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Research Article

Factors Influencing the Lentil Production in Selected Areas of Pabna District in Bangladesh

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ABSTRACT

This study was conducted to assess the existing socioeconomic and profitability status, as well as the variables affecting lentil production in Pabna district of Bangladesh. Primary data were collected from 90 randomly selected Lentil farmers. Descriptive statistics and cost-return analysis were applied to assess the current condition and profitability of lentil production. The findings showed that the undiscounted benefit-cost ratio was 1.72, indicating that the production of lentils was profitable. The Cobb-Douglas production function was used to estimate the parameters which showed that labor, seed, and fertilizer all had a significant impact on lentil production. Therefore, it would be crucial to use these resources effectively throughout the production of lentils in order to increase producer's profits. Farmers in the research region faced a number of production-related issues, including severe disease and insect attacks, expensive and poor-quality seeds, lack of training, drought and excessive rains, the high cost of pesticides and insect attacks in storage, etc. So, the government should take actions to make it easier for farmers to obtain critical inputs and provide subsidies to entice more farmers to grow lentils.

Introduction

Lentil which is a small legume seed; scientifically belongs to the Lens culinaris species and the Leguminosae (Fabaceae or Papilionaceae) family. Among the early food crops lentil is considered to be the ancient ones grown in the world which was in early 7000 BC from southwestern Asia (Dhuppar *et al.,* 2012). With other legume seeds such as pea, chickpea, and dry beans; Lentil is also classified as a pulse. It is the most popular pulse crop in Bangladesh where it is served not only as human food but also as animal feed and fodder, and raw material for agro-processing industries (Ali *et al.*, 2014). Pulse crops have played an important function to maintain the productivity and sustainability of soils by fixing nitrogen (Krishna *et al.*, 2020). According to BBS 2021 report, the area and annual production of pulses in Bangladesh are 0.141 million hectares and 0.177 million metric tons respectively where lentil is placed in the first position according to both area coverage (40% of total pulse area) and production (45% of total pulse production). As a consequence of adopting high-yielding and improved varieties in the cropping patterns replacing local varieties; it is observed that the area, production, and yield of lentils further increased unwaveringly from 2009-10 to 2019-20 (Miah *et al*., 2021a). However, the requirement for lentils in the country is around 6-7 lakh MT every year (Miah *et al.*, 2021b) which is greater than the current production level of lentils. Therefore, to meet the domestic demand for lentils, the government has to import about 12-13 lakh tonnes of lentils every year which involve huge foreign currency (Zaman, 2023). Moreover, the nutritional values of lentils are mostly disregarded by many people. It contains several micronutrients; especially it is rich in protein (25.7–33.4%) (Podder *et al.,* 2021). Among all the whole cereal crops like wheat, oats, barley, and rice; lentil contains approximately twice the amount of protein. Therefore, in places where most of the people are

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vegetarians such as in west Asia and the Indian subcontinent, to fulfil their nutritional requirements lentil has become the cheapest protein source. Like other pulse proteins, lentil protein is also proved to be a good source of the essential multinutrients such as amino acids, particularly leucine, lysine, threonine, and phenylalanine. They are also enriched with vitamin B complex, zinc, potassium, and magnesium. Because of the high protein content and low cost, pulses are called poor man's meat (Sumera and Ali, 2020). Although lentil is cultivated in different parts of Bangladesh but extensively it is produced in the mid-western parts of the country. Woefully, in Bangladesh the yield of local lentil variety is very poor; but the yield varied widely depending on farm and locations where they are being cultivated (Sikder and Elias,1985). The total contribution of lentils to pulse production is found to be 2.4% in the world (Erskine & Witecombe, 1984).

