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RESOURCE USE EFFICIENCY ANALYSIS IN STRAWBERRY PRODUCTION IN SELECTED AREAS OF BANGLADESH

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ABSTRACT

Inefficient use of existing scarce resources has adverse effect on food production and production cost hence, low income among the farmers across the nation. Strawberry farming is profitable but costly. So the study was designed to explore resource use efficiency of strawberry cultivation in Rajshahi and Joypurhat district of Bangladesh. Primary data were collected from 100 strawberry growing farmers. Data were analyzed by using descriptive statistics, Cobb-Douglass production function and marginal productivity analysis. The results showed that 41% farmers were 18 to 30 years old. Highest 26% farmers had primary level of education, 61% farmers had small farm, and 69% farmers had 1 to 3 years' experience of strawberry cultivation. The double log function showed the best fit with adjusted R^2 of 61%. Production inputs such as sapling and fertilizer had positive and labour and chemicals had negative and significant effect on outputs. Sapling, land and water were under-utilized and labour, cowdung, fertilizer and chemicals were over used. About 37% farmers reported that strawberry plants were attacked by many more diseases. Approximately, 48% farmers reported that transportation facilities of the study areas were poor. Efficiency ratio of the inputs indicates, farmers of the study area were not efficient in using inputs and it is needed to adjust resource use in order to improve farm profit at this level of technology used. The study also recommends that the farmers need training to be efficient.

Keywords: Cob-Douglas Production Function, Efficiency, MFC, MVP, Resource use, Strawberry

INTRODUCTION

Strawberry is a tasty and nutritious fruit which is popular for its attractive colour, aroma and sweetness. It is a significant cold loving fruit, grown throughout the world. USA, Spain, Japan, Poland, Korea and Russian Federation are the key strawberry producing countries of the world. A cup of strawberries provides 55

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calories and vitamin C content is more than the recommended human daily requirement (Salami et al., 2010). For producing sufficient berries for an average-sized family, 25-50 strawberry plants are enough (Dickerson, 2004). Strawberry (*Fragaria× ananassa* Duchesne) fruits are commonly consumed in fresh forms, as processed food products, and as botanical extracts for dietary supplements. Strawberry juice extracts be full of high levels of antioxidant which works against superoxide radicals, hydrogen peroxide, hydroxyl radicals, and singlet oxygen free radicals. It also has the total antioxidant capacity for low-density lipoproteins of the fruit extracts (Salami et al., 2010).

In Bangladesh, it is new crop grown commercially in few district such as Tangail, Rajshahi, Joypurhat, Bogra, Kumilla, Sathkhira, Khagrachari and Coxbazar. It has a great significance as it is grown in winter season when our native fruits are rare. In this time, strawberry can play an important role by meeting nutrition of mass people. Strawberry cultivation is also considered as a profitable crop grown to the farmers but it is not enough accepted to Bangladeshi farmers due to its huge cost association. Besides, strawberry is a highly perishable fruit and the farmers do not have any training on its production and handling technique. Consequently, they take intensive care of it and to do so sometimes they over used their resources. Agricultural economists always offer the direction of efficient utilization of inputs to the farmers. Efficient utilization of inputs has significant impacts on food security (Chiedozie et al., 2010). Resource use efficiency investigates the efficiency of each input and indicates the overutilization or underutilization of inputs (Ali et al., 2017). So it is essential to evaluate efficiency level of the farmers in case of input use as the aim of any profitable farm is to maximize profit by minimizing cost. Therefore, the study was designed with the following objectives: 1) to examine the socioeconomic characteristics of strawberry farmers; 2) to estimate input-output relationship of strawberry production; 3) to assess the resource use efficiency of strawberry growers and 4) to identify the production problems, and marketing constraints of strawberry cultivation.

