251
Farm	376423	372124	2499
Percent of holdings (%):			
Total farm holdings	63.38	67.50	6.29
Small farm	85.79	85.75	92.32
Medium farm	13.29	13.33	6.68
Large farm	0.92	0.92	1.00
Holding owning no land	9.56	7.35	40.19
Tenancy (All holdings):			
Owner holding: Number	375892	352567	23325
Owner holding: Percentage of all holdings	63.60	63.95	58.68
Owner-cum-tenant holding: Number	158654	158206	448
Owner-cum-tenant holding: Percentage of all holdings	26.84	28.70	1.13
Tenant holding: Number	56484	40507	15977
Tenant holding: Percentage of all holdings	9.56	7.35	40.19
Operated area[6]:			
Operated area of all holdings	522095	517418	4677
Average operated area per holding	0.88	0.94	0.12
Operated area of all farm holdings	505529	502914	2615
Average operated area per farm holding	1.35	1.35	1.05
Owned area[7]:			
Owned area of all holdings	497237	487074	10162
Average owned area per holding	0.84	0.88	0.26
Average owned area per non-farm household	0.14	0.14	0.18
Average owned area per farm holding	1.24	1.24	1.42
Net cultivated area[8]:			
Net cropped area of farm holdings	430870	428892	1979
Average cropped area per farm holding	1.15	1.15	0.79
Temporary crops net area of farm holdings	370203	368897	1306
Temporary crops net area per farm holding	0.99	0.99	0.52
Boro Culitvation:			
Local	29475	29319	156
HYV	163668	163307	362
Hybrid	75579	75364	213

Source: Basic Information of Jessore Zila Census of Agriculture – 2008 (2011)

[6] Total operated area equals area owned plus area taken from others minus owned area given to others. Operated area also includes uncultivated land including homestead.

[7] Owned land means the land owned by holder including members of his/her family having a little to the land with right to determine nature and extent of its use and to transfer the same.

[8] This is land area actually cropped during the census year regardless of number of crops grown plus current fallow. It includes area under temporary and permanent crops and also current fallow.

Appendix 2. Minimum, Maximum and Standard Deviation of Inputs Used for One Acre of Land Based on Farm Size.

Inputs	Farm Size (Acre)						
	0.05 – 0.49, n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5
Seeds (Kg):							
Minimum	15.00	15.00	15.00	15.00	15.00	16.00	16.00
Maximum	18.00	20.00	19.00	20.00	20.00	20.00	19.00
Standard deviation	1.2724	1.8153	1.3645	1.7507	1.7341	1.5634	1.1401
Urea:							
Minimum	80.00	80.00	80.00	80.00	80.00	80.00	80.00
Maximum	100.00	95.00	100.00	95.00	95.00	97.00	90.00
Standard deviation	7.8679	6.2005	6.0714	4.8750	4.6966	6.5341	5.3103
TSP:							
Minimum	25.00	25.00	24.00	24.00	24.00	25.00	28.00
Maximum	38.00	35.00	40.00	36.00	38.00	40.00	40.00
Standard deviation	4.8795	3.1370	4.7993	4.2289	4.6105	4.1264	4.4158
MoP:							
Minimum	24.00	27.00	26.00	24.00	24.00	24.00	30.00
Maximum	30.00	35.00	32.00	32.00	34.00	30.00	34.00
Standard deviation	3.0472	2.0816	1.6832	1.9444	2.2012	2.1213	1.7888
Zinc:							
Minimum	3.00	3.00	3.00	2.00	2.00	2.00	3.00
Maximum	5.00	5.00	5.00	5.00	6.00	6.00	5.00
Standard deviation	0.8997	0.7929	0.7567	0.8865	1.3004	1.3017	1.0000
DAP:							
Minimum	60.00	55.00	52.00	53.00	50.00	50.00	60.00
Maximum	70.00	90.00	70.00	85.00	91.00	70.00	65.00
Standard deviation	4.8795	8.2070	5.6682	5.1828	9.4596	6.6916	1.9235
Gypsum:							
Minimum	28.00	28.00	26.00	18.00	18.00	26.00	32.00
Maximum	40.00	40.00	40.00	45.00	49.00	43.00	36.00
Standard deviation	4.7858	4.9817	4.2850	6.4487	8.4935	4.6666	1.5165

