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Profitability Analysis of Less Water Consuming Crops and Its Impacts on Rural Peoples using Solar Structured Dug Wells in Hard Barind Areas of North-Western Region.

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Abstract

This study was conducted mainly to analyze the production, cost; return and profitability of mostly used less water consuming crops like non-rice crops and vegetables in the hard Barind areas of north-west region of Bangladesh. An attempt has been made to change the cropping pattern and people's perception in the study area. Dug well was the mode of irrigation for less water consuming crops. Both primary and secondary data were used and analyzed to achieve the objectives of the study. Per hectare profitability was the view point of the study. It is clear from analysis of the results that vegetables production was more profitable than the production of non-rice crops. The Benefit-Cost ratio was observed highest (2.07) in tomato and lowest (1.17) in Boro paddy. In case of vegetables, the lowest Benefit-Cost ratio (1.70) was found in country bean. Per hectare gross production costs of tomato and Boro paddy were BDT 253380 and 97030 respectively. The corresponding net returns were BDT 271620 and 16805 respectively. There were a positive and significant average rate of return (90.55%) and average rate of net return (9.44%) on investments among the vegetables. A positive impact was observed in cropping pattern in the study area. The percentage of triple cropped areas was increased from 14.80% (year 2008-09) to 24.75% and quadruple cropped areas were increased to 0.50% after about 10 years of cropping periods. There was zero quadruple cropped area in the year 2008-09, or before. Moreover, single and double cropped areas were increased due to massive crop cultivation practices using such production techniques of less water consuming cropping practices to vegetables, wheat, maize, potato, mustard, onion, garlic etc. in the dug well schemes. Dug well irrigation has changed the condition of life style in this drought prone area.

Keywords: Dug Well Irrigation, Cropping Pattern, Cost-Benefit Ratio, and Profitability Margin.

I. Introduction

Bangladesh is an agro-based country. Agriculture sector is the single largest contributor to the national economic development. About 14.23% of the country's GDP (7.90%) comes from this sector [1]. Agriculture is being modernized which is fully based on trade, business and marketing. Agriculture production is largely dependent on the use of advanced knowledge and technology such as, quality seeds along with timely supply of all other modern inputs and irrigation which has attained high priority in the National Agriculture Policy. Bangladesh has

high potential for agriculture development despite cultivable land is decreasing gradually for many infrastructural developments. In spite of this, effort for increased per unit production of crops is needed to be enhanced as it is significant to meet food and nutrition demand of the growing population of Bangladesh. As because of the per capita income of the population is very low (2064 USD as on 2020) [1] that causing food insecurity and chronic under and mal nutrition among the resource poor farmers of this country, increase of agriculture production through using available water resources in the form of modern irrigation plays a potential role in accelerating the process of increasing food production. Efficient management of water resources is one of the most vital factors for achieving the desired targets of production. Therefore, available water during monsoon and dry season particularly for cultivation of high yielding crops are crucial factor, which severely restricts diversity of production.

Excessive abstraction of ground water for irrigation through deep tube wells and shallow tube wells, seasonal variability of rainfall, intensity of rain, weather condition, excessive use of ground water for crop production, inefficient use of irrigation water for rice based cropping pattern are the key factor which govern the water resource degradation in Bangladesh. Due to over draft of water by private deep tube wells and shallow tube wells, declination of water table is observed a serious problem in the north-west region of Bangladesh. Excessive withdrawal of ground water from this area, causing lowering of static water level, is creating a negative impact on the environment throughout the country. As a result, natural disaster occurs every year and crop production is hampered. The heavily reliance on ground water and shifting of indigenous cropping pattern and practices may bring a disaster due to continual stress on aquifer [2, 3].

Drought is a common problem in the north-western part of Bangladesh. According to the previous history, it occurs in the country with 3 to 5 years return period. Deficit rainfall is one of the main reasons for occurring drought in Barind area of Bangladesh. Naogaon district is one of the drought prone areas in the north-west part of Bangladesh. It affects about 0.26 million hectares of potential agriculture land in this region. So it is a pivoting factor for crop production, drinking purpose and other domestic uses in high Barind areas of northern region. Dug well irrigation may be a solution mainly for the production of less water crops and vegetables.

