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GROWING POPULARITY OF MAIZE CULTIVATION IN RANGPUR DISTRICT OF BANGLADESH: AN EVIDENCE FROM GANGACHARA UPAZILA

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ABSTRACT
Maize cultivation has been gaining popularly in the rangpur district of Bangladesh in recent years. The study is mainly an attempt to explore the reasons for the growing popularity of maize cultivation in the Gangachara upazila (Sub-district) of Rangpur district. It also examines the future viability of maize cultivation in this area. For data collection, three-stage cluster sampling method has been used to determine the setting of the study selecting 110 farmers who have been involving themselves in maize cultivation for at least ten years, by replacing traditional crops like tobacco and boro rice. Benefit-cost (ratio) analysis is carried out in the study for its purpose and it is found that the cultivation of maize is more profitable than that of boro rice and tobacco. Furthermore, water table data analysis in the study also reveals that the ground water level is depleting in the study area in rabi season and causing groundwater scarcity. Therefore, it would be viable to cultivate maize in the near future at the backdrop of the scarcity of the ground water as maize is less water-intensive crop than other traditional crops grown in this region.

KEY WORDS
Maize, crop diversification, cost- benefit ratio, water table, groundwater.

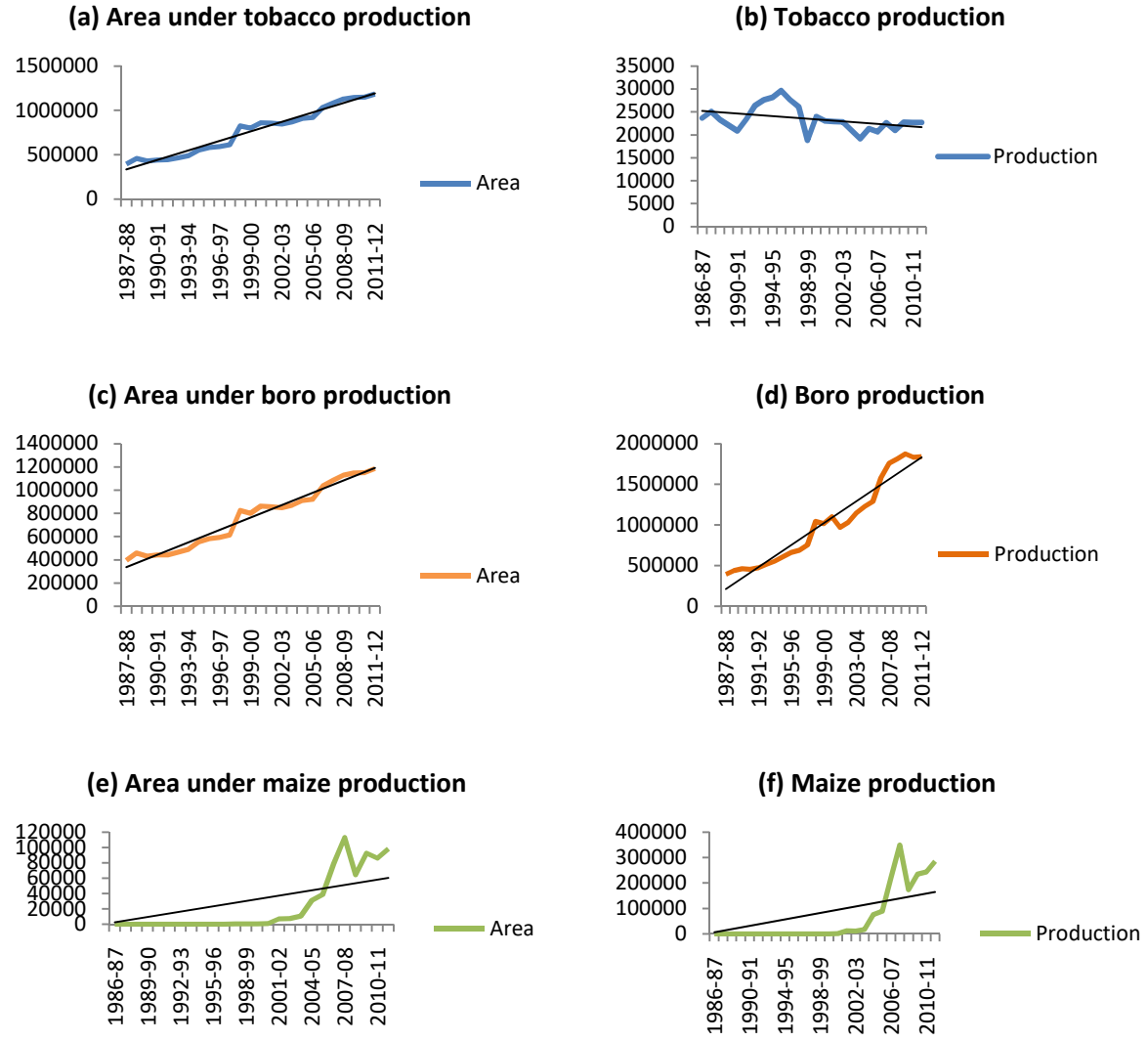
The replacement of traditional crops with the new profitable one is no longer a new phenomenon in the agricultural sector of Bangladesh. In this process, farmers tend to switch to a new profitable crop from their traditional crops and maize is such one of these switched crops, which is pivotal of this study. The cultivation of maize is gaining popularity among the farmers in the Rangpur district of Bangladesh. Both the area of cultivation and production of maize are increasing gradually because of its huge market demand for poultry, fish feed industry, bakery as well as other human consumer products. Maize provides food, feed, and fuel in rural areas of Bangladesh (OXFAM, 2013) and hence is creating its own demand.

