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Research Paper

Factors Affecting Production of Cereal Crops in Rajasthan: The Cobb-Douglas Analysis

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ABSTRACT

Indian Economy is an emerging economy, but it is still an agricultural economy because most people earn their livelihood from agriculture. The present study was carried out to determine the factors affecting cereals production in Rajasthan. This paper is based on secondary data and inputs such as seed, fertilizer, manure, human labor, irrigation, bullock labor, and plant protection collected over the years i.e.; from 2000-01 to 2015-16. The Cobb-Douglas production function was used to estimate elasticities of selected variables contributing to the production of cereals in Rajasthan state and assess the effects of seed, fertilizer, manure, human labor, irrigation, bullock labor, and plant protection measures on cereals production. The results from the study have shown that seed, fertilizer, and irrigation water were positively significant. At the same time, the variable corresponding to plant protection measures was significantly negative, affecting wheat production. The variables such as seed and fertilizer were found positive and significant while human labor measures significantly negatively affected barley. Only two variables, namely human labor and irrigation water, were found positively significant in the production of maize. In contrast, seed, bullock labor, and plant protection measures were found to be negatively non-significant contributing factors. The variables such as seed and fertilizer were found to have a significantly positive effect on bajra production. In contrast, bullock labor and plant protection measures were negatively non non-significant contributing factors.

Highlights

- Seed, fertilizer, and irrigation water were positively significant, affecting wheat production.
- The variables such as seed and fertilizer were found to be positive and significant effect on barley production.
- Human labor and irrigation water were found to be positively significant in estimating the production of maize.
- Seed and fertilizer were found positive and significantly affected on bajra production.

Keywords: Growth, production, cereals, Cobb-Douglas

Cereals occupy a prime position in the diet composition of all human beings, with rice, wheat, and maize being the major staple cereals with more than 70% share among all the food grains (Handral *et al*. 2017). With the inception of the green revolution, India, from being a food deficit and net importer of food grains became self reliant and one of the major exporters of food grains with the adoption of modern wheat and rice varieties.

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Rajasthan occupies nearly 10.4 percent geographical area of the country. With its vast geographical area of 342.7 lakh hectares, the state is the largest state of India, and agriculture is reflected to be the mainstay of rural crowds. Agriculture and allied activities account for nearly one-fourth of the Gross State Domestic Product (GSDP) against 14 percent at National Level (GOI, 2017). Agriculture is rain-fed in most parts of the state and prone to high production risks. In order to satisfy the requirements of the farms and the community, farmers in the state have evaluated various combinations of crops, livestock, horticulture, and forestry, etc. Production of cereals, oilseeds, vegetables, pulses, fruits, milk, and other commodities be fitting to diverse agro-climatic situations has been a matter of great concern for the rural people (Rao *et al.* 2015).

With the decline in the share of agriculture in the GDP, the Indian economy has faced structural changes. Even Though a fall in its share from 55.11 percent in 1950-51 to 13.90 percent in 2018-19 (GOI, 2017). Despite two big reasons, the importance of agriculture has not diminished. First, the country achieved self-sufficiency in food grain production at the macro level, but still is a food deficit country acing massive challenges of the high prevalence of malnourished children and high incidence of rural poverty. There is a high demand for agriculture to produce more and to increase income for farmers. Second, the rural workforce's reliance on agriculture for jobs did not decline about its sectoral contribution to GDP. As a result, the income gap between the agricultural and non-agricultural sectors has increased (Chand and Chauhan, 1999). The experiences of developed countries have shown that there has been a transition of labor-power from agriculture to non-agricultural generally and, in particular, to the manufacturing sector. This had brought improved agricultural production growth and higher incomes. Under these situations, higher growth in agriculture assumes vast importance and is a matter of worry for policymakers and research scholars in current times.