Dug Well irrigation in hard Barind is now a very popular mode of irrigation practice to produce valuable and less water consuming crops which has changed the traditional agriculture practice in north-west region of Bangladesh. Due to consecutive several years of drought, depletion of ground water, shortage of rainfall, dryness of surface water bodies, increasing crisis of food production with respect to population growth, food crisis was worsening day by day. The price of our daily agricultural commodities was growing up day by day and going out of reach to the rural peoples; in such situation, dug well irrigation was introduced in the study area. Dug well irrigation has changed the condition of life style in this drought prone area.

The government of Bangladesh has also given emphasis on the production of non-rice and vegetable crops round the year to meet nutritional and caloric need for the growing population and income of farmers. Irrigation water harvested through solar powered dug well has saved in many cases of ripen T-Aman rice by providing supplementary irrigation, produced low water consuming crops, potato, vegetables, other non-rice crops etc. and has also changed the

cropping pattern in the study area. Single and double cropped areas were converted to triple and quadruple cropped areas.

The food demand will be increased in the next 25 years by about 29% [4] due to increase of population. So, judicious use of ground water through dug well and conservation of rain water can minimize the effect to some extents. The following research work will ensure a better prospective in Barind area and will help in the development of agriculture sector in Bangladesh. It may be an example of appropriate technological issue in developing countries.

But the major factors of production are land and modern inputs like HYV seeds, irrigation, pesticides, manures/fertilizers, etc. Since specific agro-ecological condition at various regions of the country determines the suitability of land and availability of inputs for the production of different types of crops, one cannot easily change land use patterns and crop yield from one crop to another. The major concern for our government is maintaining stability in food prices by providing subsidies in agricultural inputs and selling food crops at fair prices by buying from the farmers at a higher price. In general, financial profitability of a crop is the basis of farmers' decision making of inputs and outputs that the farmers actually pay and/or receive for their crops. Since price instability directly affects food security of the poor, therefore, maintaining food crop prices at an affordable level is a major strategic element for poverty alleviation [5].

Shahabuddin et al. (2002a) concluded that several non-cereal crops, including vegetables, potatoes and onions have financial and economic returns that were as high as or higher than those of High Yielding Variety (HYV) rice [6]. Appropriate agricultural practices have positive and sustainable impacts on rural farmers' livelihood possessions and strategies to overcome the climate vulnerabilities. The benefit cost ratio (BCR) is a relative measure which is used to determine benefit per unit cost and helps farmers in decision making activities [7]. The relationship of price and input use and it influence on crop production, gross and net income of rice crop, labor, seed, fertilizer and irrigation were the factor significantly contributed towards output [8].

Bangladesh has made substantial progress towards achieving its goal for self-sufficiency in the production of food grains. Ensuring food security for the vast population of Bangladesh is directly associated with the agricultural development in the country. To alleviate poverty and malnutrition in our country, it is necessary to increase production and simultaneously consumption of nutritious and health promoting vegetables. Moreover there is a great need for vegetable cultivation in a view of increase income, employment and reduce widespread malnutrition in Bangladesh [9].

So, the production of both summer and winter vegetables needs to be increased. Our government has given emphasis on vegetable production in the year-round to meet the nutritional and caloric needs for the growing population and for increasing employment opportunities and income of farmers. The farmers in the study area are not in a position to take appropriate decision towards vegetables cultivation and less water consuming cropping patterns and they have some deficiencies about adequate inputs and cost benefit analysis information. If some information can have to provide about cost of cultivation, cost of production, crop rotation, knowledge about crop calendar, benefit cost analysis of crop production, doses of fertilizer applications, the farmers in the study area will be benefited.

In the views above, the present study was conducted

- To analyze and examine cost benefit analysis of different less water consuming crops and their production techniques.
- To analyze and compare the profitability of selected crops and vegetables.
- To create opportunity of small and marginal farmers to provide supplementary irrigation in their less water consuming crops in case of scarcity of moisture.
- To motivate and train up the farmers for effective operation and management of their farms.