According to Karim (1992), “Calorie yield per hectare of maize is one of the highest and cost per 1000 Calories from maize is one of the lowest among the crops”.

Moniruzzaman et al .(2009) calculate the Benefit-cost ratios of maize cultivation in the major maize growing areas, namely Chuadanga, Dinajpur, Bogra, and Lalmonirat districts of Bangladesh during 2006-2007 to know the profitability level of maize production and finally, the study finds that maize cultivation is more profitable than other existing crops. Moreover, some recent studies conducted by (Ali et al., 2009; Hasan, 2008; Karim et al., 2010 and Mohiuddin et al, 2007) show that the cultivation of maize is increasing, being more profitable than other crops such as boro rice, wheat and so on. But, so far, there is probably, no quantitative study behind the growing maize cultivation in Rangpur District, particularly at

Gangachara upazila. For this reason, the study tries to fill the said gap. The main objective of the study is to explore the reasons for the growing popularity of maize cultivation in this area.

Overview of boro, tobacco, and maize production in Rangpur district. Boro rice is the most important and single largest crop in Bangladesh with respect to the volume of production and is transplanted in the winter season (December to February). Boro rice contributes to more than 55% to the total rice production during 2008-09 and its yield depends on a considerable part of irrigation and fertilizer management practices (Basak, 2011).



Source: Various issues of Yearbook of Agricultural Statistics of Bangladesh, 1990-2012.

Figure 1 – Area (in Acre) and Production (in MT) of tobacco, boro rice, and maize respectively in Rangpur district

Tobacco is a non-food crop and its cultivation requires a huge amount of fertilizers, pesticides, seeds, irrigation water and labor. Tobacco cultivation has been being introduced into the cropland of Testa-silt in Rangpur district since the mid-sixties of the past century and has been pushed by a multinational company named British American Tobacco and some local companies after the liberation of Bangladesh (Sarkar and Haque, 2001).

In contrast to boro rice and tobacco, maize is a food grain, which is a year-round crop. In Bangladesh, maize is cultivated mostly in rabi[1] and kharif-1[2] season. The production of maize doesn't require an extensive amount of water as is required for boro rice and tobacco production. But, quality of maize production, rather, requires the best quality of seeds and an appropriate amount of fertilizers at the right time.

To get an insight into the production scenario of boro rice, tobacco, and maize in the Rangpur district, secondary data for FY 1987-88 to 2011-12 are collected from the Bangladesh Bureau of Statistics (BBS) and analyzed. It is found that both the cultivated area and production for boro rice are in overall increasing trend over the time period [Figure-1 (c & d)]. As boro rice is a staple food of our country and so production and area are quite large in comparison to other crops. High-yield varieties seeds, availability of fertilizers, underground irrigation system, pesticides as well as new machinery have brought revolutionary change in boro production.

Despite Rangpur district is a drought- prone area, irrigation water supply from Barind Multipurpose Development Authority (BMDA) and application of deep tube well to bore water have made it possible to produce a huge amount of boro rice. At the same time, a production boom in maize has also been observed since the start of the new century [Figure 1e,f]. From 2000 to till now, both production and cultivation areas of maize have shown an overall increasing trend. On the other hand, areas under tobacco production have found to be increased over the period but its production has remained almost the same over the same period [Figure 1a,b] due to, perhaps, loss of soil fertility.

