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Resource Use Efficiency of Celery Production in Punjab

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Abstract

Punjab is one of the major celery-producing states of India, contributing about 90 per cent to the total production. The following study was conducted in 2020-21 among sixty farmers of Amritsar and Patiala districts of Punjab. Cobb-Douglas production function was fitted to find out the variables influencing the yield of celery crop. The output-input ratio came out to be 2.79 which highlights the profitability of celery crop. The major cost component of celery cultivation was human labor (75.04%). The average cost of cultivating celery was Rs. 42070 per ha and net returns obtained were Rs. 75665 per ha. Besides urea, crop duration, plant protection and machine hours came out to be significant factors in affecting the yield of the crop. The ratio of MVP to MFC was more than one for urea and machine hours and less than unity for plant protection depicting the under and over-utilization of the resources, respectively.

Keywords: Celery, Input-output ratio, Cobb-Douglas production function, Human labour

JEL Classification: Q12, C31

Introduction

The celery plant (*Apium graveolens)* is a hardy biennial crop, belonging to the family Apiaceae. It is cultivated for its fleshy leafstalk and used as a vegetable along with essential oil extracted from the seeds. Celery is an herbaceous plant of height 60-120 cm bearing white flowers with compound umbels, seeds of the crop are greenish-brown in colour with very small in size about 1-2mm in length and oval in shape. Seeds of celery have a fine crisp texture and a subtle flavor with a slightly bitter taste. Seeds and seed oil of celery crops can be used for flavoring tinned food and sauces, also in pickles. Celery seeds have some medicinal properties like carminative and nerve stimulant, used as neuro-tonic and used to cure joint pain, nervousness, headache, weight loss, gout and blood purification. It is rich in vitamin K, vitamin C, vitamin B6 and potassium. The leaves of celery are used in salad, cooked as a vegetable and dried fruits of celery are utilized as spice (NHB, 2019). Celery is familiar with different names in different countries like Karnauli or Ajmoda in India, Sedano in Italian, Karafs in Arab, Celeri in French, Selderiji in Dutch, Syelderey in Russian, Chin in Chinese, Aipo in Portuguese, Serorjini in Japanese and Sellerie in German. In Western Asia and temperate regions of Europe, wild forms of celery are cultivated. The eastern Mediterranean region is found as a breeding ground of this crop (Rubatzky and Yamaguchi, 1997, Parasar *et al*, 2016). The main cultivated regions of celery are Asia, America and Europe. In Western countries, celery is one of the most important crop being cultivated after lettuce, mainly consumed as a salad but also be cooked as vegetables. In the Asian region like China and India, it is cultivated for its seed, for making spice from them. India is a major producer and exporter of celery seeds in the world market that contributes to oil and oleoresin extraction. The major producers of crop are Punjab (Amritsar, Tarn Taran, Gurdaspur and Patiala), Haryana (Panipat) and Uttar Pradesh (Saharanpur). Punjab is one of the major celery-producing states of India, contributing about 90 per cent to the total production (NHB, 2019). The area under celery cultivation 2017-18 was 4457 hectares in Punjab, with the production of 6210 metric tonnes (Department of Horticulture, Govt. of Punjab). The world's total production of its oil is close to 45 tonnes,

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of which, 17 tonnes are produced from India and the rest are from China, UK, Egypt, USA and France. India alone meets the 62 per cent demand of the world. The bulk of the product (Seeds and other parts) is exported to USA, Germany, Canada, United Kingdom, Netherlands, Kuwait, Singapore, South Africa and Japan (Malhotra, 2006). India exported 6100 tonnes of crop worth Rs. 6649 lakhs in 2018-19 (Spice board, Ministry of Commerce, Govt. of India). Celery usually is stored, and when possible, transported at 34 degrees Fahrenheit and 85 per cent relative humidity (AGMRC, 2018). Therefore, the present study was conducted to examine the resource use efficiency in celery in Punjab during 2020-21.

Data Sources and Methodology

The present study was conducted in Punjab state. A required sample of 60 celery growers were selected from two districts namely Amritsar and Patiala covering 20 villages for the year 2020-21. Celery is mainly cultivated in Amritsar, Tarn Taran, Patiala and Gurdaspur districts of Punjab. Amritsar and Patiala accounts for major proportion of area under celery cultivation, as such these two districts were purposively chosen for the study. A multi-stage purposive sampling technique was adopted for the selection of the sample. At the first stage two districts i.e. Amritsar and Patiala have been selected keeping in view the major proportion of total cultivated area of celery in these districts. As the celery growers were scattered over many villages, thus 14 villages from Amritsar district and six from Patiala district became the part of the present study. The primary data were collected from the sample farmers by filling the information in detailed schedules through personal interview method. The information regarding the operational holding, cropping pattern, area under celery cultivation, detailed cost on celery cultivation, their related crops involved in rotation, year of cultivation, input used, production, price were obtained from the farmers.