Every farmer in agriculture faces the primary challenge of improving output and minimize the cost. For this, one must know how effectively the farmers are currently using the inputs, identify the inefficiently used inputs, and then measures can be suggested to use such inputs to increase production and minimize cost efficiently. In order to identify the efficient use of inputs, production function analysis is the appropriate technique. The production function analysis gives an explicit idea regarding the use of inputs and their influence on output. The production function analysis determines the productivity levels of different inputs and assesses the contribution at the margin to the output. To know input-output relationship among the farmers contacted in the present study, Cobb – Douglas production function technique is employed. The use of Cobb-Douglas production function in agriculture production economics is due to (1) computational manageability with this algebraic form and (2) the information regarding returns to scale which it provides and theoretical fitness to agriculture (Tun, 2015). The Cobb-Douglas production function has been estimated using the least square method of regression.

This study aimed to determine the factors affecting agricultural production and the relative importance of each factor in increasing the level of production. Hence, relying on scientific research, it can be expected to improve the productivity and performance of agriculture as a whole. The study's overall goal is to estimate the crop production yield, determining the elasticity of production, measuring the effect of a factor in production.

MATERIALS AND METHODS

The present investigation was based on the cost of cultivation scheme running in Agricultural Economics & Management, Rajasthan College of Agriculture, Udaipur. The crops namely wheat, barley, maize and bajra which are under the cost of cultivation scheme, were selected for the present study. The study was relying on secondary data. We have examined factors responsible for temporal changes in production during the study for the period 2000-01 to 2015-16. The data on crop inputs included human labor (man-days/ha), bullock labor (pair days/ha), machine labor (man-days/ha), seed (kg/ha), manure (tonnes/ha), fertilizer (kg/ha), insecticides (kg/ha) and irrigation (₹/ha).

The Cobb-Douglas Production Function is used to calculate the impacts of various inputs seed, fertilizer, manure, irrigation, plant protection measures, human and bullock labor of temporal change in the production of cereal crops.

The Model

The following model of Cobb-Douglas production function was used in the study (Nazir, *et al.* 2013).

$$Y = A\, X_i^{b1} X_i^{b2} X_i^{b3} X_i^{b4} \ldots\ldots\ldots\ldots X_n^{bn}$$

Where,

Y = production (kg/ha), X_i = seeds, plant nutrients, plant protection chemicals, human and bullock labor, etc. (in physical/value units per hectare); A = Scale parameter; b = Production elasticity.

This study aims to determine the factor affecting production and the relative importance of each factor in increasing production. Hence, relying on scientific research, we can expect an improvement in the productivity and performance of the agricultural units. The study's overall goal of the study study's overall goals to estimate the crop production yield, determine the elasticity of production, and measure the effect of a factor in production (Sekhar *et al.* 2016).

RESULTS AND DISCUSSION

Production Function Estimates for Wheat Crop in Rajasthan State during the period from 2000-01 to 2015-16

The Cobb-Douglas production function was used to estimate elasticities of selected variables contributing to the production of wheat in Rajasthan state (Table 1). The Cobb-Douglas production function was employed to assess the effects of various inputs like seed, fertilizer, manure, irrigation, plant protection measures, human and bullock labor in wheat crop production. The value for the coefficient of multiple determinations (R^2) 0.79 directly explained that the selected resources were jointly contributed 79 percent to the total variation in wheat production in Rajasthan.

It was concluded that among the different variables under study, seed (X_1), fertilizer (X_2), and irrigation water (X_6) were found positively significant and could increase the production by employing more units of these inputs in producing the wheat crop in Rajasthan state. The variable plant protection measures were found to have a significantly negative effect on wheat production. The negative and unexpected sign of plant protection measures signals that this chemical input was overutilized in wheat disease control. Excessive use of plant protection measures was strongly affected by wheat quality and environment (through contaminating soil, air, and water) and plants and animals' lives, including humans. The sign of coefficients of seed, fertilizer, and irrigation water were positive and significant. The seed, fertilizer and irrigation water coefficient was 0.97, 0.29, and 0.02, respectively. These coefficients can be interpreted as one percent increase in seed, fertilizer, and irrigation w, which would lead to 0.97, 0.29 and 0.02 percent increase in a 0.97, 0.29 and 0.02 per cent increase in wheat production. At the same time, 1 percent increase in plant protection measures would lead to 0.06 percent decrease in wheat production. (Chaudhary *et al.* 2009) found that manure and human labor were found positive and non-significant factors to contribute to the production of the wheat crop, while bullock labor was found to be a negatively non-significant contributing factor.

