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COMPARATIVE ECONOMIC EVALUATION AND INPUT USE EFFICIENCY OF FRESH AND RATOON SUGARCANE PRODUCTION ACROSS SELECTED DISTRICT OF CENTRAL PLAIN ZONE OF UTTAR PRADESH INDIA

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ABSTRACT

The economics of planted and ratoon sugarcane cultivation have been computed using primary data collected from 150 sugarcane growers spread over two blocks (three villages from each block) of Sitapur district in Central Plain Zone of Uttar Pradesh (INDIA). The use of CACP methods for various aspects of costs and returns, Benefit- cost ratio (BCR) and Cobb –Douglas production function for higher value of coefficient of multiple determination was determined. The study had shown that the value of BCR on variable cost was higher for ratoon crop (3.65) than in planted crop (2.97). In all the situation, ratoon crops realized more profit from each rupee invested as compared to planted crop. The net return on operational cost realized per hectare were Rs. 1,77,594 and Rs. 1,60,665.0 in planted and ratoon condition. The mode of pattern followed was same as has been conducted by Singh *et al.* (2021) .The almost resource input were found significant at 1% and 5% level of probability except human labour, fertilizers and plant protection chemicals used, these resources were not utilized efficiently resulting in low productivity of sugarcane. There is enough scope for investment in human labour, fertilizer and plant protection chemicals to increase productivity. Therefore, ratoon sugarcane was more remunerative and yield can be sustainable if induce the farmers to go for ratooning continuously and addressed a proper package of practices will be followed.

Keywords **:** Sugarcane, cost of cultivation, input-output ratio, resource use efficiency, Central plain Zone, Uttar Pradesh, India

Introduction

Sugarcane is an important commercial crop of the world; the sugarcane production is found in Indian composition of the period 1400 to 1000 B. Sugarcane is grown in diversified climatic condition i.e. tropical and subtropical region. India is only country in which sugarcane is grown in both type of climate. Sugarcane is an important commercial crop in India and play a pivotal role in agriculture and industrial economy of our country (Singh *et al.*).

India ranks second after Brazil in Sugarcane area and production of 4.86 million hectares, with average production of 399.20 million tonnes (20 %) of the world in 2020-21 (Economic Survey -2022).

Sugarcane is mostly cultivated in India's tropical and subtropical zones. Northern states like Uttar Pradesh, Bihar, Haryana, and Punjab is the part of the subtropical zone; they produce up to around 53% of the country's total areas and produce 49 percent of its overall production (Singh *et al*., 2021). The production of sugarcane in Uttar Pradesh is highest along with the

area and production 2.18 Mha with production of 1.77 million tonnes sharing about 46.45 percent and 45.89 percent of the country respectively.

The sugar industry, along with sugarcane cultivation, plays a crucial role in Uttar Pradesh's economy. During the crushing season of 2020-21, a total of 118 sugar mills were operated in the state. The sugar recovery rate during the season was recorded at 9.54% with B-Heavy molasses & direct cane juice use for ethanol production, and 11.40% without these components used for ethanol production.

Sitapur district is one of the major producing districts of Central Plain zone of Uttar Pradesh, with an area of about 1.50 lakh hectares and a production of 11.16 million tonnes (Crop production statistics, Govt. of India, 2019-20. Ratooning is a traditional method of sugarcane propagation under which underground buds on the stubble (the portion of cane left underground after harvesting) sprout new crop stands. Sugarcane ratooning reduces the costs of planting procedures, seed material, and seed-bed preparation. However, yields from ratoon crops are often lower than those from plant crops.

The study conducted on the same pattern provided by Singh *et al.* (2018) on Economic analysis of production resource use efficiency and constraints analysis of sugarcane cultivation in East Champaran district of North Bihar.emphasized on cost concept and estimating resource use efficiency by Cobb-Douglas production function. Therefore, to explore the possibilities of raising farm production and farm income in this region, there is need to understand sugarcane plant-ratoon cropping system and their economics. The present study was taken up to know the comparative economics along with resource use efficiency of fresh and ratoon sugarcane crop with the following specific objectives:

- To work out the costs and return in sugarcane production under plant and ratoon crop
- To determine the resource use efficiency of various factors used in the sugarcane production

Materials and Methods

In the study multistage sampling technique was adopted for selecting the sampling units at various levels. The central plain zone (CPZ) of Uttar Pradesh has six districts, viz. Sitapur, Shahjahanpur, Hardoi, Farrukhabad, Unnao and Lucknow. All the districts under Central Plain Zone, were listed and one district like Sitapur district having highest area of sugarcane was selected purposively. (*Source*: Crop statistics, 2019-20).