Similarly, for Gangachara upazila, it is found that the cultivation area of maize production stood at 3,200 acres, with an increase of 6% in FY2010-11, which was 3000 acres in 2009-10 while the production increased to 6,400 MT from 6,000 MT, 6% more than in the previous fiscal year. In the case of tobacco, the area of cultivation arrived at 13300 acres from 13250 acres with an increase in only around 0.4% increase while production reached to 7692MT with an increase in only around 1% from FY 2009-10 to FY 2010-11. And for boro rice, the production increased to 47800 MT with an increase of around 10% and the cultivation land is increased by only about 2% in FY 2010-09, compared to the previous fiscal year. It indicates that the cultivation of maize is gaining ground in this area (Based on Rangpur district Statistics, 2011).

MATERIALS AND METHODS OF RESEARCH

Selection of study area, sampling design, and data collection. Gangachara upazila of Rangpur district is selected as the study area, which is reputed for its tobacco cultivation for long. The upazila consists of 10 union parishads[3], 92 mouzas[4], and 128 villages. The total cultivable land in the study area is 38598 acres. Apart from maize, rice, tobacco, potato, and other vegetables are the main crops of the area. However, it is known that many farmers in that area have replaced their important traditional crops (i.e. tobacco, boro rice) with maize.

Keeping this view in mind, to examine the reasons for the increasing popularity of maize cultivation, the study is mainly carried out based on primary data with a sample size of 110 maize farmers. For selecting the farmers, three-stage random sampling is used in it. In its first stage, from among 10 (ten) union parisads (UPs), 2(two) UPs are selected randomly. From the selected UPs, in the second stage, 3 villages are randomly selected. And from those selected villages, a sampling list of 200 farmers, who have been cultivating maize by replacing boro rice and tobacco for at least ten years, is formed. Finally, from the sampling list, a total of 110 farmers are selected randomly for face to face interview from 15 to 25 November 2015 through a pre-designed semi-structured interview schedule.

In the study, the total production cost of maize per 25 decimal of land (locally known as

[1] *Winter/dry season, typically spanned along mid-October through mid-March.*
[2] *Summer or wet or rainy season, conventionally spread over the period of mid-April to mid-October.*
[3] *Union Parishad is the smallest administrative rural geographic unit comprising of mauzas and villages and having union parishad institution.*
[4] *Mauza is the lowest administrative unit having a separate jurisdiction list number (J.L. number.) in revenue records.*

don, which is a unit of measurement of land) and selling price of produced maize from that 25 decimal are collected from the 110 sampled farmers for the year 2005, 2010 and 2015. And finally, the arithmetic mean value of total production cost of maize and their selling price is taken. On the other hand, two FGDs are conducted separately to find out the average total cost of boro rice and tobacco production for 25 decimal of land and their selling prices from that 25 decimal are collected for the year 2005, 2010 and 2015. Each FGD has contained 15 farmers who involved in boro rice and tobacco cultivation for long. Furthermore, secondary data are collected from different research reports; journal articles and the published books to achieve the study objectives.

Analytical Framework. For the study, the general form of the benefit-cost ratio is used. In determining the cost, the total production cost is considered while net return is as the benefit. The cost of labor (own and hired), fertilizer, land preparation, irrigation, pesticide, land rent, and threshing per acre[5] of land are considered in calculating total production costs. To do the benefit-cost ratio analysis, the following formulas are considered:

$$\textit{Total cost} = \textit{Cost of Labor} + \textit{Cost of Fertilizer} + \textit{Cost of Land Preparation} + \textit{Cost of Irrigation} + \textit{Cost of Pesticide} + \textit{Cost of Land Rent} + \textit{Cost of Threshing}$$

