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ECONOMICS OF CAULIFLOWER AND CABBAGE PRODUCTION IN SELECTED AREAS OF SYLHET DISTRICT

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Abstract

The study is an attempt to examine the economic analysis of cauliflower and cabbage production in selected areas of Sylhet district. A total of 45 farmers were randomly selected from three villages namely Dighirpar, Basantagaon and Paschimdarsa at Sylhet Sadar upazila in Sylhet district. The major findings of this study revealed that production of the selected homestead vegetables were profitable. Per acre gross cost of production of cauliflower and cabbage were Tk. 93860.55 and Tk. 92135.8, respectively and the corresponding gross returns were Tk. 229407.4 and Tk. 230800, respectively. Per acre net returns of producing cauliflower and cabbage were Tk. 135546.85 and Tk. 138664.2, respectively. Benefit cost ratios of cauliflower and cabbage production acre^{-1} were 2.44 and 2.50, respectively. The farmers earned the highest profit from cabbage production. The results of Cobb-Douglas production function model indicated that acre^{-1} gross returns were significantly influenced by the use of human labour, tillage operation, seeds, fertilizers, manure, irrigation and insecticides. These factors were directly or jointly responsible for influencing acre^{-1}gross returns of cauliflower and cabbage. Some essential policy recommendations have been arisen which are: input and price support, and motivation and training programmes should be arranged by different government and non-government organizations and public-private partnership should be emphasized for creating scope to improve the overall economic condition of the farmers through homestead vegetable farming.

Keywords: Economics, cauliflower, cabbage, production, Sylhet.

Introduction

Bangladeshis is predominantly an agricultural country where agriculture sector plays a pivotal role for accelerating the economic growth. About 75% of the total population live in rural areas and are directly or indirectly engaged in a wide range of agricultural activities (BBS, 2010). Agriculture generates 48.4% of total employment, contributes a quarter of total export earnings and provides food security for the increasing population (Islam, 2012). Since provision of food security, improvement of the living standard and generation of employment opportunities of the huge population of the country are directly linked to the development of agriculture.

Vegetables are considered as one of most important groups of food crops due to their high nutritive value, relatively higher yield and higher return. Vegetable production in Bangladesh has increased at an average rate of 2.8% over the last two decades (Awal, 2013). In 2006-07, vegetables contributed 11.33 % value added to agriculture while in 2009-10 it stood at 9.63%. Total cropped area in 2010-11 was 14949798 ha and net cropped area during this time was 7841295.5 ha in Bangladesh of which vegetables (summer and winter) were cultivated in 367611.34 ha of land (BBS, 2011). Bangladesh earned US$ 41.11 million from export of agricultural products in 2003-2004, which contributed 0.54% to total export earnings (BER, 2008).

In Bangladesh, daily capita^{-1} availability of vegetables excluding tuber crops is only 52 g against the required amount of 200 g. This big gap is the main reason for widespread malnutrition. But the paradox is that indigenous vegetables such as bitter gourd, pumpkin, stem amaranth, Indian spinach, plantain, aroids, brinjal, etc. are the most

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inexpensive and rich sources of Calories, Vitamin A, Vitamin C, Riboflavin, minerals and essential amino acids. IVs offer scope for year-round production in the homesteads and hilly region of Bangladesh and can create a number of job opportunities in the rural and suburban areas (Mondal, 2010; Hasan and Sultana, 2011).

Vegetables are generally labor intensive crops and thus offer a considerable promise for generating increased rural employment opportunities. Homestead crop production systems especially production of horticultural crops can, to a considerable extent, help to ensure food and nutrition security in addition to self-employment, poverty alleviation and income generation of the farmers. Vegetables can be identified as a significant one for this economy for its noteworthy contribution in raising the foreign exchange earnings and occupies an important position among the items exported from Bangladesh.