Production function in general form can be written as:

$$\ln(y) = \ln(a_0) + \sum_{i=1}^{n}(a_i lnx_i) \quad i = 1,2 \ldots \ldots 7$$

$$\ln y = \ln a_0 + a_1 lnx_1 + a_2 lnx_2 \ldots \ldots \ldots \ldots \ldots + a_7 lnx_7$$

where,

y = Yield per hectare of celery crop (kg)

x_1 = Seed (kg per ha),

x_2 = Urea (Kg per ha)

x_3 = DAP (Kg per ha)

x_4 = Crop duration (no. of days)

x_5 = Plant protection (Rs. per hectare)

x_6 = Labour use (hours per hectare)

x_7 = Machine use (hours per hectare)

Determining the Resource Use Efficiency and Returns to Scale

A basic criterion of an efficient resource-use is that the ratio of marginal value product (MVP) of a factor to marginal factor cost (MFC) is equal to one. If MVP > MFC, then it means underuse of input and if MVP < MFC then it means overuse of input. The marginal value productivity (MVP) of the i^{th} input was calculated as following:

$$MVP = a_i \left(\frac{\bar{y}}{\bar{x}_i}\right) P_y$$

Where,

a_i = Regression coefficient of ith input

$\bar{y}$ = Geometric mean level of celery productivity per hectare

$\bar{x}_i$= Geometric mean level of the ith input used

P_y =Price of celery

Economic optimum takes place where MVP = MFC. If r is not equal to 1, it suggests that resources are not efficiently utilized. Adjustments could be therefore, made in the quantity of inputs used and costs in the production process to restore r = 1

Results and Discussion

The socio-economic profile of the farmers' household in Punjab is presented in table 1. The study showed that the average family size of celery farmers were 6.63. Besides, the average age of celery farmers was about 44 years with 16 years of average experience in celery production. The average duration of education for celery growers was found to be about 11 years. The average farm size of celery farmers was found to be 9.6 ha.

Cost and return structure of Celery crop

All the input costs realized in celery cultivation have been shown in table 2. The expenditure incurred on seeds, fertilizers, insecticides, etc. and the payments given to casual labourers were added up to calculate the per acre variable expenses incurred in celery cultivation.

Table 1. Socio-economic characteristics of celery farmers in Punjab

Particulars	Value
Family Size (number)	6.63
Average age of the farmer (years)	44.13
Farming Experience (years)	26.15
Education (years)	11.38
Farm Size (hectares)	9.6

The operational cost of cultivating celery crop came out to be Rs.42070 per ha. The study revealed that in the case of celery cultivation the highest proportion of expenditure was spent on hired human labour i.e. more than half of the total expenditure (64.85 %) mainly due to intensive use of labour in hoeing and harvesting of the crop. The cost incurred on human labour-use was Rs. 4287 per ha for family labour and attached labour whereas it was Rs. 272823 per ha for hired labour. The cost incurred on machine labour came out to be Rs. 1373 per ha for owned and Rs. 4000 for hired machine labour, thus constituting 12.77 per cent of total operational cost. The operational cost incurred on fertigation of the crop came out to be Rs. 2388 per ha which was 5.68 per cent of the operational cost. The cost incurred on fertigation of the crop was more than the cost on plant protection chemicals. Thus the major cost component of celery cultivation was human labour-use followed by machine labour and fertilizers.

The average productivity of celery came out to be 14.1 quintals per hectare. The average price realized by farmers was about Rs. 8350 per quintal. Thus gross returns came out to be Rs. 117735 per ha. The variable cost incurred on celery crop was Rs 42070 per ha. The returns over variable cost came out to be Rs. 75665 per hectare. As the gross returns were higher than the operational cost of cultivating celery, an output-input ratio of 2.79 was realized.

Resource use efficiency

The regression analysis was performed to determine the strength and character of the relationship between the dependent variable and independent variables (yield). Table 3 shows the regression analysis of the Cobb-Douglas production function for celery crop on sample farmers. Output of the farm resources per acre for particular crop on a farm is a function of different inputs used. The results brought out that in the case of celery crop, the coefficient of multiple determination (R2) came out to be 0.612 and was positively significant indicating that 61.20 per cent of variation in the dependent variable was explained by the included explanatory variables in the model. The regression coefficients for total machine use came out to be positively significant at one per cent level indicating that if machine use is increased by one per cent, the productivity of celery would increase by 0.315 per cent respectively. The regression coefficient for urea was positively significant indicating that if dose of urea is increased by one per cent, the productivity of celery would increase by 0.146 per cent. Abd-Elkader and Alkharpotly (2016) also reported the positive impact of nitrogenous fertilizers on the productivity of celery. The regression coefficient for crop duration and plant protection were negatively significant. Delayed harvesting results in the lodging of the crop and shattering losses occurred indicating that one per cent increase in crop duration would decrease celery productivity by 0.504 and overuse of plant protection chemicals affects the productivity, and a per cent increase would decrease the celery productivity to 0.044 per cent.