$$\textit{Total Revenue} = \textit{Selling Price} * \textit{Production}$$

$$\textit{Total Benefit} = \textit{Total Revenue} - \textit{Total Cost}$$

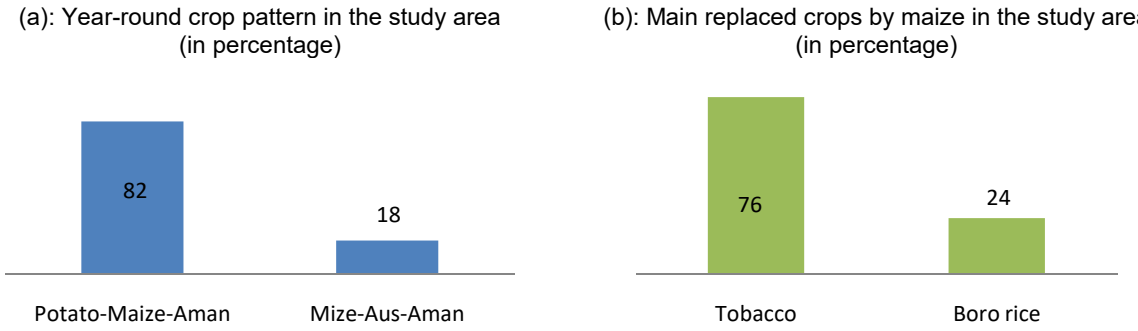
$$\textit{Benefit-Cost Ratio} = \frac{Total\ Benefit}{Total\ Cost}$$

RESULTS AND DISCUSSION

Descriptive Analysis:

Cropping pattern in the study Area. From the interview, it is observed that farmers are very careful in the selection of their round crops so that they can be able to get the maximum benefit. In the study area, two types of crop pattern are found and they are Potato-Maize-Aman and Maize-Aus[6]-Aman[7]. Potato-Maize-Aman crop pattern is found to be the most popular among the farmers as it is reported by about 82% of the respondents, because Potato-Maize-Aman crop pattern is economically beneficial which, requires less land, less organic fertilizer and plow as well. Maize-Aus-Aman crop pattern is followed by the rest of the 18% [Figure 2a].

Tobacco is found to be the major replaced crop by maize which is reported by 76% respondents. On the other hand, 26 respondents (24%) report that they have replaced Boro rice with Maize [see Figure 2b].

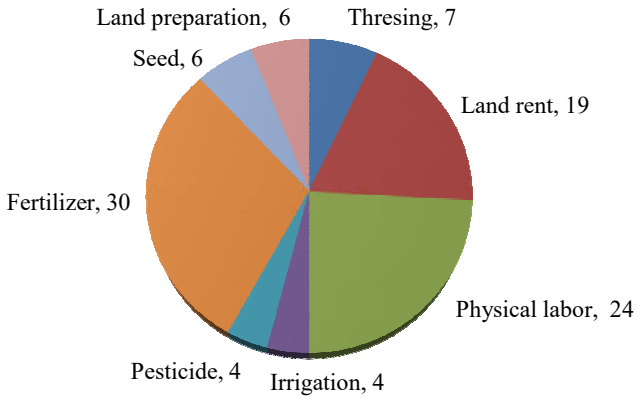


Source: Field Survey, 2015.

Figure 2 – Year-round crop pattern and main replaced crops in the study area

[5] *To get per acre of production cost, collected production cost for 25 decimal is multiply by 4.*
[6] *Aus, a type of rice grown in summer months.*
[7] *Aman, a type of winter rice.*

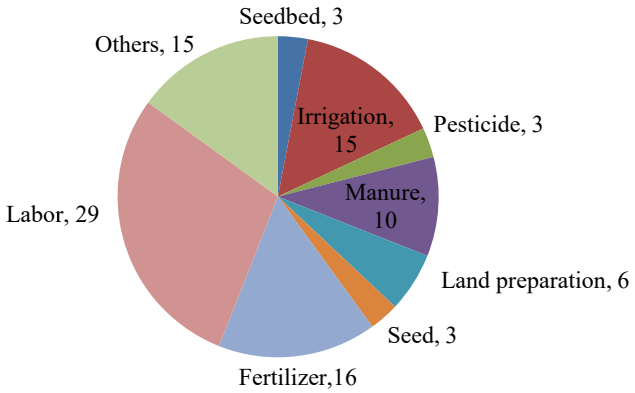
Production cost of maize, boro rice, and tobacco. The production cost of maize is quite lower (if we consider own labor cost) than that of boro rice and tobacco. Maize requires less water as well as fertilizers. The data reveals that for 25 decimal of land, the total cost of maize cultivation is about Tk.5, 000-6,000 And the majority of the cost goes to fertilizer, which is about 30% of the total cost. On the other hand, physical labor; land rent, threshing, land preparation, seed, irrigation, and pesticide account for 24%, 19%, 7%, 6%, 6%, 4%, and 4% of the total cost respectively (Figure 3).



Source: Field Survey, 2015.