A tropical location, lush greenery, moisture-rich loamy soil and production-friendly climate make Bangladesh one of the notable growers of a vast range of fruits and vegetables of impeccable quality. More than 60 types of vegetables of indigenous and exotic origin are grown in Bangladesh. Based on the growing season, vegetables are categorized assummer/rainy season vegetables, winter season vegetables, and all-season vegetables. Of the summer vegetables, various cucurbits, vegetables cowpea, hyacinth bean, stem amaranth, several aroids and Indian spinach are predominant. Winter vegetables include tomato, cabbage, cauliflower, bitter gourd, carrot, etc. Crops like okra, heat-tolerant brinjal, carrot, spinach, many leafy vegetables and small onion are grown all year round. The production of vegetables is higher during winter season (60 to 70%) and most districts produce marketable surplus during that season. Climatic condition of Bangladesh is congenial for winter vegetables. Possibilities of cultivating a wide variety of vegetables are found in Bangladesh.

The above discussion reveals that large numbers of studies have been conducted on vegetables production but few researches have been conducted on homestead vegetables production, specifically cauliflower and cabbage production in Sylhet district. The present study aims to examine the profitability of homestead vegetables production in some selected areas of Sylhet district. It is expected to bring into focus important information regarding homestead vegetables production. The specific objectives are: i) to measure the profitability of cauliflower and cabbage production; and ii) to determine the factors which influence cauliflower and cabbage production.

Materials and Methods

Three areas from Sylhet district namely Dighirpar, Basantagaon and Paschimdarsa were purposively selected for data collection. There were some reasons behind the selection of these areas which were: a) a good number of cauliflower and cabbage farmers were available in the selected areas; b) cooperation from the respondents was expected to be high and reliable data was expected to be obtained; c) easy accessibility and communication system in the selected villages; and d) these villages had some identical characteristics like topography, soil and climate condition for producing cauliflower and cabbage. Stratified random sampling technique was followed to select 15 respondents (i.e., 12 small, 2 medium and 1 large farmers) from each area. Thus, a total of 45 sample respondents were included in the study for data collection using a structured questionnaire.

Analytical Techniques

Profitability analysis

Per acre gross return, gross margin and net return of cauliflower and cabbage were calculated for analysis the financial profitability.

Gross return

Gross return was calculated by multiplying the total volume of output of an enterprise by the average price in the harvesting period (Dillon and Hardaker, 1993). It consisted of sum of the volume of main product and by-product. The following equation was used to calculate gross return:

$$GR_i = Q_{mi}P_{mi} + Q_{bi}P_{bi}$$

Where, GR_i = Gross return from i^{th} Product (Tk.acre^{-1}); Q_{mi} = Quantity of the i^{th} product (Kgacre^{-1}); P_{mi} = Average price of the i^{th} product (Tk.kg^{-1}); Q_{bi}= Quantity of the i^{th} by- product (kgacre^{-1}); P_{bi} = Average price of the i^{th} by-product (Tk.kg^{-1}); and i= 1, 2, 3....n (number of inputs).

Gross margin

Gross margin calculation was done to have an estimate of the difference between total return and variable costs. The analysis is also easily understandable because of its simplicity. The Following equation used to assess gross margin:

$$GM = TR\text{-}VC$$

Where, GM = Gross margin; TR = Total return; and VC = Variable cost.

Net return

Net return analysis considered fixed costs; cost of rental value of land, interest on operating capital etc. So, acre^{-1}net return was determined by subtracting acre^{-1}total cost (variable cost and fixed cost) of production from acre^{-1} total return. To determine the net returns of cauliflower and cabbage production, the following equation was used in the present study:

$$\pi = GR_i - \sum(P_{xi}X_i) - TFC$$

Where, π = Net return (Tk.acre^{-1}); GR_i= Gross return from ith product (Tk.acre^{-1}); P_{xi} = per unit prices of ith inputs used for producing the relevant vegetables (Tk.); X_i = Quantity of the ith inputs used for producing per acre vegetables (kg); TFC = Total fixed cost involved in producing concerned vegetables (Tk.); andi = 1, 2, 3... n (number of inputs).