The positive coefficient of fertilizers variable indicates that increasing productivity of wheat was depended mainly dependent on the type and amount of chemical fertilizer applied. These results will provide helpful information to wheat growers of Rajasthan state to achieve a proper balance of chemical fertilizers, which was essential to increase productivity and maintain sustainable soil fertility. Similar results were also reported by (Minh, 2004) in tea.

Table 1: Cobb-Douglas Production Function Estimates for Wheat crop

Sl. No.	Particulars	Regression coefficient	Value of coefficient
1	Constant	A	6.68
2	Seed (kg) X_1	b_1	0.97** (1.09)
3	Fertilizer (kg) X_2	b_2	0.29* (0.46)
4	Manure (kg) X_3	b_3	0.04 (0.04)
5	Human Labor (hrs.) X_4	b_4	0.28 (0.38)
6	Bullock Labor (Pair hrs.) X_5	b_5	-0.13 (0.04)
7	Irrigation (X_6)	b_6	0.02* (0.03)
8	Plant protection measure (X_7)	b_7	-0.06* (0.17)
9	R^2		0.79

** and ** significant at 1 and 5 percent level of significance, respectively; Figures in the parenthesis indicates standard error of respective coefficients.*

Production Function Estimates for Barley Crop in Rajasthan State during the period from 2003-04 to 2015-16

Table 2 represents the production function estimates for barley crop with the same inputs and value for the coefficient of multiple determinations (R2) 0.71 directly explained that the selected resources were jointly contributed 71 percentper cent to the total variation in barley production Rajasthan state. According to Table 2, only two variables seed and fertilizer were found positively significant in barley production.

Table 2: Cobb-Douglas Production Function Estimates for Barley Crop

Sl. No.	Particulars	Regression coefficient	Value of coefficient
1	Constant	A	6.56
2	Seed (kg) X_1	b_1	0.26* (0.68)
3	Fertilizer (kg) X_2	b_2	0.18* (0.18)
4	Manure (kg) X_3	b_3	-0.04 (0.03)
5	Human Labor (hrs.) X_4	b_4	-(0.18)* (0.19)
6	Bullock Labor (Pair hrs.) X_5	b_5	0.08 (0.03)
7	Irrigation (X_6)	b_6	0.03 (0.17)
8	Plant protection measure (X_7)	b_7	-0.05 (0.03)
9	R^2		0.71

** and ** significant at 1 and 5 percent level of significance, respectively; Figures in the parenthesis indicates standard error of respective coefficients.*

The sign of coefficients of seed and fertilizer were found positive and significant. The human labor variable had negative and significantly effect on barley production. It showed that increasing labor was not critical way for increasing barley productions. It implies that there would be no significant increase in barley production even if human labor would increase. Rajasthan state farmers tend to engage excess human labor, which was either not used or not fully used in actual production. Human labor input was at the macro level, and we can observe a decreasing return to scale when adding more working days into barley production. The coefficient of seed and fertilizer were 0.26 and 0.18, respectively. These coefficients can be interpreted as one percent increase in seed and fertil, which would lead to a 0.26 and 0.18 per cent increase in barley production. On the contrary one percent increase in human labor would lead to 0.18 percent decrease in production of barley. Bullock labor and irrigation water were found positive and non-significant factors to contribute to production for barley crop while plant protection measures and manure were found to be negatively non-significant contributing factors. It was revealed that 1 percent increase in plant protection measures would lead to 0.05 percent decrease in barley production. Similar results were reported that by (Sikdar *et al.* 2008).

Production Function Estimates for Maize Crop in Rajasthan State during the period from 2000-01 to 2015-16

Table 3 represents the production function estimates for maize crop with same inputs and value for the coefficient of multiple determinations (R^2) 0.72 directly explained that the selected resources were combined contributed 72 percent to the total variation in maize production Rajasthan state.