To evaluate the economic efficiency of resource-use in celery cultivation, the ratio of marginal value products of input factors were compared with their respective prices. The basic criterion of an efficient resource-use is that ratio of marginal value product of a factor to the marginal factor cost is equal to one.

A ratio of greater than one indicated that the returns could be increased by using more of that resource and ratio less than one indicated the unprofitable use of that resource which should be reduced to increase profit or gross margin. In order to examine the resource-use efficiency, the ratios of marginal value product of each resource with significant coefficient to the respective marginal cost were calculated and have been presented in Table 4. The results revealed that the ratio of MVP to MFC of machine use and urea was found to positive and above unity, indicating that these resources were not being used optimally for celery production by the farmers. The results showed that by spending an extra rupee on machine use and urea application, the celery farmers on an average would have been able to generate additional returns worth Rs.1.10 and Rs.10.32 respectively. Whereas it was found that for plant protection, the ratio of MVP to MFC was found to

Table 2. Cost and returns of celery crop, Punjab, 2020-21

(Rs per ha)

Particulars	Value
Seed (gram)	233 (0.55)
Fertilizer(in Kg)	
Urea	1687 (4.01)
DAP	700 (1.67)
Agrochemicals	452 (1.08)
Human Labor	
Hired labor	27282 (64.85)
Family labor and Attached labor	4287 (10.19)
Machine labour	
Owned	1373 (3.26)
Hired	4000 (9.51)
Marketing charges	243 (0.57)
Total	40257
Interest @ 9 per cent per annum for half of the period of crop on operational cost	1813 (4.31)
Total operational cost	42070 (100.00)
Yield of celery (in qtl.)	14.10
Price per qtl	8350
Gross Return	117735
Return over variable cost	75665
Input-output ratio	2.79

Note: Figure in parentheses are percentages of the total

be less than unity, indicating the excessive use of plant protection chemicals in celery cultivation. Temperature and humidity conditions favour the aphid attack on the crop in the month of March. Natural enemies i.e. ladybird beetle, spider, etc are also present in the field for their control but more insecticide sprays also kill the beneficial elements and negatively affect the yield of celery because, at this time crop was at flowering stage. Farmers in sample areas growing celery have increased pesticide use and spray on the crop at less (EIL) Economic Injury Level on the perception that insecticide spray increases yield but results of resource use efficiency analysis showed that celery growing farmers are overutilizing utilizing plant protection chemicals. The ratio of MVP to MFC for celery farmers was estimated as -29.12 which was less than unity. Hence farmers have an opportunity to increase their profit by decreasing plant protection chemicals on their celery fields to equate MVP to MFC or ratio of MVP to MFC equal to unity. It was evident from the above

Table 3. Estimates of production function for celery farmers in Punjab

Variables	Unit	Estimated coefficients	t-value
Intercept	-	6.804*** (1.553)	4.382
Seed	Kg	-0.004 (0.050)	-0.084
Urea	Kg	0.146* (0.078)	1.876
DAP	Kg	-0.001 (0.017)	-0.068
Crop duration	No. of days	-0.504* (0.275)	-1.830
Plant Protection	Rupee	-0.044** (0.020)	-2.185
Human labour	Hours	0.093 (0.144)	0.649
Machine labour	Hours	0.315*** (0.068)	4.666
Coefficient of multiple determination (R^2)	-	0.612***	
Adjusted coefficient of multiple determination ($\bar{R}^2$)	-	0.577	

*Note ***, **, * significant at 1, 5, 10 per cent respectively*
Figures in parentheses indicate standard errors of regression coefficient

Table 4. Marginal Value Product (MVP) and Marginal Factor Cost (MFC) of production inputs in celery production in Punjab

Inputs	MVP	MFC	Efficiency ratios
Urea	61.97	6	10.32
Plant Protection	-29.2	1	-29.19
Machine Labour	528.24	477	1.1

discussion that the ratio of MVP of resources to their factor cost was different from unity, which suggests that there were inefficiencies in resource-use in celery production, which needed correction by optimizing the allocation of these resources.

Conclusion and Policy Implications

This study has measured the efficiency of resource use among celery growing farmers in Punjab. The strategy showed the production inputs i.e. urea and machine labour were being under-utilized because the ratios of MVP to MFC were greater than unity which implies that farmers can increase celery output by increasing the level of all these inputs up to an optimal point. Whereas, for plant protection, the ratios of MVP to MFC were less than unity which implies that with a decrease in the use of plant protection chemicals, farmers can increase their overall celery yield. Awareness should be created among farmers against use of pesticides on celery as overutilization of resources results decrease in overall yield of the crop. Higher use of pesticides than recommended leads to increase MRL (Maximum residual limit) in crop which in turn leads to rejection in export markets. The study concluded that there was a dire need to optimally allocate the resources to enhance celery production. If the inputs are properly arranged and timely provided to the farmers, the celery production can be further enhanced. To address this

issue, the government may provide subsidized inputs mainly on machines and fertilizers to farmers along with proper extension services, which will help to enhance celery productivity and profitability.

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