The study is based on the primary data on various aspects were collected from the 150 sample farmers from the sugarcane growing blocks in Sitapur district, one block from highest and lowest sugarcane area were selected. Three villages were selected from each bock and thus six villages were selected. Post stratification was made to classify the farmers into four group i.e. marginal (< 1 ha), small (1-2 ha), medium (2-4 ha) and large farmers (> 4 ha) respectively. The relevant information was collected through pre-tested schedule by survey method. The primary data were collected during 2022-23.

Analytical Tools and Technique

An analysis of costs and returns, resource use efficiency and marginal value productivity in sugarcane cultivation, a simple percentage analysis was employed to identify the costs and returns. The Cobb-Douglas production function used due to higher level of coefficient multiple determinations were obtained. The mode of calculation followed was same as has been provided in (Singh *el al.,* 2018, Rama Rao, 2012, Singh *et al.,* 2020 and Singh *et al.,* 2021).

Estimation of cost and returns

CACP method was used in estimating costs and returns. The costs incurred in the cultivation of sugarcane were estimated in terms of Cost A_1, Cost A_2, Cost B_1, Cost B_2, Cost C_1, Cost$_2$, and Cost C_3, here are the details of these Costs

Cost A_2: Cost A_1 + Rent paid for leased land.

Cost B_1: Cost A_1 + Interest on fixed capital assets (excluding land)

Cost B_2: Cost B_1 + Rental value of own land (net of land revenue) and rent paid for leased in land.

Cost C_1: Cost B_1 + Imputed value of family labour

Cost C_2: Cost B_2 + Imputed value of family labour

Cost C_3: Cost C_2 + cost of management (10% of cost C_2)

Income measure

It is calculated as under:

1. Gross return = Value of output
2. Farm business income = Gross return – Cost A2
3. Farm investment income = Farm Business income – Imputed value of family labour
4. Family labour income = Gross return – Cost B2
5. Net return = Gross return – Cost C3

Production function

The Cobb-Douglas production function was used due to higher value of coefficient of multiple determinations obtained

The following form of production function equation was used for the analysis: -

$$Y = aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} + e^u$$

b_1=Regression coefficient

u_i=Error term (i=1, 2….n)

Where, y is the yield of sugarcane (tonnes), X_i is the human labour (man days), X_2, X_3….X_5 denotes the machine labour (hr/ha), seed /cane setts (q/ha), irrigation cost (hr/ha), and fertilizers (kg/ha,) respectively.

Resource use efficiency

The estimated coefficients of significant independent variable were used to compute the marginal value products (MVP).

$$MVP_i = B_i \frac{\overline{Y}}{\overline{x}_i} \times P_y$$

Here,

MVP_i= Marginal value product of the i^{th} input

$\overline{Y}$ = Geometric mean of the value of output (rupees)

$\overline{x}_i$ = Geometric mean of the i^{th} input (rupees)

B_i= Estimated co-efficient (or) production elasticity with respect to x_i input.

P_y= price of output.

Result and Discussion

Cost and return structure in sugarcane production:

The detailed break up of cost of cultivation has been presented in Table -1. The cost of cultivation was worked out for the year 2022-23**.**

Table 1: Comparison of Cost of Cultivation of Planted and Ratoon Sugarcane crops. (Rs./ha)

Particulars/ Operations	Planted	Ratoon
Hired human labour	12862 (14.27)	7106 (11.71)
Machine Power	6515 (7.23)	7794 (12.84)
Harvesting &Transport	12621 (14.0)	11345 (18.70)
Seed (setts) planting	23343 (25.90)	6883 (11.34)
Fertilizers	12019 (13.33)	7995 (13.18)
Manures	7089 (7.87)	5876(9.68)
Plant protection Chemicals	7149 (7.93)	5083 (8.38)
Irrigation charges	8534 (9.47)	8599 (14.17)
Cost A1 (variable cost)	90132 (100)	60681 (100)
Interest on variable @ 7 %	6309	4248
Cost A	96441	64929
Fixed Cost:		
Land Revenue	147.0	134
Rental value of Land	36000	28000
Interest on fixed capital @ 10%	4955	3696
Total Fixed cost (TFC)		
A_2 (A1+Rent paid for leased- in Land)	90132	60681
B_1 (A_1+Interest on capital assets)	90132	60681
B_2 (B_1+Rental value of owned land)	126132	88681
C_1 (B_1+Family labour)	101364	69423
C_2 (B_2+ Family labour)	137364	97423
C_3 (C_2+10% of C_2)	151100	107165
Total cost /(Cost C2)	137364	97423