Figure 3 – Production cost of maize (in percentage) in 2015

The production cost of boro rice is quite higher than maize. Most of the costs are alike maize, except for labor and irrigation. According to the interview data, it is found that per acre production cost of boro rice is around Tk.40, 000 and the lion's share of the cost go to labor, which accounts for 29% of the total cost. The cost of fertilizer, irrigation, and manure is about 16%, 15%, and 10% respectively. While Seedbed, seed, and pesticide account for 3% each of total cost. Finally, other costs which include: threshing, packaging, etc. responsible for 15% of the total cost.

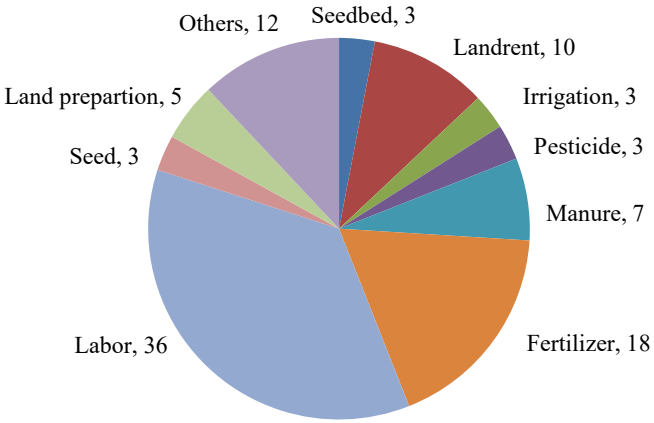


Source: Field Survey,2015.

Figure 4 – Production cost of boro rice (in percentage) in 2015

Tobacco is a luxury product and production cost of it is quite high. It is extensively produced in Rangpur district and is responsible for supplying one-third of the total production in Bangladesh. It needs more care as well as labor. In a nutshell, tobacco is a labor-intensive crop. So, a major portion of the cost goes into labor, which accounts for 36% of total production cost. Fertilizer is the second highest and that accounts for 18%. Other costs include threshing, drying, packaging, storing etc. which account for 12 percent. Land rent is

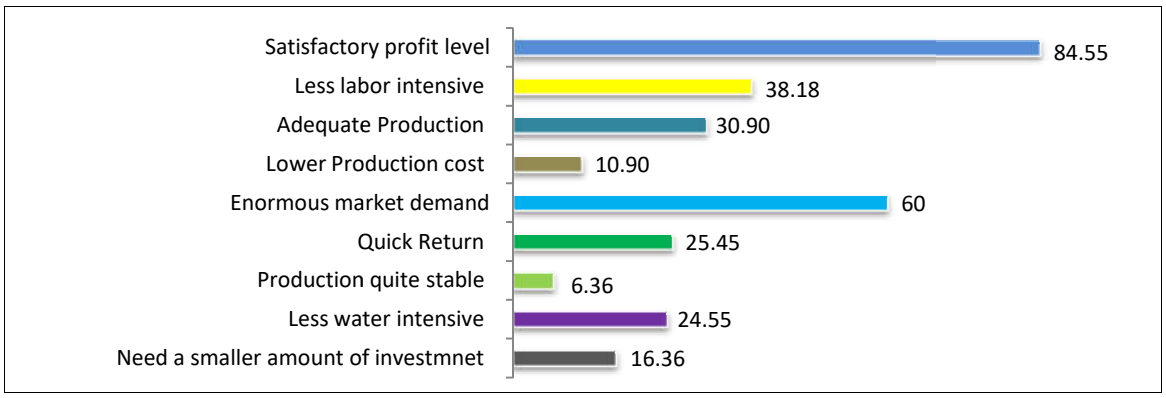
the fourth highest cost 10%. The cost of manure and land preparation is only 7% and 5% respectively. The cost for seedbed, seed, pesticide and irrigation all account for around 3% each of the total cost of production (Figure 5).



Source: Field Survey, 2015.

Figure 5 – Production cost of tobacco (in percentage) in 2015

Farmers' perception towards maize cultivation. From the field survey, it is found that about 16.36% of the respondents chose maize cultivation because they think maize requires a smaller amount of investment. Whereas about 25% of the respondents who once used to grow boro rice or tobacco on their farms, but now cultivate maize, has replied that maize is less water intensive. The statement that production of maize is quite stable is supported by 6.36% of respondents. Again, 25.45% of the respondents have agreed with this view that maize is a cash crop and quick return is possible in case of maize production. 60% of the respondents think that maize has gained popularity for its enormous market demand. In fact, this increasing market demand motivates the farmers to switch from their traditional crops to maize cultivation. On the other hand, about 11% of the farmers have agreed that the production cost of maize is low. About 31% of the respondents agree that there is an adequate level of maize production. Maize is less labor intensive, about 38% of respondents are agreed with this statement. But, around 85% of the respondents have considered the satisfactory profit level as the reason for maize cultivation (Figure 6).