Benefit-Cost Ratio (BCR)

The BCR is a relative measure, which is used to compare benefit unit^{-1} of cost. The BCR is estimated as a ratio of gross returns and gross costs. The formula of calculating BCR (undiscounted) is shown below:

$$\text{Benefit cost ratio} = \frac{Gross\ Benefit}{Gross\ Cost}$$

Factors influencing cauliflower and cabbage production

Cobb-Douglas production function was used in the present study to determine the factors that influence cauliflower and cabbage production.

Cobb-Douglas production function

Cobb-Douglas production function model was chosen to estimate the effects of key variables on gross return of cauliflower and cabbage production. The double log form of the function proved to be a superior alternative on theoretical and econometric grounds. Therefore, the following Cobb-Douglas production function was used in the present study:

$$Y_i = \alpha X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} X_6^{\beta_6} X_7^{\beta_7} e^{u_i}$$

By taking log in both sides, the Cobb-Douglas production function was transformed into the following logarithmic form because it could be solved by the ordinary least square method:

$$LnY_i = ln\alpha + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \beta_7 lnX_7 + u_i$$

Where, Y = Gross return (Tk.acre^{-1}); $ln\alpha$= Constant or Intercept of the function; X_1 = Human labor cost (Tk.acre^{-1}); X_2 = Tillage cost (Tk.acre^{-1}); X_3 = Seeds/seedlings cost (Tk.acre^{-1}); X_4= Fertilizers cost (Tk.acre^{-1}); X_5= Manure cost (Tk.acre^{-1}); X_6 = Irrigation cost (Tk.acre^{-1}); X_7 = Insecticides cost (Tk.acre^{-1}); β_1, β_2, ……β_7 = Coefficient of respective variables;ln = Natural logarithm;e = Base of natural logarithm; u_i = Error term; andi = l, 2, 3, ..., n.

Results and Discussion

Socioeconomic characteristics of the selected farmers

Table 1 represents the basic information of the selected farmers in the study areas. It was found that average household and farm size of small, medium and large farmers was 6.0, 5.0 and 6.0; and 0.83, 2.11 and 3.09 ha, respectively. Average dependency ratio of large farmers (2.6) was comparatively lower than small and medium farmers (1.2 and 1.9, respectively) which indicated that large farmers were more self-sufficient and self-employed.

Table 1. Basic information about the selected farmers

Particulars		Farmers' categories		
		Small	Medium	Large
Average household size (no.)		6.0	5.0	6.0
Average farm size (ha)		0.83	2.11	3.09
Average dependency ratio (no.)		1.2	1.9	2.6
Average sex distribution (% of farmers)	Male	62.0	72.1	67.5
	Female	38.0	27.9	32.5
Average age (years)		31	38	35
Literacy rate (% of farmers)	Illiterate	32.0	56.5	55.6
	Sign only	42.0	27.5	22.4
	Primary and above	26.0	16.0	22.0
Occupational status (% of farmers)	Agriculture only	26.0	22.0	29.0
	Agriculture and others	74.0	78.0	71.0

Source: Field survey, 2016.

The percentages of male and female respondents were 62.0, 72.1 and 67.5; and 38.0, 27.9 and 32.5 for small, medium and large farmers, respectively. Average age of small, medium and large farmers was 31, 38 and 35 years, respectively. Though 42.0% small farmers could put sign only, majority of the medium and large farmers (56.5 and 55.6%, respectively) were illiterate in the study areas. Most of the farmers were engaged in agriculture as well as other income generating activities like labour selling, service, small business, etc. (74.0, 78.0 and 71.0% small, medium and large farmers, respectively) (Table 1).

Profitability of cauliflower and cabbage production

Estimation of production cost

For calculating total production cost, variable and fixed costs were taken into consideration. The components of variable cost were land preparation, sowing, weeding, harvesting, power tiller, seed/seedlings, fertilizer, manure, irrigation, insecticides, wastage and miscellaneous. Fixed cost items for crop production were agricultural equipment, land use cost and interest on operating capital.