(**Figures in parentheses are in percentage**)

The cost of cultivation per hectare of planted and ratoon sugarcane crop are given in table-1 A comparison between plant and ratoon sugarcane cost revealed that total cost of cultivation per hectare of sugarcane on variable cost was highest in planted sugarcane conditions (Rs. 90132.0/ha) and was least in

ratoon crop (Rs.60681.0/ha.). Out of total operational cost under planted sugarcane 25.90 per cent (Rs.23345.0/ha) was incurred on seed setts and planting, followed by 14.27 per cent on hired human labour, harvesting and transport 14 percent, cost of fertilizers applications, 13.33 per cent and irrigation charges 9.47 percent whereas, under ratoon crop sugarcane cultivation, 18.70 per cent (Rs. 11345/ha) on harvesting and transport, 14.17 percent on irrigation, 13.18 per cent on cost of fertilizers, 12.84 per cent on machine power and 11.71 per cent on hired human labour respectively. This shown that labour intensive nature of sugarcane under planted as well as ratoon conditions. The mode of pattern is same as provided by Singh, *et al.* (2021).

Table 2: A Comparative measure of farm profit between sugarcane plant and ratoon (Rs/ha)

Particulars	Plant	Ratoon
Yield (t/ha)	765	634
Cost of Cultivation (variable cost)	90132	60681
Cost of cultivation (Total cost)	137364	97423
Cost of production (Rs./q)	118	117
Gross return	267726	221346
Net return (on operating cost)	177594	160665
B-C ratio (on variable cost)	2.97	3.65
B –C ratio (on total cost)	1.95	2.27
Farm business Income (Rs /ha)	177594	160665
Family Labour Income (Rs/ha)	141594	132665
Farm Investment Income (Rs/ha)	166362	212604

The yield of sugarcane per hectare was found to be 76.5 tonnes per hectare and 63.40 tonnes per hectare in planted and ratoon conditions respectively.

The gross return realized per hectare were Rs.267726.00 and Rs.221346 .00 in plant and ratoon sugarcane crop respectively. Similarly, the net returns per hectares on operational cost realized were Rs.177594.00 and Rs. 160665.00 in planted and ratoon conditions respectively. It was also revealed that Benefits -cost ratio on variable cost of sugarcane farming was highest on ratoon crop 3.65 and lowest on plant crop 2.97 on (operational cos.). In all the situations ratoon crop realized more profitable from each rupees invested as compared to plant crop

The Farm business income per hectare of both sugarcane (plant) and ratoon were Rs. 177594.0 and 160665.0, similarly family labour income for plant and ratoon were Rs. 141594.0 and 132665.0, and farm investment income were Rs. 166362.0 and Rs 212604.0 per hectare respectively in the study area

Resource use efficiency in sugarcane cultivation:

Resource use efficiency means low efficiently the farmer can use his resource in the production process. It is very important because resource of the farmer is limited.

$Y=-0.970x_1^{-0.109}x_{-2}^{0.120}x_3^{-0.292}x_4^{0.443}x_5^{0.456}$ ($R^2=0.936$)

The production function analysis attempted in the present study had sugarcane output in tonnes as dependent variable (y) on five independent variables viz. human labour (x_1) in man days, machine labour (x_2) in rupees, cane setts (x_3) in rupees, irrigation cost (x_4) in rupees, fertilizers cost (x_5) in rupees respectively. The mode of analysis was same followed by (Singh *et al.,* 2020).

Table 3 : Cobb-Douglas production function estimates for plant and ratoon sugarcane crop.