Several researchers have conducted by different researches occasionally on the adoption practices and production of lentil (Islam *et al.* 2020; Rashid *et al.,* 2018), measurement of technical efficiency (Huq *et al.,* 2007; Dutta, 2016), economic assessments of lentil cultivation such as profitability, gross margin (Sarker *et al.,* 2020; Ahmed *et al.,* 2018), constraints of production and marketing (Rahman *et al.,* 2012), production and value chain analysis (Hajong *et al.,* 2020), estimating the profitability, domestic resource cost (DRC) and comparative advantages of lentil (Tithi and Barmon, 2018). Matin *et al*. (2018) revealed that HYV lentil is proved to be more profitable than other local variety and Hossain *et al.* (2016) conducted a study on performance of BARI released lentil varieties in char land ecosystem under Kurigram district. Islam *et al.* (2015) performed another research on lentil varieties under relay and minimum tillage conditions. All the relevant past studies conducted on lentil cultivation mostly estimated the profitability of lentil production in some selected areas of Bangladesh but not in the Pabna district. But to get better understanding about the profitability and information of lentil production, we need to have proper knowledge on lentil cultivation in all areas of Bangladesh not only on some selected areas. As far we know, Pulses Research Centre (PRC) of BARI which is situated at Ishwardi upazila under the Pabna district has developed 9 varieties of lentils. These developed varieties are not only high yielding but also good sources of iron and zinc than the previous local varieties. Although, these developed varieties are growing by the farmers but the adoption status and the economic performance of this crop may be still unknown to many lentil producers of the country as only a limited number of studies was done in this sector. Since the rate of sustainability and adoption of any crop by farmers depends on its economic profitability to a large extent; the present study estimates the financial profitability and factors affecting the profitability of lentil production in selected areas of Pabna district. In addition, this study also tries to identify the problems faced by farmers and also the potentiality of lentil production to promote the large-scale domestic production of lentils, which might lower significant import costs, secure food security and bolster our country's economy.

Methodology

Sampling techniques, selection of the study areas, and sample size

As the respective study was based on the primary data; all the required data were collected from 3 major lentils growing Upazillas such as Bhangura, Chatmohar and Faridpur from Pabna district of Bangladesh. Afterward, three villages namely Diyapara, Chhaikola and Chakchokia were purposively selected from Bhangura, Chatmohar and Faridpur upazilas respectively for conducting a household survey. Finally, using the simple random sampling technique, a total of 90 lentil farmers were selected from the selected 3 upazilas. All the required data were collected through interviewing the respondents directly through using a prescribed survey schedule in 2021. Notably, each survey schedule was carefully checked and verified in order to eliminate all the associated possible errors and inconsistency after the interview had been taken.

Analytical Techniques

To fulfil the objectives of the study, all the collected data from the survey were analysed by using tabular and statistical methods. In order to represent the results of the study a tabular analysis including different statistical tools like averages, ratios and percentages were used. To compare and analyse the socio-economic status of the respondent farmers, descriptive statistics were used. To measure the per hectare financial profitability of lentil production from the perspective of individual farmers some statistical ratio such as net return, the benefit-cost ratio (undiscounted) and gross margin were applied in this study.

In order to calculate gross return, the following equation was employed (Dillon and Hardaker, 1993):

$$GR_i = \sum_{i=1}^{n} Q_i P_i$$

Where, GR_i= Gross return of ith product (Tk./kg); Q_i = Quantity of the ith product (kg.); P_i = Average price of the ith product (Tk.); i = 1, 2, 3, ..., n (no. of lentil farmers).

We calculated Interest on operating capital (IOC) using the following formula:

$$IOC = AI \times i \times t$$

$$AI = \frac{Total\ investment}{2}$$

Where, i = Rate of interest per year (%); and t = Period of production (in month).

The gross margin was calculated using the formula below:

$$GM = TR - TVC$$

Where, GM = Gross Margin; TR = Total Return; and TVC = Total Variable Cost.

To determine the net return of lentil cultivation, the following equation was used for each of the selected farmers:

$\Pi = P_l * Q_l - (TVC + TFC)$

Where,

Π = Net return / Profit of lentil growers per hectare,

P_l= Per unit price of lentil (Tk/kg),

Q_l= Total quantity of lentil (product and by-product; Kg/ha),

TVC = Total variable cost,

TFC = Total fixed cost.