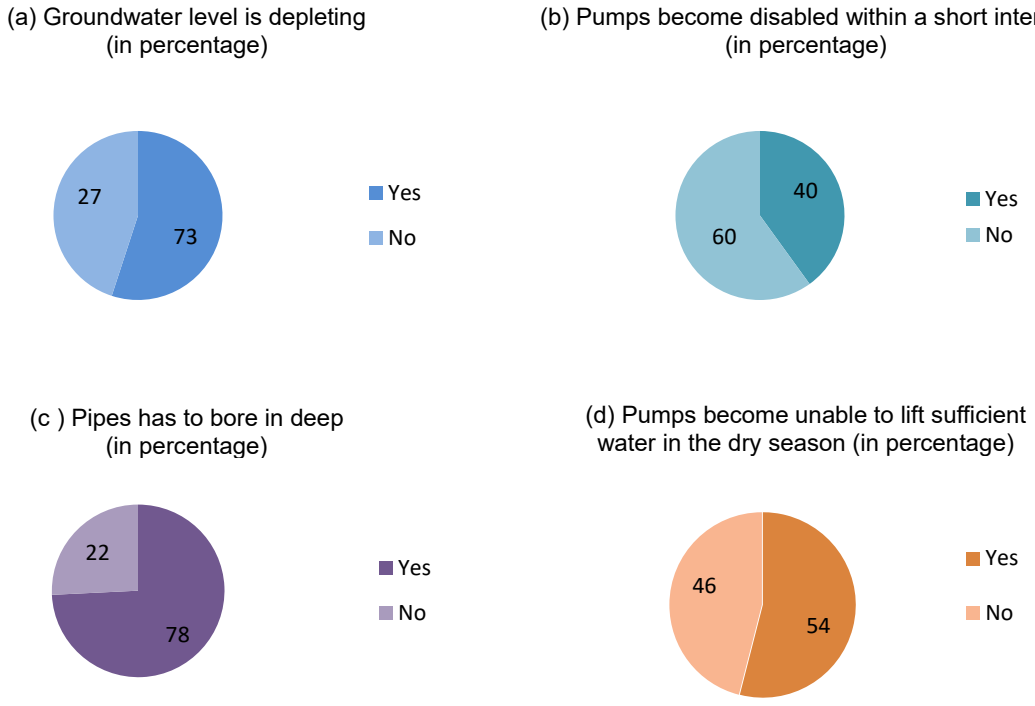
Source: Field Survey, 2015.

Figure 6 **–** Perception towards maize cultivation (in percentage) (multiple answers allowed)

Scenario of groundwater depletion in the study area. Farmers in Bangladesh are now experiencing groundwater depletion problem due to the extensive extraction of it. The northwestern part of Bangladesh also faces groundwater depletion problem because of its

drought-prone nature or being free from seasonal flooding due to water withdrawal from major rivers by upstream countries (Rahman *et.al,* 2012). Like other areas of the northern region, due to the unavailability of surface water, agricultural production at Gangachara upazila is totally dependent on the groundwater based irrigation system and groundwater is depleting gradually in robi season due to more extraction than its regenerating capacity. Boro rice, tobacco, maize, potato, mustard, spice, wheat, other vegetables are some major crops in the rabi season. And it is noted that cropping in rabi season is totally dependent on groundwater irrigation because it is a very dry season and rainwater is rarely found in this season. Furthermore, most of the farmers do not have an own irrigation system and have to depend on the rented irrigation supply by paying Tk.100 for 25 decimals of land for an hour as the irrigation cost. It is also known that there is no electricity connection in those villages of the study area and irrigation is totally fuel-based. So, the increase in the price of fuel is making the irrigation to be costly and ultimately hampers the boro rice cultivation. However, the study has, therefore, tried to show the scenario of ground water level on the basis of respondents' perception about it and water table data collected from the Bangladesh water development board.

Understanding the groundwater depletion from the farmer's perception. In the answer to the question whether the ground water level is depleting or not, most of the respondents (about 73%) say that the ground water level is depleting. And the remaining 27% respondents do not agree to or do not know whether the ground water level is depleting [Figure 7a].