Sl. No.	Particulars	Parameter	Regression coefficient	Standard error	t- value
1	Intercept	A	1.382	0.176	7.846
2	Human labour (man days)	X^1	-0.109**	0.034	-3.188
3	Machine labour (Rs.)	X^2	-0.120**	0.038	-3.151
4	Seed /Cane Setts (Rs.)	X^3	-0.292	0.030	-9.769
5	Irrigation Cost (Rs.)	X^4	0.443	0.045	9.894
6	Fertilizer (Rs.)	X^5	0.456	0.044	10.318
7	Sum of Elasticities	Σbi	0.970	-	-
8	Coefficient of multiple determination (R-Square)	R^2	0.950	-	-

Note: ** indicates significance at 5% probability level

The value of the coefficient of multiple determination (R^2) was estimated to be 0.950, indicates that 95.0 per cent variation in logarithmic value of output per hectare was explained by the independent variable included in the equation. While rest of the variation in output were explained by those factors which had not been taken into consideration. The sum of elasticity of the coefficient of the human labour machine labour was found to be negative but significant for all the farm level, and seed was also negative and non-significant. Further irrigation cost and fertilizer was positive and a non – significant The, impact of return to scale (sum of the production elasticity) was found less than one indicating that production process was turned towards decreasing return to scale. Level in the study area. The significant and negative coefficient of human labour, machine labour (value term) indicating that excessive use of human labour, machine labour will decrease gross return. The elasticity coefficient of irrigation cost and fertilizer was statistically insignificant. The insignificant return to scale (sum of the production elasticity) was found less than one which revealed that production process in deceasing trend to scale in study area.

Table 4 : Resource use efficiency in plant and ratoon sugarcane production

Sl.No.	Resource	G.M.	MVPx	MFCx	MVPx/MFCx
1.	Human labour (X^1)	2.90	-89.98	24093.03	-0.004
2.	Machine labour (X^2)	1.73	-1432.82	6515.05	-0.219
3.	Seed/ Cane Setts (X^3)	1.6	-4287.49	25692.34	-0.167
4.	Irrigation cost ($X^{4)}$	3.21	148.28	23343.63	0.006
5.	Fertilizer (X^5)	3.06	202.65	19107.5	0.011

It was observed from the Table 4.0 that, geometric means of human labour, machine labour, Seeds/cane setts, irrigation cost and fertilizer were found to be 2.90, 1,73,1.60, 3.21 and 3.06, respectively. The marginal value products of human labour, machine labour seeds/cane setts, irrigation cost, fertilizer were found to be -89.98, -1432.82, -4287.49, 148,28 and 202.65 respectively. The factor costs of human labour, machine labour, seeds/ cane setts, irrigation cost, fertilizer were Rs.24093.03, Rs. 6515.05, Rs.25692.34, Rs. 23343.63 and Rs. 19107.50 sequentially. The final values of MVP/MFCX of human labour, machine labour, seeds/cane setts, were -0.004, -0.219, -0.167 means, resource was over utilized but irrigation cost, fertilizer were, 0.006 and 0.011 was also over utilized and there is further no scope for adding these inputs to increase the gross returns in irrigation and fertilizer, human labour, machine labour, and seeds when we adding these inputs resulting to decrease the gross returns. This indicates that one-rupee additional use on each of resources under consideration like, human labour, machine labour and seeds/cane setts, irrigation cost and fertilizer would reduce in income by Rs. -0.004, Rs. -0.219, Rs. -0.167, Rs. 0.006 and Rs. 0.011 respectively.

Conclusion and policy Implication

The present investigation was intended to depict the picture of planted and ratoon sugarcane cultivation in Sitapur district of Uttar Pradesh. The following observations can be accounted for policy planning suitable to this region.

- The result showed that the utilization of labour cost in general was high in planted sugarcane and it was positively correlated with the fertilizer, harvesting and transportation, irrigation and plant protection chemicals.
- Through there is higher yield in plant crop than the ratoon crop, the higher B-C ratio for ratoon crop induces the farmers to go for ratooning continuously, due to which average yields are decreasing. Therefore to increase the yields, farmers should be encouraged to take-up fresh plantings after one or two ratoons.
- The study had shown that inputs such as seed (setts) had positive and significance on the yield of sugarcane crop.
- The resource inputs such as human labour, machine labour, fertilizers, plant protection chemicals in the district were not utilized efficiently resulting in low productivity of sugarcane.
- Thus, it is imperative for providing proper training to the sugarcane growers regarding proper and optimum utilization of available resources inputs for fetching optimum income from sugarcane cultivation.

Further sugarcane growers should form a formal strong association that would represents their right interest so as to help them to acquire final and technical supports from the government and stake holders like sugar mills in the state.

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Competing Interests

Authors have declared that no competing interest exists.

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