II. Why Dug Well Irrigation IN BMDA?

The land formations of Barind area are mostly undulating in the western region and level in the eastern region. Moreover, in the north-western terraced area of land mass (called high Barind) is slightly tilted to the south-east direction. The topography of high Barind area is shown in (Figure 1a). The area was once upon a time single cropped. In some areas of High Barind, peoples were habituated to drink water from some water bodies like ponds, canals, rivers, beels (local name of a water body) etc. due to unavailability of ground water (Figure 1b).

Figure 1a: Undulated terrace land

Figure 1b: Poor people using canal water

Hand tube wells, shallow tube wells and other manually operated pumps did not operate here, till now do not operate actively in these areas. As a result, peoples suffered from some water borne diseases. Due to scarcity of rainfall and limitation of the use of ground water due to shortage and continuous depletion, dug well may be a solution. Barind Multipurpose Development Authority (BMDA) first introduces this dug well with a new design for irrigation and drinking purposes.

The study area is a drought prone area in the north-west part of Bangladesh. To eliminate the situation and to meet up irrigation demand and drinking water crisis, BMDA introduces solar structured dug well in Barind area from 2015-16 and BMDA is the pioneer organization in Bangladesh to start it. Before that it was in a piloting stage in BMDA. Ultimate goal of the schemes (dug well) is to reduce excessive use of groundwater and to develop and ensure an agro-ecological balance for addressing the adverse impact of climate change in these draught

prone areas. It can also play vital role for drought mitigation in this area. Supplementary irrigation can save a vast land for crop cultivation in this area.

III. Methodology

In this study, selection of the study area was an important factor for proper representation of cost benefit analysis. The areas, where dug well irrigation was very much appropriate and feasible, were selected for the study. Keeping the study objectives in view, six upazilas of Naogaon district were selected. The upazilas were in remote areas in the district. Both primary and secondary data were collected. The primary data have been collected directly from the field. The secondary data were collected from various issues of Year Book of Agricultural Statistics of Bangladesh, Manuals, Annual Reports, and Evaluation Reports etc. Some production related inputs/parameters were selected for the analysis and the results have been presented in the form of tables and graphs/charts. Profitability has been estimated for Boro rice, less water consuming crops and vegetables like wheat, Potato, Brinjal, Cabbage, Patol, Bean, Tomato. Per hectare profitability of growing crops were measured in terms of gross return, gross margin and net return. Benefit-Cost Ratio (BCR) was a major indicator for production costs of studied crops.

The return of main product was calculated simply by multiplying the total production with per unit of sale price in the harvesting period. The gross return was calculated with the total return of main product and by product. In this study, costs were measured in terms of variable and fixed cost basis. Variable costs were labour, seed, irrigation, fertilizers, pesticides etc. according to different applications and doses. Fixed costs of production were the cost of rental value of land, interest on operating capital etc. The total costs were calculated by adding fixed cost and variable cost. Net return analysis was done by deducting total cost of production from gross return. It was assumed that the farmers borrowed the money from a bank and they had to pay interest on loan amount. So, per hectare net return was determined by subtracting per hectare total cost (variable cost and fixed cost) of production from per hectare gross return. The BCR is a relative measure, which was used to compare with benefit per unit of cost and it (BCR) was estimated as a ratio of gross returns and gross costs.

In this system, an overhead tank of 5000 liter (may vary from site to site) capacity was designed and constructed to store irrigation water and also drinking water (Figure 3). uPVC underground pipe line systems were designed to connect the dug well for proper distribution of irrigation water. Moreover, solar pumps were used to lift water from those dug wells.

As a result, farmers' families were benefitted for getting water easily for the purpose of their limited irrigation and house hold uses. The same solar panels were used for operating pumps and lighting the pump house areas and the funnel over the dug well was used for harvesting rain water as well as recharging subterranean water level.

Figure 3: Diversified cropping pattern with drinking water system in a dug well scheme.

IV. Study Area in Brief

The study area is bounded on the north by India, on the east by Joypurhat districts, on the south by Rajshahi Districts and on the west by Nawabganj and India. The total area is 2027.23 sq.km of which 3.30 sq.km. is riverine and 19.45 sq.km is under forest. The annual average temperature varies from maximum 37.8°C to minimum 11.2°C. The annual average rainfall is 1862 mm [10]. The study area comprises 6 upazilas viz. Patnitola, Niamotpur, Mohadevpur, Porsha, Sapahar and Dhamoirhat of Naogaon district, north-west hydrological region out of 6 hydrological regions of Bangladesh. It was categorized 3 agro-ecological zones [11]. Location wise soil types are given in table 1.