Appendix 3. Minimum, Maximum and Standard Deviation of Inputs Used for One Acre of Land Based on Farm Size

Inputs	Farm Size (Acre)						
	0.05 – 0.49, n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5
Organic Fertilizer (Kg):							
Minimum	550.00	400.00	500.00	450.00	300.00	450.00	500.00
Maximum	600.00	750.00	700.00	750.00	750.00	700.00	700.00
Standard deviation	23.9356 (4)	112.5991 (8)	50.7173 (16)	83.4847 (12)	150.0000 (13)	79.4949	79.0569
Pesticide (Kg):							
Minimum	3.00	3.50	3.00	3.00	2.00	2.50	3.00
Maximum	6.00	5.00	6.00	5.00	6.00	6.50	5.00
Standard deviation	1.01770	0.43301	0.60455	0.56181	1.13111	1.08972	0.74162
Labor (Man day):							
Minimum	65.00	60.00	70.00	60.00	64.00	66.00	66.00
Maximum	80.00	85.00	85.00	82.00	85.00	75.00	75.00
Standard deviation	5.1269	6.0802	3.7097	5.1328	5.1105	3.1666	3.8340
Irrigation(Hour):							
Minimum	120.00	118.00	101.00	95.00	95.00	112.00	120.00
Maximum	145.00	138.00	146.00	146.00	152.00	152.00	145.00
Standard deviation	8.1795	6.9522	10.3325	10.7366	15.9198	12.7747	10.4259

In case of organic fertilizer, the figures inside the bracket indicate the number of farmers used that fertilizer to their cultivated land.

Appendix 4. Minimum, Maximum and Standard Deviation of Cost of Inputs (Tk.) Used for One Acre of Land Based on Farm Size

Inputs	Farm Size (Acre)						
	0.05 – 0.49 n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5
Seeds:							
Minimum	666.00	674.00	576.00	675.00	593.00	640.00	648.00
Maximum	811.00	888.00	856.00	900.00	806.00	800.00	741.00
Standard deviation	58.9786	71.7518	78.0141	71.9616	57.7666	64.4362	37.1685
Urea:							
Minimum	1762.00	1600.00	1658.00	1520.00	1520.00	1535.00	1520.00
Maximum	2207.00	2095.00	2200.00	2068.00	2090.00	1900.00	1733.00
Standard deviation	173.4836	167.6757	136.7839	117.0710	138.2448	136.0595	103.6990
TSP:							
Minimum	630.00	550.00	576.00	525.00	552.00	525.00	588.00
Maximum	950.00	870.00	982.00	981.00	875.00	803.00	812.00
Standard deviation	124.9699	87.9791	126.4497	111.8093	115.1785	81.2159	87.7781
MoP:							
Minimum	355.00	398.00	365.00	360.00	352.00	324.00	380.00
Maximum	495.00	499.00	589.00	600.00	544.00	485.00	434.00
Standard deviation	59.5866	28.8801	53.3515	51.3352	47.8568	41.1828	21.4406
Zinc:							
Minimum	350.00	377.00	303.00	306.00	207.00	189.00	265.00
Maximum	744.00	700.00	997.00	780.00	788.00	543.00	365.00
Standard deviation	143.0755	102.3740	166.8478	132.8856	181.5213	116.4270	37.3189
DAP:							
Minimum	1620.00	1678.00	1451.00	1645.00	1576.00	1354.00	1634.00
Maximum	2170.00	2768.00	2177.00	2632.00	2798.00	2012.00	1755.00
Standard deviation	211.0440	254.2677	178.7662	189.8608	306.3212	194.2752	51.1047
Gypsum:							
Minimum	140.00	145.00	156.00	115.00	99.00	133.00	160.00
Maximum	508.00	272.00	387.00	294.00	288.00	216.00	183.00
Standard deviation	118.3521	42.7816	50.7271	51.3627	56.3693	24.3669	8.4380

Appendix 5. Minimum, Maximum and Standard Deviation of Cost of Inputs (Tk.) Used for One Acre of Land Based on Farm Size