It is evident from Tables 2 and 3 that total cost of human labor for land preparation amounted to Tk. 3433.33 and Tk.3635.56 acre^{-1}in cauliflower and cabbage production, respectively those covered 3.66 and 3.95of the respective total cost of production. Total cost of human labor for sowing amounted to Tk. 3117.78 and Tk. 3208.89 acre^{-1}in cauliflower and cabbage production, respectively; those covered 3.32 and 3.48 of the respective total cost of production. Total cost of human labor for weeding amounted to Tk. 3273.33 and Tk. 3224.44 acre^{-1}in cauliflower and cabbage production respectively; those covered 3.48 and 3.50 of the respective total cost of production. Total cost of human labor for harvesting amounted to Tk. 4493.33 and Tk. 4093.33 acre^{-1}in cauliflower and cabbage production, respectively; those covered 4.79 and 4.44 of the respective total cost of production. For cauliflower and cabbage production, the average acre^{-1}power tiller cost was 6085.19 and 3570.37, respectively. In percentage terms it shared 6.48 and 3.88% of total cost (Tables 2 and 3).

The farmers used different kinds of fertilizers for higher yield of vegetables. Commonly used fertilizers were Urea, TSP, MP, Gypsum, etc. All the fertilizers were purchased. Costs of fertilizers were estimated according to the cash price paid. Market prices of Urea, TSP, and MOP were Tk. 20, Tk. 25, and Tk. 18, respectively. Most of the farmers used cowdung as manure in producing cauliflower and cabbage. The cost of cowdung acre^{-1} was Tk. 5863.03 and Tk. 5996.03, respectively. The total amount of seeds requirement acre^{-1}for producing cauliflower and cabbage production were 0.064 kg and 0.059 kg, respectively and their respective costs were Tk. 3105.83 and Tk. 2886.41, respectively which shared 3.31 and 3.13% of total cost of production. The cost of insecticides amounted to Tk. 6640 and Tk. 6387.002 acre^{-1} for cauliflower and cabbage production, which occupied 7.08% and 6.93% of their respective total costs. Per acre cost of irrigation water in cauliflower and cabbage were Tk. 6242.72 and Tk. 6185.95, respectively which represented 6.65 and 6.71% of their respective total costs. Per acre miscellaneous cost in cauliflower and cabbage were Tk. 2554.44 and Tk. 2565.19, respectively which represented 2.72 and 2.78% of their respective total costs. Summation of the costs of variable inputs gave the total variable costs which was Tk. 61591.06 and Tk. 59933.62 acre^{-1}for cauliflower and cabbage production, respectively. In percentage term, total

variable costs covered 65.62 and 65.05% of total costs for cauliflower and cabbage production, respectively (Tables 2 and 3).

Table 2. Cost and return of cauliflower production acre^{-1}

Items	Unit	Quantity	Price unit^{-1} (Tk.)	Total value (Tk.)	% of Total
A. Gross returns					
Main Product	No.	11470.37	20	229407.4	
By Product	Tk.	-	-		
Total gross return	Tk.	-	-	229407.4	
B. Variable cost					
Human Labor					
Land preparation	Man-days	11.44	300	3433.33	3.66
Sowing	Man-days	10.39	300	3117.78	3.32
Weeding	Man-days	10.91	300	3273.33	3.48
Harvesting	Man-days	14.98	300	4493.33	4.79
Power Tiller	Times	-	-	6085.19	6.48
Urea	Kg.	95.40	20	1908.15	2.03
TSP	Kg.	294.95	25	7373.70	7.86
MOP	Kg.	112	18	2016.00	2.15
Cowdung	Kg.	2162.59	2.71	5863.03	6.25
Seeds	Kg.	0.064	48444.44	3105.83	3.31
Pesticides	Tk.	-	-	6640.97	7.08
Irrigation	Tk.	-	-	6242.72	6.65
Wastage	Tk.	-	-	5483.26	5.84
Miscellaneous	Tk.	-	-	2554.44	2.72
Total variable cost				61591.06	65.62
C. Fixed cost					
Ag. Equipment	Tk.	-	-	2664.12	2.84
Land Use Cost	Tk.	-	-	20000.00	21.31
Interest on OC	Tk.	-	-	9605.37	10.23
Total fixed cost	Tk.	-	-	32269.49	34.38
D. Gross cost (B+C)	Tk.	-	-	93860.55	100
E. Gross margin (A-B)	Tk.	-	-	167816.35	
F. Net return (A-D)	Tk.	-	-	135546.85	
G. BCR(Undiscounted)				2.44	

Source: Authors' estimation, 2016.