Benefit Cost Ratio

BCR= Total Benefit/Total cost

Factors affecting the lentil production

To determine the factors that influence the lentil production in the selected areas, the Cobb-Douglas production function has been used. By employing log in both sides of the equation, the Cobb-Douglas production function was transformed into the following form because it could be solved by applying the ordinary least squares (OLS) method. To estimate the contribution of factors that influence the production of lentils in the study areas the following form of Cobb-Douglas production function was used:

$$lnY = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \beta_6 lnX_6 + \varepsilon_i$$

Where,

Y = Output from lentil (kg)

X_1 = Farm Size (Hectare)

X_2 =Seed (kg)

X_3 = Irrigation (no. of application)

X_4 = Fertilizer (kg)

X_5 = Pesticides(kg)

X_6 = Labor (man-days)

β_0 is intercept and β_1, β_2, β_3, β_4, β_5, and β_6 are the coefficients of the regression to be estimated. ε_i is the error term which is independently distributed. In addition, t-test was used to find out the significance level of the regression coefficient in the model.

Results and Discussion

Socio-economic status of lentil farmers

The socioeconomic conditions of households of lentil farmers are of much importance in the planning and improving the production process as it is intensively affected by the nature and status of the farmers. The age of farmers acts as a key influencer on the adoption of new farming practices in agricultural production process (Singh *et al.,* 2010). It is observed that, on an average most of the lentil growers in the study area were belonged to the middle age group of 41-50 years (31%). Education is necessary to encourage farmers to adopt and use new technology in farm- level activities and it also enable them to use the scarce resources more effectively in order to gain more profit. But unfortunately, Table 1 revealed that the education level of lentil growers was very low (i.e., only sign). Additionally, average land holding of the respondent farmers was 1.02 ha where lands under lentil cultivation was only 0.14 ha and agriculture was the main occupation of most of the growers (63%). Since, the farming experience reflects the knowledge and skill of a person, it is an important indicator of the socio-economic status of the farmers and the average farming experience was found to be about 18 years for the lentil growers in the respective areas.

Table 1. Socio-economic status of lentil farmers

Attributes	Categories	Percentage of farmer	Area
Age (year)	Less than 30	4	
	31- 40	25	
	41-50	31	
	51-60	28	
	Above 60	12	
Level of literacy	Illiterate	14	
	Only sign	32	
	Primary	19	
	SSC	23	
	HSC	9	
	Graduate and above	3	
Occupational Status	Agriculture only	63	
	Agriculture with business	14	
	Agriculture with services	13	
	Agriculture with Van/Auto/Rickshaw puller/ Day labourer	10	
Farming experience (average)		17.5	
Farm ownership (Ha)			1.02
Lentil cultivated area (Ha)			0.14

Profitability analysis of lentil production

Profitability is an indicator for measurement of efficiency and is considered to be the major factor for determining the acceptance of a crop. For calculating the cost of lentil production, the costs associated with the cost of human labour, land preparation, seed, fertilizers, pesticides, irrigation and interest on operating capital were taken into consideration. As, the total cost consists of both-total variable cost and total fixed cost. Table 2 reveals that total variable cost and total fixed costs of lentil cultivation were 30331 and 39034 Tk./ha respectively which covered 44 and 56% of the total cost for lentil production. The highest cost in case of lentil production was for land use cost which is lease value of the land (40%) followed by human labor (37%), power tiller (4%), fertilizer cost (8%), seed (6%) and irrigation costs (3%) respectively. Interest on operating capital which includes variable cost in the production where Interest rate of 4 % per annum was considered for calculation. The cost of lentil cultivation was found the highest at Faridpur (Tk. 75075/ha) due to higher labour and irrigation costs followed by Bhangura (Tk. 64495 /ha) and Chatmohar (Tk. 68524/ha). In Table 3, the average return from lentil production in different areas has been shown. The average yield of lentils was calculated to be 1610 kg/ha. The highest yield was found to be at Faridpur (1677 kg/ha) followed by Chatmohar (1665 kg/ha) and Bhangura (1487 kg/ha). Matin *et al.,* (2018) found the average yield 1479 kg/ha in Jashore district. Whereas, Kazal *et al.,* (2013) experienced a much lower yield (1160 kg/ha) in Natore district. The price of lentils was found the highest at Bhangura (Tk.72/kg) and the lowest at Faridpur (Tk. 68/kg). It was observed that the gross return from lentil production consists of the return of lentils and straws. In relation to Table 3, the average gross return of lentil production was calculated Tk.119376/ha. According to the area, the gross return of Bhangura, Chatmohar and Faridpur was found 113890, 123750 and 120488 Tk./ha respectively. It is presented in the table that, the average gross margin was 89045 Tk./ha on a variable cost basis, and the gross margin of Chatmohar (Tk.92248/ha) was highest followed by Bhangura and Faridpur (89214 and 85674 Tk./ha respectively). The average net return of lentil production was calculated Tk. 50011/ha along with the highest (Tk.55226/ha) net return at Chatmohar and the lowest net return at Faridpur (Tk.45413/ha). Moreover, the Benefit-cost cost ratio (BCR) was found out to be1.72 implying that lentil cultivation at the farm level is highly profitable. Matin *et al.* (2018) and Hajong *et al.* (2020) calculated the BCRs (1.81 & 1.75) of lentil cultivation using improved varieties which are higher than the present result (1.71). On the contrary, Rahman *et al.* (2012) found a BCR of 1.53 that was lower than the present study. Among the selected areas, the BCR was the highest at Chatmohar (1.80) which means that lentil cultivation is more profitable in Chatmohar than in other study areas.