Source: Field Survey, 2015.

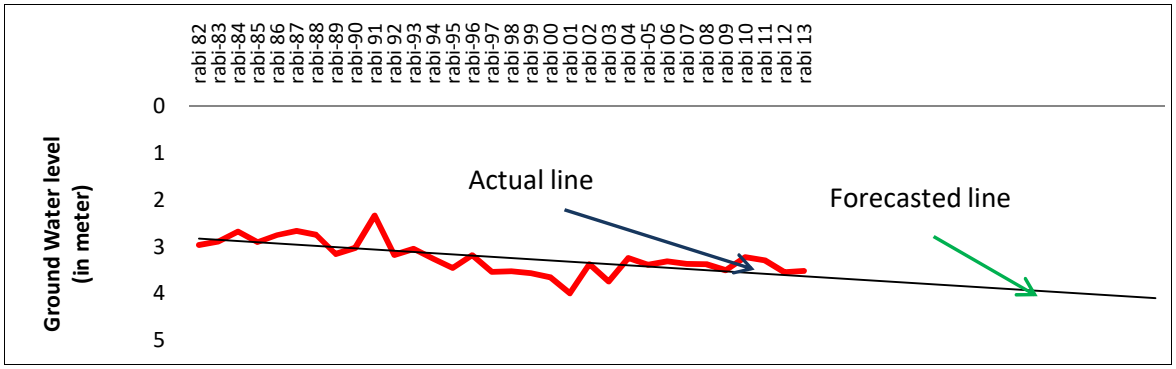
Figure 7 – Understanding the groundwater level depletion from respondent's perception

In the case of pumps become disabled within a short interval as an indicator for depletion of ground water level, 40% of the respondents say yes and make excessive water extraction as responsible for this type of disability. But, 60% of the respondents don't show their concern [Figure 7b].

Furthermore, 78% of the respondents say that in every year pipe of the pump is to set deeper because the pump is not able to lift sufficient water. To bore pipe in deep is one of

the signs that is ground water is continuously depleting. But, 22% of the respondents do not make any comment about it. On the other hand, 54% of the respondents say that in the dry season, the pump becomes unable to lift sufficient water and water contains sand and other materials. On the other hand, 46% of respondent do not agree with this matter [Figure 7c,d].

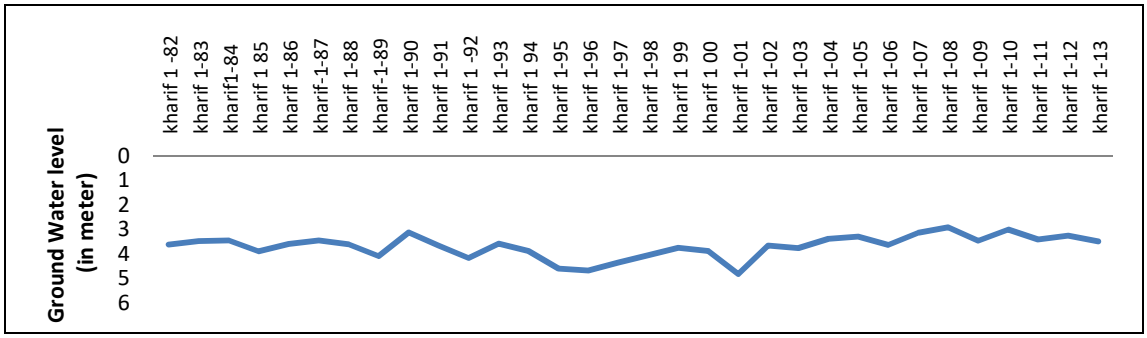
Water table analysis. Trend line forecasting of water table data reveals that in 2030, the ground water level will be about 4-meter depth from the surface in rabi season and that indicates severe water crisis for this season in the near future. In figure-8, the red line is the water table trend line (actual) and the black line is the possible scenario of the water level in 2030.



Source: Authors' compilation based on data from Bangladesh water development board (BWDB), 2015.

Figure 8 – Water table scenario for rabi season at the study area

But, like rabi season, the ground water level is not depleting in kharif-1 season (Figure 9). This stability of water table can be attributed to the rain of the rainy season and regeneration thereby (mid April-mid October). In this season, farmers tend to cultivate water intensive aus rice. Kharif-2 season's data are also available but has been discarded from the analysis because it is found that aman rice is the main adopted crop for this season and almost every farmer commonly cultivate aman rice in this season.