Table 3. Cost and return of cabbage production acre^{-1}

Items	Unit	Quantity	Price unit^{-1} (Tk.)	Total value(Tk.)	% of Total
A. Gross returns					
Main Product	No.	11540	20	230800	
By Product	Tk.	-	-	-	
Total gross return	Tk.	-	-	230800	
B. Variable cost					
Human Labor					
Land preparation	Man-days	12.11	300	3635.56	3.95
Sowing	Man-days	10.70	300	3208.89	3.48
Weeding	Man-days	10.75	300	3224.44	3.50
Harvesting	Man-days	13.64	300	4093.33	4.44
Power Tiller	Times	-	-	3570.37	3.88
Urea	Kg.	101.70	20	2034.07	2.21
TSP	Kg.	329.47	25	8236.85	8.94
MOP	Kg.	133.93	18	2410.67	2.62
Cowdung	Kg.	2267.407	2.64	5996.03	6.51
Seeds	Kg.	0.059	48555.56	2886.41	3.13
Pesticides	Tk.	-	-	6387.002	6.93
Irrigation	Tk.	-	-	6185.95	6.71
Wastage	Tk.	136.19	40.38	5498.86	5.97
Miscellaneous	Tk.	-	-	2565.19	2.78
Total variable cost	-	-	-	59933.62	65.05
C. Fixed cost					
Ag. Equipment	Tk.	-	-	2762.70	2.99
Land Use Cost	Tk.	-	-	20000.00	21.71
Interest on OC	Tk.	-	-	9439.48	10.25
Total fixed cost	Tk.	-	-	32202.18	34.95
D. Gross cost (B+C)	Tk.	-	-	92135.8	100
E. Gross margin (A-B)	Tk.	-	-	170866.38	
F. Net return (A-D)	Tk.	-	-	138664.2	
G. BCR (Undiscounted)				2.50	

Source: Authors' estimation, 2016.

Per acre cost of agricultural equipment in cauliflower and cabbage were 2664.117 and 2762.70, respectively which represented 2.84 and 2.999% of their respective total costs. The land use cost acre^{-1}was Tk. 20000 for cauliflower and cabbage production. Land use cost covered 21.31 and 21.71% of total costs of cauliflower and cabbage production, respectively. In production practice, acre^{-1}interest on operating cost was Tk. 9605.37 and Tk. 9439.48 for cauliflower and cabbage production, respectively. In percentage term, this cost covered 10.23 and 10.25% of total costs for cauliflower and cabbage production, respectively. Summation of the costs of fixed inputs made total fixed costs. Total fixed costs were Tk. 32269.49 and Tk. 32202.18 acre^{-1} for cauliflower and cabbage production, respectively. In percentage term total fixed costs covered 34.38 and 34.95% of total costs for cauliflower and cabbage production, respectively. In order to estimate gross costs acre^{-1}, all the resources used in cauliflower and cabbage production have been recaptured together. Per acre gross costs of cauliflower and cabbage production were Tk. 93860.55 and Tk. 92135.8, respectively (Tables 2 and 3).

Estimated returns

It was seen from Tables 2 and 3 that acre^{-1} average yields of cauliflower and cabbage were estimated to be 11470.37 kg acre^{-1}, and 11540 kg acre^{-1}, respectively. Per acre gross returns of cauliflower and cabbage were Tk. 229407.4 and Tk. 230800, respectively. Per acre gross margins were estimated at Tk.167816.35 and Tk.170866.38 for cauliflower and cabbage, respectively. Per acre net returns of cauliflower and cabbage were Tk. 135546.85 and Tk. 138664.2, respectively. Benefit cost ratios of cauliflower and cabbage production acre^{-1}were 2.44 and 2.50,

respectively which implies that Tk. 2.44 and Tk. 2.50, respectively will be achieved for corresponding crop by investing Tk. 1.00 in crop production.