Several literatures are accessible about the estimation of resource use efficiency for different agricultural crops except strawberry (Majumder et al., 2009; Islam et al., 2011; Rahman, 2011; Ahmed et al., 2015; Bapari, 2016; Sujan et al., 2017a; Sujan et al., 2017b; Sarker et al., 2018). Goni et al. (2013) investigated the efficiency of resource use in the production of dry season vegetables in Nigeria. They stated farmers were inefficient in the utilization of all resources because of under-utilization (seed, pesticide and land) and over-utilization (fertilizer, herbicide and labour). They mentioned if farmers increase the use of seed, pesticide and land, vegetable output will be increased by 114.58, 322.64 and 568.72 kg ha^{-1}, respectively. Similarly, Shrestha et al. (2015) estimated the efficiency of resource use in the production of vegetables in Nepal. The value of technical efficiency (0.79) pointed out toward the possibility of increase in the production of vegetable by efficient utilization of resources (land, seeds, labour, fertilizers, compost, farm capital and pesticides) while

technology remains constant. They suggested for improvement in land, labour, training, and easy capital access. Miah et al. (2006) explored the resource use efficiency of credit users and non-credit users in modern variety of boro rice production. They showed that both types of farmers did not use inputs efficiently. Non-borrowers under-utilized human labour, tillage, manure, fertilizer and pesticides and over used seeds and irrigation. Borrowers paid out less money on the use of seed or seedling, manure, fertilizer, pesticide and human labour and more money on tillage and irrigation. Khandoker et al. (2014) studied resource use efficiency of commercial floriculture in Bangladesh. They found positive and significant effect of power tiller, seedling and chemical fertilizer on floriculture. They also mentioned flower cultivator allocated their resources in the first stage of production where increasing returns to scale prevail.

But, resource use efficiency in strawberry production was still not studied in Bangladesh. For this reason this study was conducted.

MATERIALS AND METHODS

The study was mainly based on primary data that were collected through face to face interview using a pre-tested interview schedule which was conducted through field survey during the month of December, 2016 to March, 2017. Rajshahi and Joypurhat district was the pioneer of strawberry cultivation. At present strawberry is being cultivated by the farmers of Tangail, Kumilla, Sathkhira, Khagrachari and Coxbazar in scattered way but in Rajshahi and Joypurhat a good number of farmers are cultivating strawberry. So, Rajshahi and Joypurhat were selected for this study.

Sampling technique and sample size

Multistage sampling technique was followed to collect sample farmers for this study. At first, two districts namely Joypurhat and Rajshahi were selected on the basis of availability of strawberry farmer. In the second stage, concentrate strawberry growing upazila from each district were selected on the basis of area and production of strawberry. Sadreupazila from Joypurhat and Charghatupazila from Rajshahi were selected. Thirdly, 2-3 agricultural Blocks were selected in consultation with DAE personnel for selecting sample farmers. Finally, the samples were randomly selected from the complete list of strawberry farmers for interview. Mari (2009) and Ali et al, (2017) stated that 60 sample was appropriate for decision making in case of large population. However, a total of 100 strawberry growers taking 50 farmers from each district were selected for the study. Open source software R, Microsoft Excel and STATA-10 were used for analyzing results.

Production function and its stages

Production function is a functional relationship between output and inputs (Jhingan, 2007). There are three stages of production. MPP is negative in stage III and it is not rational to produce with negative MPP (Akighir and Shabu, 2011).

Model Specification

The Cobb-Douglas production model was useful for the estimation of resource use efficiency due to econometric and statistical advantages like sign and size of coefficients, t-test, f-test and R^2 (Ashfaq et al., 2012).It was also used in many studies (Abid et al., 2011; Ali et al., 2017; Khatun et al., 2017; Ibitoye et al., 2015; Umar and Abdulkadir, 2015). The double-log function (Cobb-Douglas) provided the best fit and was therefore chosen for the study (Olomla, 1991; Mbata et al., 1993).

Using the ordinary least square (OLS) estimator, the production response function model was expressed implicitly as:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, Ui)$ ..... (1)

Where

Y = quantity of output in kilograms,

X_1= labour(man-days),

X_2 = no. of sapling,

X_3 = quantity of cowdung in kilograms,

X_4 = quantity of fertilizer in kilograms,

X_5=land (farm size),

X_6= quantity of water in liter and

X_7= quantity of chemicals in kilograms.