Table 1: Upazila wise AEZ*[1], soil types and soil compositions of the study area.

Upazila	AEZ*[1]	Soil type	Soil Composition (%)			Remarks
			Sand	Silt	Clay	
Patnitola	25	Grey clay	6	86	8	LBT*[2]
Niamotpur	25, 26	Reddish to Grey clay	0	9	91	LBT*[2], HBT*[3]
Mohadevpur	25	Grey clay	0	3	97	LBT*[2]
Porsha	26	Reddish to Brown clay	0	13	87	HBT*[3]
Sapahar	26	Reddish to Brown clay	0	13	87	HBT*[3]
Dhamoirhat	3, 25	Non-calcareous grey				TMF*[4]

*[1]AEZ= Agro Ecological Zone, *[2]LBT= Level Barind Tract, *[3]HBT= High Barind Tract
*[4]TMF= Teesta Meander Floodplain

This Area is tilted upward along the western edge. Soil type of the study area can broadly be classified into two groups: Flood plain soils (recent deposit) and terrace soils (older alluvial or paleosol) [12]. Terrace soils are Barind clay and Flood plains soils are of Teesta alluvial, Atrai alluvial and Ganges River alluvial deposits. These morphologic units are separated by long, narrow bands of recent alluvium, which can be used for rainwater harvesting [13].

The climate of the area is generally warm to humid. Based on rainfall, humidity, temperature and wind speed nature, the weather condition is classified as i. Pre-monsoon, ii. Monsoon, iii. Post-monsoon and iv. Winter. Rainfall is comparatively low in this area. The rainfall mainly occurs during the monsoon. The rainfall varies from place to place as well as year to year. This region has already been designated as drought prone. The average temperature ranges from 35^{o}C to 25^{o}C in the hottest season and 9^{o}C to 15^{o}C in the coolest season. Majority lands of the study area are very suitable for agricultural crop production, specially in cereals and vegetables.

V. Results and Discussion

A. Land use and cropping pattern

Land use in this area has changed dramatically since last two decades. Land for specific crops and cropping pattern are largely determined by hydrologic, physiographic and soil conditions. The most important factors affecting the land resources utilization for crop production are rainfall pattern, soil fertility and availability of water for irrigation, soil topography and flooding and drainage. The land use situation in 2002 is given in table 2.

Table 2: Land use and cropping status in the study area.

Financial Year: 2008-09[10]			Financial Year: 2018-19[14]		
Cultivable land under irrigation (%)	Cropping status	Area coverage (%)	Cultivable land under irrigation (%)	Cropping status	Area coverage (%)
80	Single cropped	35.86	86[15]	Single cropped	23.25
	Double cropped	49.34		Double cropped	51.50
	Triple cropped	14.80		Triple cropped	24.75
	Quadruple cropped	0		Quadruple cropped	0.50
	Total	100	Total		100
Average Cropping Intensity(CI) = 176			Average Cropping Intensity(CI) = 202, National average= 197		

Before starting of BMDA, the cropping system and irrigation status were not well off because of its old and traditional farming system. With enhancement and progress of BMDA activities, single cropped area was sharply reduced with the increase of production area under double and triple cropping. It is reported that the cropping intensity which is a major indicator of progress of the crop agriculture has increased about 46% with a present situation in the study area.

In recent years, a sudden increase of agricultural development has been achieved in the study area due to installation of different production wells. Dug wells have given at present an added dimension in agricultural production system. Different vegetables, potato mustard, water melon, pulses, oil seeds, etc. are producing besides rice, jute, wheat sugarcane etc. The major cropping pattern in the study area was rice based. BMDA activities have changed the past scenario of barren land and some areas in single crop. Around 12 new crops and many types of vegetables were recorded here. Some minor crops were also recognized.
Past and present cropping pattern, cropped area by percent and cropping status in the study area is given in table 3.

Table 3: Past and present cropping pattern in the study area.