Factors affecting cauliflower and cabbage production

To identify and measure the effects of relevant variables of production on gross returns of cauliflower and cabbage, Cobb-Douglas production function model was used. Estimated values of the production function analysis, estimated values of the coefficients and related statistics of the Cobb-Douglas production functions of cauliflower and cabbage are presented in Tables 4 and 5.

Factors affecting production of cauliflower

Human labor cost (X_1)

The magnitude of the regression coefficient of human labor costs was 0.142 with a positive sign. This coefficient was statistically significant at 5% probability level it implies that, 1% increase in human labor costs, keeping other factors constant, would lead to an increase in the gross return by 0.14% (Table 4).

Tillage cost (X_2)

The magnitude of the regression coefficient of tillage cost was 0.043 with a negative sign. This coefficient was insignificant. This indicates that an increase in 1% of tillage cost, remaining other factors constant, would result in decrease in the gross return by 0.04% (Table 4).

Seeds cost (X_3)

It can be seen from Table 4 that regression coefficient of seeds cost was 0.406 with a positive sign. This coefficient was statistically significant at 1% probability level it implies that, 1% increase in seed costs, keeping other factors constant, would lead to an increase in the gross return by 0.41%.

Fertilizers cost (X_4)

It can be seen from Table 4 that regression coefficient of fertilizer (Urea, TSP, MOP, etc.) cost was 0.274 with a positive sign. This coefficient was statistically significant at 1% probability level it implies that, 1% increase in fertilizer costs, keeping other factors constant, would lead to an increase in the gross return by 0.27%.

Manure cost (X_5)

It can be seen from Table 4 that the magnitude of the regression coefficient of manure cost was 0.36 with a positive sign. This coefficient was insignificant. This indicates that an increase in 1% of manure cost, remaining other factors constant, would lead to an increase in the gross return by 0.36%.

Table 4. Estimated values of Cobb-Douglas production function model for cauliflower production

Explanatory variables	Cauliflower		
	Estimated coefficient	Standard errors	T-values
Constant	4898.012	905.779	5.408
Human labor (X_1)	0.142**	0.062	2.292
Tillage cost (X_2)	-0.043	0.065	-0.657
Seed cost (X_3)	0.406***	0.093	4.382
Fertilizers cost (X_4)	0.274***	0.054	5.122
Manure cost (X_5)	0.36	0.099	0.366
Irrigation cost (X_6)	0.032	0.062	0.518
Insecticides (X_7)	0.020	0.107	0.187
R^2	0.632		
F-value	11.797***		
Returns to scale (Σβi)	1.19		

Source: Authors' estimation, 2016.
Note: *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level.

Irrigation water cost (X_6)

It can be seen from Table 4 that the magnitude of the regression coefficient of irrigation water cost was 0.032 with a positive sign. This coefficient was insignificant. This indicates that an increase in 1% of irrigation water cost, remaining other factors constant, would lead to an increase in the gross return by 0.03%.

Insecticides cost (X_7)

It can be seen from Table 4 that regression coefficient of insecticides cost was 0.020 with a positive sign. This coefficient was statistically insignificant. This indicates that an increase in 1% of insecticides cost, remaining other factors constant, would result in an increase in the gross return by 0.02%.

Coefficient of multiple determinations (R^2)

It is evident from Table 4 that the value of the coefficient of multiple determinations (R^2) was 0.632. It indicated that about 63% of the variations of the gross return are explained by the explanatory variable included in the model.

Goodness of fit (F-value)

The F-value (11.797) of the estimated production function was significant at 1% probability level (Table 4), which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining the variation of cauliflower production.

Returns to scale ($\sum \beta i$)

The summation of all the regression coefficient of the estimated production function of cauliflower was 1.19. This implies that the production function exhibited increasing returns to scale. In this case, if all the variables specified in the production function were increased by 1%, gross return on an average would increase by 1.19% (Table 4).

Factors affecting production of cabbage

Human labor cost (X_1)

The magnitude of the regression coefficient of human labor costs was 0.001 with a positive sign. This coefficient was insignificant. This indicates that a 1% increase in human labor costs, keeping other factors constant, would lead to an increase in the gross return by 0.001% (Table 5).