The functional form of the double-log function was ex-pressed as follows:

$\ln Y = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + \ldots + b_7 \ln X_7 + e$ .... (2)

Resource use Efficiency

It is a ratio between Marginal Value Product (MVP) for a specific input and Marginal Factor Cost (MFC) of that particular input (Abid et al. 2011; Ashfaq et al. 2012; Mohammed et al. 2014; Umar and Abdulkadir, 2015; Ali et al. 2017) as:

$r_i = MVP_i / MFC_i$……..(3)

where:

r_i = Resource use efficiency ratio

MVP_i = Value of additional output by using an additional unit of a particular input resource

$MVP_i = MPP_i \times Py$ ..... (4)

$MFC_i = PX_i$ = It is price of one unit of input resource.

Where, Py and MFC_i, are the unit prices of output and factor input respectively.

The marginal physical product (MPP) was given by: $MPP_i = b_i \times APP_i$.....(5)

Where b_i = elasticity's of the various inputs

$$APP_i = \frac{\bar{Y}}{\bar{X}_i} \quad \text{..... (6)}$$

Where

$\bar{Y}$ is the mean of output and $\bar{X}_i$ is the mean of factor inputs and bi are the regression coefficients.

The decision of whether a resource is used efficiently or not, thus efficiency, is based on the value of r_i, Ifr_i is equal to one (r_i = 1), then the factor input is efficiently utilized. The factor input is over-utilized if r_i is less than 1 (r_i<1) and under-utilized if r_i is greater than unity (r_i>1). The relative percentage change in MVP of each resource required so as to obtain optimal resource allocation, which is r = 1 or MVP = MFC, was estimated using equation 7 below:

D = (1 – MFC/MVP) X 100 = (1 – r-1) x 100

=(1 -1/r)x 100 ……(7)

Where:

D = absolute value of percentage change in MVP of each resource (Mijindadi 1980; Gani and Omonona 2009; Chandra et al. 2017). The significance of each explanatory variable was determined using the t-test. The overall significance was determined by the F-ration.

RESULTS AND DISCUSSION

Farmers' profile

Age: Age is an important factor that influences farmer's production decision, efficiency and managing the capital used in farming. Strawberry is a new crop in Bangladesh and comparatively young farmers (minimum age 18 years) were cultivating it. Majority of the strawberry farmers (41%) were 18 to 30 years old (Table 1). Mean age of the strawberry farmers was 36.52 years. Other farmers were belonging to the age group of 31 to 43 years (32%), 44 to 56 years (17%), 57 to 69 years (8%) and 70 to 82 years (2%). Maximum age of the farmers was 74 years and standard deviation was 13.30.

Literacy status: The sample farmers were classified into six categories based on their education level. Table 1 indicates that literacy status of the strawberry farmers were better in position. Only 4% farmers were illiterate. Highest 26% farmers had primary level of education. Number of farmers having higher secondary level of education was 11%and degree and above level education was 21%. About 19% farmers had secondary level of education and another 19% farmers can sign only.

Table 1. Profile of the respondent farmers in the study areas

Particulars	Freq.	%	Min.	Max.	Mean	Std. dev
1. Age			18	74	36.52	13.30
18-30 years	41	41				
31-43 years	32	32				
44-56 years	17	17				
57-69 years	8	8				
70-82 years	2	2				
2. Literacy status						
Illiterate	4	4				
Can sign	19	19				
Primary (Class I-V)	26	26				
Secondary (Class VI-X)	19	19				
Higher secondary (HSC)	11	11				
Degree and above	21	21				
3. Occupation						
Main occupation						
Agriculture	70	70				
Student	20	20				
Business	6	6				
Service	2	2				
Other	2	2				
Subsidiary occupation						
No profession	54	54				
Agriculture	31	31				
Business	15	15				
4. Farm size (ha)			0.07	4.90	0.71	0.67
Marginal (below 0.19 ha)	16	16				
Small (0.19-0.99 ha)	61	61				
Medium (1.00-3.03 ha)	22	22				
Large (above 3.03 ha)	1	1				
5. Experience			1	8	2.94	1.14
1-3	69	69				
4-6	30	30				
7-9	1	1				