Cropping Patterns	Total area covered (%) in 2010-11[16]	Total area covered (%) in 2018-19[14]	Remarks
Boro	27.46	36.48	increased
aus	8.06	11.96	increased
Aman	29.13	31.62	increased
Wheat	1.65	4.60	increased
Maize	0	1.35	increased
potato	2.94	4.17	increased
vegetable	0.08	1.40	increased
others	30.68	8.42	decreased
	100	100	

The total non-rice crops were 2, 75, 327 hectares in the year 2010-11 which were increased to 515385 hectares in 2018-19. The cropping intensity has increased from 195 (2010-11) to 202 in 2018-19 in the study area. From the above figure, it is clear that the cropped area has increased by 87% after around one decade. The cultivated area has also increased due to re-excavation of silted canals, derelict ponds, beels, dighis (surface water bodies) etc. for storage of rain water which promoted different crop cultivation practices.

B. Cropping Pattern under dug well schemes (capacity 2.0 liter/second) in the study area

Majority areas of this district were very suitable for agricultural crop production, specially in cereals and vegetables. Vegetables and non- rice crops produced in dug well schemes in 2019-20 in the study area is given in figure 4.

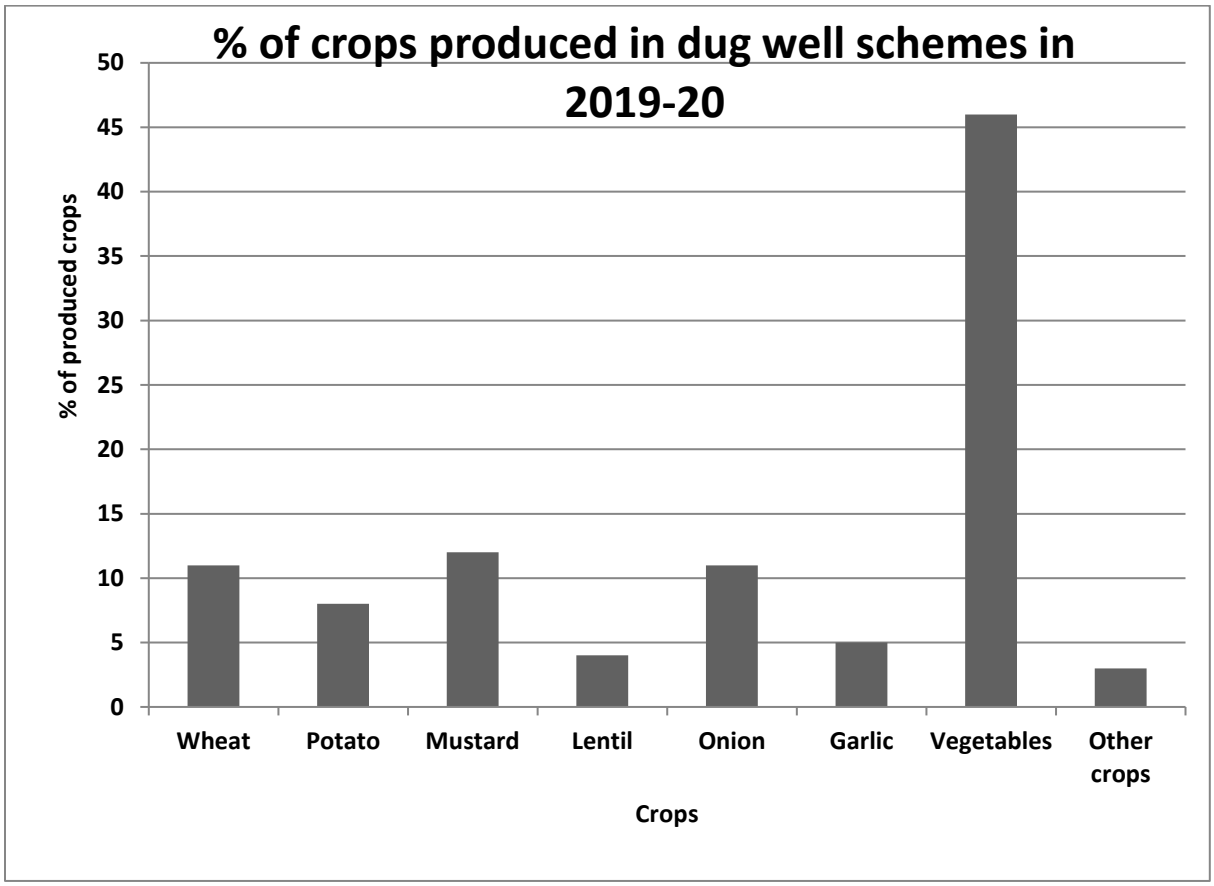

Figure 4: Vegetables and non-rice crops produced in dug well schemes in 2019-20 in the study area.