Tillage cost (X_2)

It can be seen from Table 5 that regression coefficient of Tillage cost was 0.455 with a positive sign. This coefficient was statistically significant at 5% probability level it implies that, 1% increase in tillage costs, keeping other factors constant, would lead to an increase in the gross return by 0.46%.

Seeds cost (X_3)

It can be seen from Table 5 that the magnitude of the regression coefficient of seed cost was 0.063 with a positive sign. This coefficient was insignificant. This indicates that an increase in 1% of seeds cost, remaining other factors constant, would lead to an increase in the gross return by 0.06%.

Fertilizers cost (X_4)

It can be seen from Table 5 that regression coefficient of fertilizer cost was 0.153 with a positive sign. This coefficient was statistically significant at 1% probability level it implies that, 1% increase in fertilizer costs, keeping other factors constant, would lead to an increase in the gross return by 0.15%.

Manure cost (X_5)

The magnitude of the regression coefficient of tillage cost was 0.407 with a positive sign. This coefficient was insignificant. This indicates that an increase in 1% of manure cost, remaining other factors constant, would lead to an increase in the gross return by 0.41%.

Irrigation water cost (X_6)

The magnitude of the regression coefficient of tillage cost was 0.224 with a negative sign. This coefficient was significant at 5% probability level. It implies that 1% increase in irrigation water cost, keeping other factors constant, would lead to a decrease in the gross return by 0.22% (Table 5).

Insecticides cost (X_7)

It can be seen from Table 5 that regression coefficient of insecticides cost was 0.307 with a positive sign. This coefficient was statistically significant at 5% probability level it implies that, 1% increase in insecticide costs, keeping other factors constant, would lead to an increase in the gross return by 0.31%.

Table 5. Estimated values of Cobb-Douglas production function model for cabbage production

Explanatory variables	Cabbage		
	Estimated coefficient	Standard errors	T-values
Constant	7968.172	754.752	10.557
Human labor (X_1)	0.001	0.052	0.028
Tillage cost (X_2)	0.455**	0.202	2.248
Seed cost (X_3)	0.063	0.150	0.422
Fertilizers cost (X_4)	0.153***	0.045	3.422
Manure cost (X_5)	0.407	0.140	0.762
Irrigation cost (X_6)	-0.224**	0.102	-2.203
Insecticides (X_7)	0.307**	0.119	2.570
R^2	0.498		
F-value	7.225***		
Returns to scale (Σβi)	1.62		

Source: Authors' estimation, 2016.
Note: *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level.

Coefficient of multiple determinations (R^2)

It was evident from Table 5 that the value of the coefficient of multiple determinations (R^2) was 0.498. It indicated that about 50% of the variations of the gross return are explained by the explanatory variable included in the model.

Goodness of fit (F-value)

The F-value (7.225) of the estimated production function was significant at 1% probability level (Table 5), which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining the variation of cabbage production.

Returns to scale ($\sum \beta i$)

The summation of all the regression coefficient of the estimated production function of cabbage was 1.62. This implies that the production function exhibits increasing returns to scale. In this case, if all the variables specified in the production function were increased by 1%, gross return on an average would increase by 1.62% (Table 5).

Conclusion and Recommendations

The study concludes that cauliflower and cabbage production are highly profitable in the study areas. Specifically, profitability of cabbage production is relatively higher compared to cauliflower production. It is experienced that involvement with cauliflower and cabbage production created ample scope to increase income, employment and nutritional status of farmers; ameliorate the problem of gender issue by enabling the women to participate in the household decision making in rural areas. The study reveals that human labor, seed cost and fertilizers cost had significant impact on cauliflower production where tillage cost, fertilizers cost, irrigation cost and insecticides cost had significant impact on cabbage production. Considering the findings of the study, some essential policy recommendations have been arisen which are: input and price support, and motivation and training programmes should be arranged by different government and non-government organizations; and public-private partnership should be emphasized for creating scope to improve the overall economic condition of the farmers through homestead vegetable farming.

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