Table 2. Per hectare cost of lentil production

Cost component	Cost of production (Tk./ha)			All	% Of the total cost
	Bhangura	Chatmohar	Faridpur		
A) Total variable cost	24676	31502	34814	30331	44
Hired labour	9956	15594	16137	13896	20
Seed	3951	4696	4189	4279	6
Power tiller	1647	2083	4865	2865	4
Fertilizer	5746	5892	5551	5730	8
Cowdung	0	154	73	76	0.10
Urea	368	467	814	550	1
TSP	0	202	50	84	0.12
MP	1157	958	1361	1159	2
DAP	4221	3946	3230	3799	5
Boron	0	0	34	11	0.02
Zinc	0	319	62	127	0.18
Pesticide	1359	1988	1294	1547	2
Irrigation cost	1854	886	2474	1738	2
Interest on operating capital	163	209	231	201	0.28
B) Total Fixed cost	39819	37022	40261	39034	56
Family labour	14454	8081	12234	11590	17
Land use cost	25365	28941	28027	27444	40
Total cost (A+B)	64495	68524	75075	69365	100

Table 3. Profitability of lentil production

Particulars	Bhangura	Chatmohar	Faridpur	All
Output (Kg/ha)	1487	1665	1677	1610
Return from lentil (Tk/ha)	107064	114885	114036	111995
Return from straw (Tk/ha)	6826	8865	6452	7381
Gross return (Tk/ha)	113890	123750	120488	119376
Total variable cost (Tk/ha)	24676	31502	34814	30331
Total cost (Tk/ha)	64495	68524	75075	69365
Gross margin (Tk/ha)	89214	92248	85674	89045
Net return (Tk/ha)	49395	55226	45413	50011
Benefit-cost ratio (BCR)	1.76	1.80	1.60	1.72

Factors affecting the profitability of lentil production

This study also determines the factors that affect the profitability of lentil production. According to production function analysis, as presented in Table 4, the Cobb-Douglas production function model has been adopted to identify the effect of some variables on lentil production. It is observed that the coefficients of seed, fertilizer and labour were statistically significant which indicates that they have significant positive effect on lentils' productivity. Statistically, the coefficient of the seed is significant at 10% level and positive, indicating that using more seed in the production process results in significant increase in the productivity of lentil. Undoubtedly, seed is the most pivotal and key input and one of major drivers to increase the productivity of agricultural products. Seeding density also affect the plant's ability to absorb natural resources and nutrients from the soil. Increased seeds also contribute to increase the production through vigorous germination and also improve yield contributing traits (Shoaib *et al.*, 2022). According to the estimation, coefficient of fertilizer is also found to be positive and significant at 5% level indicating that the use of additional fertilizer also contributes to increase the lentil production. Fertilizers are the chemical which are used by the farmers to improve soil fertility and increase plant nutrients. Moreover, fertilizers improve the capacity of the plants to hold more water and also increase root depth traits of plants. Fertilizers also enhance the capability of plants to survive the illness and sharing ability of soil nutrients with invasive weeds (El-Sayed El-Hendawy 2021). Again, the calculated coefficient of human labour was positive and significant at 1% probability level, suggested that the use of more labour would definitely increase the lentil production. Labor is certainly the most vital input of any agricultural production system and mandatory or any type of farm operations, planting, weeding, pruning and harvesting. Furthermore, the necessity of labour is not confined in the agricultural land only, other farms and