The increment of cropping intensity could be attributed to major shift in areas from mono cropped to double/triple/quadruple cropping pattern. Specially, vegetable crops were increased rapidly. These were less water consuming crops. Dug wells of BMDA have given added benefit for irrigation to the villagers. A picture of vegetable cultivation with other non-rice crop is shown in figure above.

C. Benefit-Cost Analysis

There were two types of input in the cost of crop production. Variable cost of cultivation practices included the cost of human labour, seed, irrigation, fertilizers, pesticides etc. Urea (for nitrogen), TSP (Triple Super Phosphate), MP (Murate of Potash), Gypsum, Boron, Zinc etc. were used as fertilizer and cow dung was used as manure.

The prices of different variable inputs in the production period are presented in table 4a. Fixed costs were land use cost and interest on Bank or any other loans. Also the crop wise costs of fertilizers/manure are shown in table 4b.

Table 4a: The prices of different variable inputs in the production period of crops/vegetables.

Inputs	Urea	TSP	MP	Gypsum	Boron	Zinc	Cow dung
Prices of fertilizers/manure per kg	17	24	16	9	80	100	1.25

*Source: Field Survey, 2019-20 **All prices in BDT (Bangladesh Taka)

Table 4b: The costs of manure/fertilizers applied in different crops/vegetables.

Crops	Item wise costs of manure/fertilizers per hectare in BDT							Total costs
	Urea	TSP	MP	Gypsum	Boron	Zinc	Cow dung	
1. Boro paddy	3570	3000	1120	630	800	1000	0	10120
2. Wheat	3145	3600	800	900	640	800	0	9885
3. Potato	3060	1560	2080	975	600	750	550	9575
4. Brinjal	5100	4800	3200	927	600	750	350	15727
5. Country Bean	340	1200	800	360	0	0	200	2900
6. Patol	1020	1680	1600	270	240	0	250	5060
7. Tomato	4080	3600	3040	360	0	0	400	11480
8. Cabbage	5100	2400	2400	360	240	750	750	12000

Table 4c: The costs of production in different crops/vegetables.

Crops	Item wise costs of manure/fertilizers per hectare in BDT						Total costs of production
	Labour	Seed	Irrigation	Fertilizer	Pesticides	Others	
1. Boro paddy	56250	880	5600	10120	3180	21000	97030
2. Wheat	8800	3900	400	9885	1500	10500	34985
3. Potato	130000	45000	7500	9575	6300	10500	208875
4. Brinjal	145000	15500	16300	15727	25500	55000	273027
5. Country Bean	105000	90000	4800	2900	16500	45000	264200
6. Patol	120000	40000	5500	5060	7500	60000	238060
7. Tomato	155000	8000	10500	11480	3400	65000	253380
8. Cabbage	160000	6000	9300	12000	4500	60000	251800

It was observed from table 4c that the cost of production per hectare of land was highest in Brinjal (BDT 273027) and lowest in Wheat crops (BDT 34985). The item wise input costs were relatively higher in labour costs and lower in irrigation and pesticides. The cost of production per hectare in vegetables was comparatively higher than that of grain crops. Among the item wise costs, the labour cost was highest (51.66%) on an average and the rest (48.34%) was the total cost of other input items. Though the production cost of vegetables were relatively higher, the vegetables production in the study area was more profitable.

Table 5: The costs of economics in different crops/vegetables.