Occupational status: A good number of respondent farmers have both main and subsidiary occupation. Main occupation of a farmer generally reflects his commitment in that particular field and demonstrates his economic standing in the society. Majority of the farmers (70%) main occupation was agriculture (Table 1). In the study areas main occupation of few farmers were business (6%), service (2%) and others (2%). More than half of the farmers (54%) had no subsidiary occupation. About 31% farmers had agriculture and 15% farmer had business as their subsidiary occupation.

Farm size: Farm size of most of the farmers (61%) was small. In the study areas lowest farm size was found 0.07 ha. Average land holdings of the farmers were estimated 0.71 ha. Farm size was medium and marginal reported by 22% and 16% farmers respectively. Only 1% farmers had large farm size which is 4.90 ha and standard deviation was 0.67.

Farmers' experiences: Highest strawberry cultivation experience of the farmers was found 8 years. Mean experience of strawberry farming was 2.94 years. About 69% of the farmers had 1 to 3 years' experience. A good percentage of farmers (30%) had also experiences with in the year ranged from 4 to 6 years (Table 1). Minimum experience was only 1 year and standard deviation was 1.14.

Estimated production function and resource use efficiency

Results of the production function indicate output was positively related to sapling, Cow dung, fertilizer, land (farm size) and water. This implies that output increased with the increase of the quantities of those inputs. On the other hand output was negatively related to labour and chemicals (insecticides, pesticides and fungicides). This implies that output increased with the increase of the quantities of those inputs. The value of the coefficient of determination (R^2) was 0.611 which indicated that around 61% of the variation in output was explained by the independent variables included in the model (Table 2). The value of F was 1.931 which was significant at 5% level indicates the good fit of the model. The total elasticity (sum of the partial elasticity 0.456) showed decreasing returns to scale implies that when all other variables are held constant, a unit increase in one of them results in less than proportionate increase in output.

Table 2. Estimated value of coefficients and related statistics of Cobb-Douglas production function

Dependent Variable: LNOUTPUT			
Included observations: 100			
Variable	Coefficient	Std.Error	t-statistic
Labour	-0.0094*	0.004	-1.92
Sapling	0.3187***	0.170	3.20
Cowdung	0.0068	0.0072	0.94
Fertilizer	0.0715*	0.038	1.86
Land	0.067	0.110	0.609
Water	0.0057	0.0037	1.53
Chemicals	-0.0043***	0.0016	-2.620
Constant	6.128***	1.073	5.71
R-squared		0.611	
F-ratio		1.931**	
Returns to scale (b_{1+} b_{2+} b_{3+} b_{4+} b_5+b_6+$b_{7)}$		0.456	

Note: ***, ** and * indicate significant at 1% and 5% and 10% level respectively

Table 3 shows that the ratios of MVP and MFC are greater than unity for sapling, land, and water indicating that such inputs were underutilized. Farmers in the study area used too little of these inputs to cultivate strawberry that means the cost of using these inputs is less than the value of marginal product. This suggests that farmers can incur more cost for these inputs to be efficient. For key variable, labour, cow dung, fertilizer and chemicals comparison of the ratio of MVP to MFC revealed a resulting ratio to be less than unity implying that such inputs were over utilized. This suggests that farmers can deduct the use of the amount of these inputs to be efficient. In both cases all the inputs were not optimally utilized.