Inputs	Farm Size (Acre)						
	0.05 – 0.49, n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5
Organic Fertilizer:							
Minimum	1655.00 (4)	1259.00 (8)	1789.00 (16)	1368.00 (12)	914.00 (13)	1238.00	1515.00
Maximum	2200.00 (4)	2256.00 (8)	2526.00 (16)	2876.00 (12)	2777.00 (13)	2566.00	2618.00
Standard deviation	243.0178 (4)	288.5144 (8)	173.9452 (16)	458.5964 (12)	475.0821 (13)	454.5968	408.1908
Pesticide:							
Minimum	455.00	482.00	433.00	375.00	365.00	377.00	378.00
Maximum	945.00	800.00	913.00	734.00	845.00	943.00	632.00
Standard deviation	163.9947	84.8622	108.8283	88.7737	137.9629	158.8587	90.2900
Labor:							
Minimum	10400.00	9600.00	11046.00	9599.00	10246.00	10500.00	10235.00
Maximum	13200.00	13660.00	12878.00	13280.00	13121.00	12775.00	12755.00
Standard deviation	1011.6904	1016.0606	595.5816	836.3466	724.1410	937.0363	929.4557
Irrigation::							
Minimum	9750.00	11040.00	9090.00	8412.00	6886.00	7843.00	7569.00
Maximum	13775.00	13015.00	15087.00	13252.00	11815.00	10828.00	10177.00
Standard deviation	1598.4524	623.0583	1372.9583	1382.5482	1232.2798	896.0693	1011.6329

In case of organic fertilizer, the figures inside the bracket indicate the number of farmers used that fertilizer to their cultivated land.

Appendix 6. Minimum, Maximum and Standard Deviation (Tk.) of Land Preparation, Land Rental, Transportation and Miscellaneous for One Acre of Land Based on Farm Size

Inputs	**Farm Size (Acre)**						
	0.05 – 0.49, n = 7	0.50 – 0.99 n = 12	1.00 – 1.49 n = 21	1.50 – 2.49 n = 24	2.50 – 4.99 n = 17	5.00 – 7.49 n = 9	≥7.50 n = 5
Land preparation:							
Minimum	2150.00	1966.00	1945.00	2000.00	1888.00	2015.00	2050.00
Maximum	2350.00	2400.00	2200.00	2400.00	2200.00	2200.00	2150.00
Standard deviation	65.5380	130.0372	58.9838	68.3328	83.4663	55.4526	35.3553
Land rental:							
Minimum	7500.00	8500.00	7000.00	7500.00	7000.00	7500.00	7500.00
Maximum	9000.00	11000.00	10050.00	10000.00	10000.00	9000.00	9570.00
Standard deviation	556.3486	811.7974	657.3578	579.5894	809.3661	557.0258	897.0953
Transportation:							
Minimum	250.00	140.00	245.00	230.00	150.00	230.00	250.00
Maximum	475.00	745.00	512.00	654.00	434.00	533.00	325.00
Standard deviation	73.6859	147.8275	74.5170	114.1007	77.2212	94.7937	30.1695
Miscellaneous:							
Minimum	600.00	403.00	450.00	432.00	457.00	598.00	700.00
Maximum	840.00	1170.00	933.00	1426.00	1100.00	850.00	940.00
Standard deviation	86.5753	217.7312	99.3589	244.8059	185.3354	86.3868	100.7089

Appendix 7. Minimum, Maximum and Standard Deviation (Tk.) of Total Cost of Production for One Acre of Land Based on Farm Size

Item	**Farm Size (Acre)**						
	0.05–0.49, n = 7	0.50–0.99 n = 12	1.00–1.49 n = 21	1.50–2.49 n = 24	2.50–4.99 n = 17	5.00–7.49 n = 9	≥7.50 n = 5
Total Cost of Production:							
Minimum	41232.00	43010.00	40237.00	38542.00	36799.00	38445.00	38233.00
Maximum	45726.00	46824.00	46759.00	46923.00	45618.00	43633.00	40230.00
Standard deviation	1609.6770	1366.0187	1781.8590	2061.1780	2456.5081	1649.3282	927.3913