Crops	Yield ton/ ha	Gross return(BDT)/ha			Cost of production (BDT/ha)	Costs of production (BDT/ton)	Net return (BDT/ ha)	Net return (BDT/ ton)	Benefit -Cost ratio
		Main product	By product	Total					
1. Boro paddy	5.25	112875	960	113835	97030	18482	16805	3201	1.17
2. Wheat	4.5	63000	550	63550	34985	7774	28565	6348	1.82
3. Potato	30	420000		420000	208875	6963	211125	7038	2.01
4. Brinjal	45	540000	0	540000	273027	6067	266973	5933	1.98
5. Country Bean	18	450000	0	450000	264200	14678	185800	10322	1.70
6. Patol	18	450000	25000	475000	238060	13226	236940	13163	2.00
7. Tomato	21	525000	0	525000	253380	12066	271620	12934	2.07
8. Cabbage	30	450000	0	450000	251800	8393	198200	6607	1.79

It was observed from table 5 that the productivity was highest in Brinjal (45 ton/ha) and lowest in Wheat (4.50 ton/ha). But gross returns were highest in Brinjal (BDT 540000) and lowest in Wheat (BDT 63550). Net return was highest (BDT 271620) in Tomato and lowest (BDT 16805) in Boro paddy. The Benefit cost ratio was highest (2.07) in Tomato and lowest (1.17) in Boro paddy. It is revealed that the net returns were found positive and the BCR of all studied crops were greater than 1.00 irrespective of farm size and regions, but vegetables were more cost effective than grain crops.

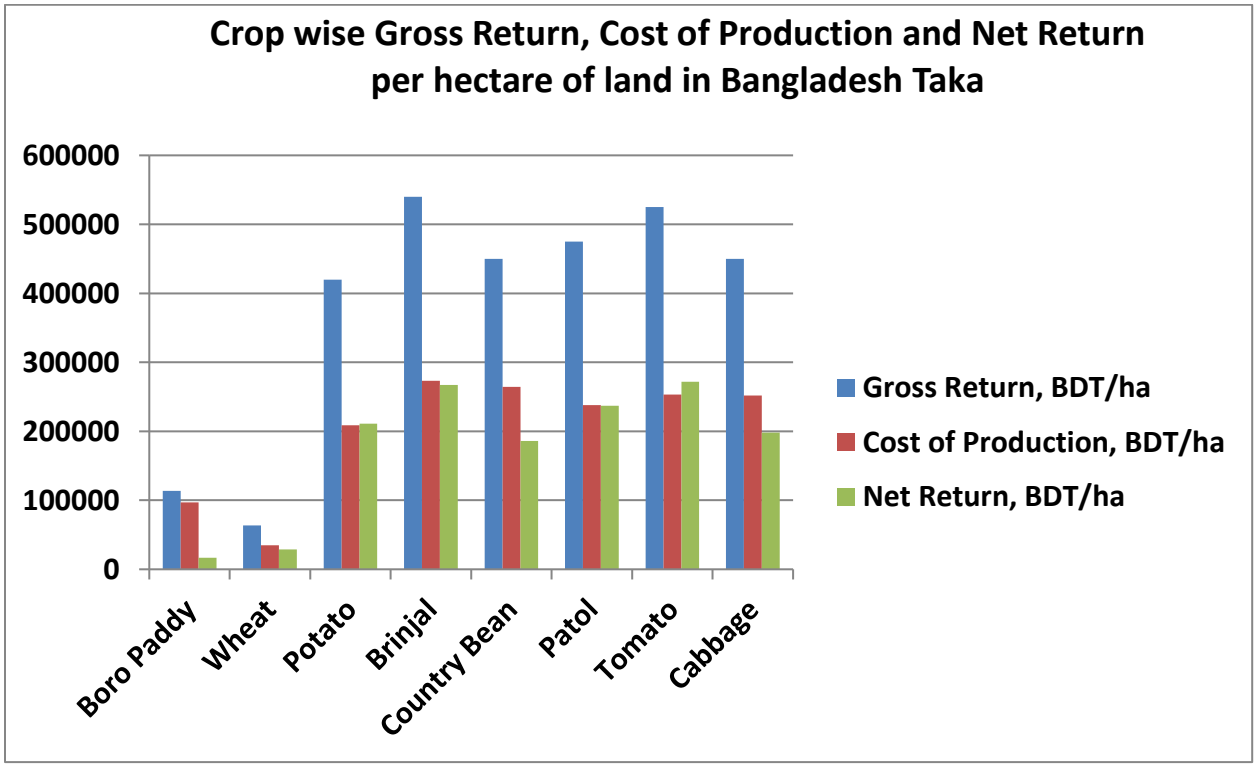

Figure 5: Comparison of Benefit Cost analysis of different grain crops and vegetables.