Source: Authors' compilation based on data from Bangladesh water development board (BWDB), 2015.

Figure 9 – Water table scenario for kharif-1 season at study area

Results of Benefit -Cost Analysis (Acre-based). In the study, the calculation of the B-C ratio is done for maize, boro rice, and tobacco cultivation respectively. From the analysis of the data, it is found that if the production cost of maize is Tk[9] 1(one) then it brings Tk. 1.40 from the market i.e. it creates a profit of Tk. 0.40 (forty paisa[8]) for the investment of Tk. 1(one) for the year 2015. Accordingly, maize brought a profit of Tk. 0.37 (thirty-seven paisa) and Tk. 0.29 (twenty-nine paisa) for the year 2005 and 2010 respectively (Table 1). So, it can be concluded that the profit of maize production is increasing gradually over the years.

[8] *Paisa is a monetary unit of Bangladesh; 1 paisa equal to one hundredth of 1 (one) Tk.*

In the case of boro rice production, for the investment of Tk. 1 (one), the incurred loss is Tk. 0.32 (thirty-two paisa) for the year 2015. On the other hand, for the investment of Tk. 1 (one), the incurred loss was Tk. 0.30 (thirty paisa) and Tk. 0.12 (twelve paisa) for the year 2010 and 2005 respectively (Table 2).

Table 1 – Results of benefit-cost ratio of maize cultivation

Particulars	2015	2010	2005
Production	61 maund[9]	53 maund	46 maund
Selling Price[a]	615	525	475
Total Return[a]	37,515	27,825	21,850
Total production cost [a]	26,777	20,265	17,000
Net return[a]	10,738	7,560	4,850
B-C ratio	1.40	1.37	1.29

Source: Field Survey, 2015.
[a]Selling Price, [a]Total and Net Return and [a]Total production cost reported in Tk.

Table 2 – Results of benefit-cost ratio of boro rice cultivation

Particulars	2015	2010	2005
Production	50 maund	44 maund	42 maund
Selling Price[a]	550	470	450
Total Return[a]	27,500	20,680	18,900
Total production cost[a]	40,438	29,500	21,500
Net return[a]	12,938 (-)	8820 (-)	2600 (-)
B-C ratio	0.68	0.70	0.88

Source: Field Survey, 2015.
[a]Selling Price, [a]Total and Net Return and [a]Total production cost reported in Tk.

Table 3 – Result of benefit-cost ratio of tobacco cultivation

Particulars	2015	2010	2005
Production	18 maund	17 maund	14 maund
Selling Price[a]	2,330	1790	1,445
Total Return[a]	41,940	30,430	20,230
Total production cost[a]	55,935	42,833	39,500
Net return[a]	13995 (-)	12403 (-)	19270(-)
B-C ratio	0.75	0.71	0.51

Source: Field Survey, 2015.
[a]Selling Price, [a]Total and Net Return and [a]Total production cost reported in Tk.

For tobacco production, the incurred loss is Tk. 0.25 (twenty-five paise) for the investment of Tk. 1 (one) in 2015. Similarly, the incurred loss was Tk. 0.29 (twenty-nine paisa) and Tk. 0.49 (forty-nine paisa) for the year 2010 and 2005 respectively for the same amount of investment (Table 3).

CONCLUSION

Maize has a huge potential market demand for its diversified uses and it can make a contribution to the overall socioeconomic development of its cultivation area. The study finds that the cultivation of maize is profitable whereas, other important traditional crops like boro and tobacco are incurring a loss in the study area. So, rational farmers in the study area prefer maize cultivation to other traditional crops due to its profitability.

The northern region of Bangladesh is totally dependent on the groundwater based irrigation system, but the soil of this region is gradually losing its soil moisture and the ground water level is alarmingly depleting. At the same time, surface water availability in this region is also found inadequate. Therefore, in this backdrop, less water intensive crop like maize is,

[9] *Maund is widely used in rural Bangladesh and India. 1 Maund equals to approx.37.32 kg.*

possibly the best solution to reduce the pressure on the ground water in this region in general and the study area in particular.

The study, lastly, calls for encouraging maize production on a large-scale by ensuring maize growers' access to quality inputs at reasonable rates and remunerative prices for their products in the market.

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AUTHOR CONTRIBUTIONS

All the authors have written the paper but Moumita Roy and Md. Touhidul Alam were actively involved in designing the study design, data collection and in analyzing the results. Both, Md. Touhidul Alam and Md. Sajib Hossain have interpreted analyzed results.

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