Table 3: Cobb-Douglas Production Function Estimates for Maize crop

Sl. No.	Particulars	Regression coefficient	Value of coefficient
1	Constant	A	16.15
2	Seed (kg) X_1	b_1	-0.06 (1.49)
3	Fertilizer (kg) X_2	b_2	0.26 (0.41)
4	Manure (kg) X_3	b_3	0.23 (0.10)
5	Human Labor (hrs.) X_4	b_4	0.89** (0.82)
6	Bullock Labor (Pair hrs.) X_5	b_5	-0.52 (0.31)
7	Irrigation (X_6)	b_6	0.56** (0.05)
8	Plant protection measure (X_7)	b_7	-0.0027 (0.059)
9	R^2		0.72

** and ** significant at 1 and 5 percent level of significance, respectively; Figures in the parenthesis indicates standard error of respective coefficients.*

According to Table 3, only two variables, human labor and irrigation water were found positively significant in the production of maize. Similar results were also observed by (Bidyasagar *et al.* 2017) in rice in the Nalbari district of Assam.

The sign of coefficients of human labor and irrigation, were found positive and significant. The coefficient of human labor and irrigation water were 0.89 and 0.56, respectively. These coefficients can

be interpreted as one percent increase in human labor and irrigation water would lead to 0.89 and 0.56 percent increase in production of maize. Fertilizer and manure were found positive and non-significant factors to contribute to production for maize crop while seed, bullock labor and plant protection measures were found to be negatively non-significant contributing factors.

Production Function Estimates for Bajra Crop in Rajasthan state during the period from 2000-01 to 2015-16

Table 4 represents the production function estimates for bajra crop with the same inputs and value for the coefficient of multiple determinations (R^2) 0.81 directly explained that the selected resources were jointly contributed 81 percent to the total variation in bajra production in Rajasthan state.

Table 4: Cobb-Douglas Production Function Estimates for Bajra Crop

Sl. No.	Particulars	Regression coefficient	Value of coefficient
1	Constant	A	5.99
2	Seed (kg) X_1	b_1	0.36* (1.16)
3	Fertilizer (kg) X_2	b_2	0.30* (0.17)
4	Manure (kg) X_3	b_3	0.05 (0.14)
5	Human Labor (hrs.) X_4	b_4	0.04 (1.21)
6	Bullock Labor (Pair hrs.) X_5	b_5	-0.20 (0.10)
7	Irrigation (X_6)	b_6	0.31 (0.07)
8	Plant protection measure (X_7)	b_7	-0.05 (0.07)
9	R^2		0.81

** and ** significant at 1 and 5 percent level of significance, respectively; Figures in the parenthesis indicates standard error of respective coefficients.*

It was concluded that among the different variables under study, seed (X_1) and fertilizer (X_2) were positively significant and could increase the production by employing more units of these inputs in producing the bajra crop in Rajasthan state. The sign of coefficients seed and fertilizer, were positive and significant. The coefficient of seed and fertilizer were 0.36 and 0.30, respectively. These coefficients can be interpreted as a one percent increase in seed and fertil, which would lead to 6 and 0.30 percent increase in production of bajra. The variables such as manure, human labor and irrigation water were found to have positive and non-significant factors contributing to production for bajra crop. In contrast, bullock labor and plant protection measures were found to be negative non-significant contributing factors. Our results are confirming the findings of (Rehman, 2017) in Pakistan in the Agriculture sector.

CONCLUSION

The Cobb- Douglas production function used in wheat resulted that seed, fertilizer, and irrigation variables were positively significant while the variable plant protection measures were significant negative effect on wheat production. The value for the coefficient of multiple determinations (R^2) for the wheat crop was 0.79. The Cobb – Douglas production function was fitted for the estimation of elasticizes of essential variables contributing to barley production in Rajasthan state. The value for the coefficient of multiple determinations (R^2) for barley crops was 0.71. The variables such as seed and fertilizer were significantly positive while human labourlabor had a significant negative effect on barley production. The value for the coefficient of multiple determinations (R^2) for maize crops was 0.72. Only two variables, human labor and irrigation water found positively significant in the production of maize. The value of the coefficient of multiple determinations (R^2) for bajra crop was 0.81. The variables such as seed and fertilizer were found to have a significantly positive effect on cotton production.

Proper management of costly inputs needs strengthening the extension services. Judicious use of inputs like pesticides and fertilizers not only help in keeping low production costs but will maintain soil health and sustain productivity.

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