From figure 5, Benefit Cost Ratio (BCR) was observed highest in tomato production (2.07) and lowest in Boro paddy (1.17). But in case of vegetables crops, the highest and lowest BCR were studied in tomato and country bean (2.07 and 1.70) respectively. The net return per hectare was highest in tomato (BDT 271620) and lowest in country bean (BDT 185800) in case of vegetables, but in case of all studied crops, the lowest return per hectare was in Boro paddy (BDT 16805). The input cost was lowest in wheat production (BDT 34985). But, in case of vegetables, the lowest cost of production (BDT 238060) was found in Patol. From the above figure it was also observed that the cost of production and net return were nearly same in Potato, Brinjal and Patol.

D. Impacts on Cropping Pattern and People's Reactions

The cropping pattern of Naogaon district was normally rice based. It is said that Naogaon district is the store house of rice production in Bangladesh. But this technology has turned the situation already. People are growing wheat, potato, maize mustard, vegetables and many

others low water consuming crops (Figure 6–8). Many farmers opined, due to the lack of rainfall, the yield of vegetables in dug well scheme are better than early days before 10 years back. More over the quality of vegetables are very good and its market price is high. Farmers are very happy for getting good market price.

Figure 6-8: Some less water consuming crops in dug well schemes

At present, the cropping pattern has changed rapidly which has given a positive impact on the people. More cropping lands which have been transformed into double, triple and in many cases quadruple cropping lands have enhanced cropping intensity by 202%.

This difference was not only due to dug well irrigation, but there were many factors involved in the whole system such as other modes of irrigation, farmers training, inputs supplied to the farmers, advertisement among the people about changes in their perception at the farm level. A change of cropping pattern is given above in some dug well schemes.

E. Opinions on Irrigation Water Utilization

BMDA's environment friendly dug-wells irrigation has spread the entire study area and saved the farmers as well as environment. This technology has removed an acute water crisis that exists in the study area resulting in the untold sufferings of the poor and other marginalized communities. Farmers in this area were facing severe water crisis for decades, but due to installation of dug well in the area, farmers and their families are becoming benefited. They are getting their daily drinking water and also cultivating crops and vegetables with the same water. Agro-ecological balance is being restored by massive cultivation of different crops and vegetables. Local marketization has turned into a new shape. Many poor farmers are becoming economically solvent. It gives extra earnings to the nation.

This situation is gradually mounting pressure on groundwater in this drought prone area. So, extension of dug-well technology and its proper uses can be the vital means of mitigating the crises of irrigation water. Since lifting of underground water through deep tube wells is becoming tougher day by day and options for surface water are also very limited, there is no alternative than dug well. Thousands of hand-driven tube wells are remaining out of use every dry season, due to the fall of water level in this area, Millions of people in the dried up areas are now dependent on dug wells both for drinking and irrigation water.

VI. Concluding Remarks

Due to adverse effect of climate change and use of over draft of ground water through deep tube well and shallow tube well for irrigation, in some areas water table is going down day by day. Sinking of new deep tube wells have also been stopped by the government of Bangladesh in these areas. In such situation, dug well is introduced to water stressed Barind area. It is an alternative approach of irrigation for less water consuming crops to change the cropping pattern which is an environment friendly approach in BMDA.

This dug well has introduced to facilitate the less water consuming crops. Less irrigation has tuned many Robi crops growing areas from Boro growing areas. Wheat, maize, potato, mustard, oil seeds and pulses, many others vegetables have increased. This study estimated profitability of Boro rice, wheat, potato, brinjal, country bean, patol, tomato, cabbage based on net and gross returns and BCRs, irrespective of land elevation, type of technology and farm size categories. Results showed that all the estimates of net returns, gross returns and BCRs are positive. This means that the production of these crops is profitable for the farmers at the current market conditions. Dug well has now given a new hope to the farmers and the people in this water stressed area.

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