Table 3. Estimated resource use efficiency in strawberry production

Variable	Coefficients	MPP	Py	MVP	MFC	MVP/MFC	Adjustment required (%)
Labour	-0.0094	-0.1487	104.56	-15.5498	300	-0.0518	2031
Sapling	0.3187	0.1945	104.56	20.341	8	2.5426	61
Cowdung	0.0068	0.0117	104.56	1.2192	1.55	0.7865	27
Fertilizer	0.0715	0.0437	104.56	4.5655	35.95	0.1270	687
Land	0.067	1962.82	104.56	205232.1	31486	6.5182	85
Water	0.0057	0.00029	104.56	0.0307	0.022	1.3941	28
Chemicals	-0.0043	-15.55	104.56	-1626.41	400	-4.0660	125

The adjustment in the MVPs for optimal resource use indicated that for optimal allocation of inputs their level of use should be increased or decreased. Human labor was needed to decrease by 20-31% to obtain the optimum profit. Similarly, the level of use of cowdung, fertilizer and chemical should be decreased by 27%, 687% and 125% respectively. On the other hand, for optimal allocation of sapling, land, and water, their level of use should be increased by 61%, 85% and 28% respectively (Table 3).

Production problems faced by the farmers

Though strawberry has a good potentialities, farmers in the study areas faced some problems to produce strawberry because they had no training on strawberry cultivation. Highest 37% farmers reported that strawberry plants were attacked by many more diseases. About 30.5% farmers reported that they faced the problem of quality sapling in time. 28% farmers reported that their plant was dying (Table 4). Since more capital was required in strawberry production, 13% farmers in the study areas faced the problem of capital. 12% farmers reported that they had no adequate knowledge about strawberry cultivation practices. They also faced the problem of fruit damage (9%), attack of birds (7%) and insect pest (4%), plant damage (4%) and scarcity of labour (2%).

Table 4. Problems faced by the farmer in producing strawberry in the study areas

Problems	% farmers responded		
	Joypurhat	Rajshahi	All areas
More disease presence in strawberry plant	38	36	37
Lack of quality sapling in proper time	18	34	30.5
Plant is dying	36	20	28
Lack of capital	16	10	13
Lack of knowledge about strawberry cultivation	20	4	12
Fruits damage due to raining	8	10	9
High price of sapling	4	12	8
Attack of birds	-	14	7
Attack of insect	-	8	4
Production of sapling is so difficult	6	2	4
Requirement of insecticide is high	4	4	4
Damage of plant due to fog	4	4	4
Lack of labour	2	-	1

Marketing constraints faced by the farmers

In the study areas there was no marketing system of strawberry, so they faced problems to market their product. 48% farmers reported that transportation facilities of the study areas were poor. Farmers (24%) could not sell their product without Arath, commission of the Arathder was high (23%). Therefore, they did not get fair price (16%) (Table 5). On an average 9% farmers reported that in local market there was no demand for strawberry. As a result, when unrest situation prevail in the country, farmers lost their whole amount of strawberry. They also mentioned there was no cold storage facility (6%) and transportation cost was high (2%).

Table5. Marketing Problems faced by the farmer in the study areas

Problems	Joypurhat (%)	Rajshahi (%)	All areas (%)
Poor transportation facilities	50	46	48
Do not sell without Arath	30	18	24
Commission of Arathdar is high	16	30	23
Do not get fair price	8	24	16
There is no specific strawberry market	-	12	12
There is no demand in local market	12	6	9
There is no cold storage facility	10	2	6
High transportation cost	2	2	2

CONCLUSION

A large number of people, mostly unemployed youths, were engaged on strawberry farming. It was observed that labour, sapling, fertilizer and chemicals had significant effect on strawberry production. As strawberry cultivation is new in Bangladesh, farmers have no scientific knowledge about its production technology. They were not efficient in using inputs, they used excessive amount of several resources like labour, cow dung, fertilizer and chemicals and under used sapling, land and water to produce strawberry. Farmers in the study area faced some problems to produce strawberry because they have no training on strawberry cultivation.

To ensure efficient use of resources training on production technology should be given to the farmers. To control disease presence in strawberry, plant pathologist should undertake research on it. To reduce the use of chemicals, Entomologist should undertake research to control insect. To make sapling of BARI variety available in the farmers' field, Pomology division, HRC, BARI should produce and disseminate it to the farmers. If done so, production of strawberry will be increased, import will be decreased and foreign currency will be saved.

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