agribusinesses related activities also require human labour throughout all the year. Sary *et al.,* (2020) revealed that an increase in the input of labour will result in an increase of output in case of rice production which is very obvious. Rest of the inputs used in the production process of lentil had both positive and negative impact but they were not statistically significant. By summing up the coefficients of all inputs the return to scale was estimated 1.00 for lentil production. This means, in case of lentil cultivation the Cobb-Douglas production function shown constant return to scale and the goodness of fit of production function which is specified by the coefficient of the determination (R^2) was estimated about 0.91. This result indicates that the production function was explained about 91% by the independent variables which was significant at 1% level statistically for lentil production.

Table 4. Factors influencing the lentil production

Variables	Coefficients	SE	t-values
Farm Size(lnX_1)	0.209	0.192	1.10
Seed(lnX_2)	0.232*	0.171	1.40
Irrigation(lnX_3)	-0.003	0.002	-1.15
Fertilizer(lnX_4)	0.270**	0.132	2.04
Pesticides(lnX_5)	-0.001	0.003	0.40
Labor(lnX_6)	0.281***	0.094	3.00
Constant	3.597	0.712	4.99
Return to scale	1.00		
R^2	0.91		
F-value	136.92		

Note: ***, ** & * indicate 1%, 5% & 10% significance level, respectively

Major constraints to lentil cultivation

The farmers in the study areas also came across some constraints during lentil production which are shown in Table 5. The Table indicates that the first ranked constraint was insect and disease infestation in all areas (90%). It was followed by the high price but the low quality of seeds (72%), lack of training (57%), drought and excess rainfall (39%), the high price of pesticides (29%) and attack insects in storage (14%) respectively. Lentil farmers in the study areas experienced some constraints regarding the lack of seed of developed varieties. Although the farmers received improved varieties for their use in the previous years but currently the latest varieties are not available to them. Therefore, it was the demand to make the latest varieties of lentils available to their nearest market. Additionally, technical knowledge about modern production technology is mandatory for the efficient and effective use of inputs and receiving higher yields but it is regretful that most of the respondent of lentil farmers could not have expected yield because of lack of knowledge. Therefore, they need proper training in lentil production to overcome this constraint. Farmers also said that some of their used varieties were very much prone to diseases and hence they suggested developing disease-resistant varieties for them. Although there are no such varieties of lentil which are completely disease free but some are less susceptible than others. Improved varieties with timely and scientific application of fungicide in persistent wet weather can increase the yield of lentil to a large extent.

Table 5. Major constraints of lentil production in the study areas

Sl. No.	Constraints	Percentage of farmers				Rank
		Bhangura	Chatmohar	Faridpur	All Areas (average)	
1	Invasion of pests and diseases	90	92	88	90	1
2	High price and low quality of seeds	78	80	60	72	2
3	Lack of training	70	50	53	57	3
4	Excessive rains and drought	40	42	37	39	4
5	The high price of pesticide	27	30	31	29	5
6	Attack bug in storage	13	10	20	14	6

Conclusion

Lentils are one of the main food grains and the main components of the daily diet of the vast majority people of Bangladesh. This study intended to find out the socio-economic condition, profitability and the factors affecting the profitability of lentil production at Pabna district of Bangladesh. The major socioeconomic characteristics that affect profitability were age, educational status, farming experience, farmer`s occupational status and the farm ownership area. The study revealed that lentil production was profitable for the farmers and had a tremendous scope to increase the production by utilizing the seed, fertilizer and labour input efficiently. It is essential for the Department of Agricultural Extension (DAE) to arrange more training for farmers as they face the problem of various disease and infection in lentil production and also Upazilla Agriculture Office should help the farmers to get better quality seed and ensure the availability of fertilizer and pesticide at the grass root level. Government should take necessary steps to control the market price of lentil seed and other necessary inputs and arrange for subsidies to encourage more farmers to engage in lentil production. Government should also

emphasize to supply disease resistant varieties of lentil seeds to the farmers with a package of modern technology which will not only increase the yield of lentil but also reduce the dependence on other countries for this precious protein source.

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