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Economic analysis of sugarcane crop cultivation in Gonda District of Uttar Pradesh

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Abstract
This study examines the economics of sugarcane cultivation in the Gonda district of Uttar Pradesh, focusing on farm structure, cropping pattern, intensity, and cost-return analysis across varying farm sizes. Using a multi-stage stratified purposive cum random sampling technique, 100 sugarcane farmers were surveyed across five villages in Chhapia block during the agricultural year 2024-25. The sample comprised 60 marginal, 24 small, and 16 medium-sized farms. Findings reveal that the average landholding was 1.10 ha, with gross cropped area averaging 2.39 ha. Cropping intensity was highest on marginal farms (232.2%), followed by small (218.6%) and medium farms (204.4%), averaging 217.27%. The cost of sugarcane cultivation per hectare was highest for medium farms (Rs. 120,801.77), compared to small (Rs. 113,703.97) and marginal farms (Rs. 106,551.41), with the overall average being Rs. 110,548.09. *Labour*, planting materials, and land rental formed major cost components. Gross income averaged Rs. 252,257.86 per hectare, with marginal farms achieving the highest income (Rs. 255,096.50). Average net income stood at Rs. 141,709.77 per hectare, with marginal farms again leading (Rs. 148,545.09). The cost of production averaged Rs. 162.29 per quintal, and yield averaged 681.78 quintals/ha. Input-output ratios and benefit-cost ratios declined with increasing farm size, with marginal farms demonstrating the highest economic efficiency (B:C ratio = 1.39). These results underscore the relatively higher profitability and land use efficiency of marginal farms in sugarcane cultivation.

Keywords: Cropping pattern, cropping intensity, cost and return, input-output ratio

1. Introduction
Sugarcane is a vital commercial crop in India, with the sugar industry playing a significant role in the national economy (Kumar *et al.*, 2014) [6]. It provides livelihood support to around 6 million farmers and their families (Verma, 2015) [12]. Besides producing sugar, sugarcane is also used to make jaggery, khandsari, and several valuable byproducts such as molasses, bagasse, and press mud. Additionally, it contributes to renewable energy production through bioethanol and other bio-based materials, earning it the reputation of being a future-oriented crop (Saw *et al.*, 2020) [9].

Cropping pattern refers to how land is distributed among different crops at a given time, how this distribution changes over time, and the factors influencing such changes (Misra and Puri, 2011). Adopting a diverse cropping pattern is often seen as an effective approach to manage the risks and uncertainties in agriculture that arise from climatic and biological fluctuations (Shiyani and Pandya, 1998; Mandal, 2010) [10, 7]. The cropping pattern and intensity in any region are shaped by a variety of factors, including geographical and climatic conditions, socio-economic circumstances, historical background, and political influences (Jamil & Sajjad, 2016) [4]. Because these factors vary from year to year, cropping patterns are dynamic and subject to regular change. In India, for instance, the monsoon's strength and timing play a major role in determining cropping patterns (Khan and Ahmad, 2019) [5].

Cropping intensity is a critical indicator of land use efficiency in agricultural systems. It refers to the number of crops grown on a piece of land during a given agricultural year and is commonly expressed as a percentage. In the context of sugarcane cultivation, cropping intensity has significant implications for resource utilization, soil fertility, and overall farm productivity.

As sugarcane is a long-duration crop with a growth cycle ranging from 10 to 18 months depending on agro-climatic conditions, its cultivation often leads to lower cropping intensity compared to shorter-duration crops (Brahmanand *et al*.2021) [3]
Globally, approximately 1869.7 million tonnes of sugarcane were produced in the harvesting year 2023-24. Brazil led sugarcane production with over 724.43 million tonnes in 2021-22, followed by India with 439.42 million tonnes and China with 103.38 million tonnes *(FAOSTAT,2022*) [2]. Among the Indian states, Uttar Pradesh is the highest producer (215.81 million tonnes) followed by Maharashtra (112.09 million tonnes) and Karnataka (41.81 million tonnes). Sugarcane is cultivated across approximately 5.6 million hectares, boasting an average yield of 81.35. tonnes per hectare. Tamil Nadu had the highest productivity of 105 tonnes/ha. In Uttar Pradesh' among the district higher production of sugarcane in the Kheri District and Gonda districts ranks 13th position in Sugarcane production (E&S, DA&FW - Final.Est.-2023-24
With this background the study was conducted with the following objectives include to study the farm structure, cropping pattern, and cropping intensity of sample farm. Also to work out the cost and returns of sugarcane production.

2. Materials and Methods

2.1 Sample design

This examination of cultivation costs and profit measures relied heavily on source data. The population sample was obtained by a multi-stage stratified purposive cum random sampling strategy. The sample procedure has commenced with the purposeful selection of Gonda districts. Firstly, a list of 16 blocks lying under Gonda districts of Uttar Pradesh was prepared. Based on the highest acreage in sugarcane cultivation One blocks were purposively selected from Gonda *viz*., Chhapia

2.2 Collecton of Data

The primary data was collected through a survey method using personal interviews with a pre-structured schedule. Secondary data was collected from various sources including Zila Vikas Bhawan, Zila Sankhyaki Patrika, the Department of Agriculture at block and district headquarters, journal reports, books, and the internet. A list of all the villages in the selected block was prepared and arranged in ascending order according to area. Five villages from Chhapia block were randomly selected for the study.

2.3 Selection of Respondent

A separate list of all respondent growing Sugarcane of each selected village was prepared. All Sugarcane grower of selected village was stratified into three categories.
i.e.
marginal - (less than 1 ha),
small - (1-2 ha) and,
medium - (2-4 ha & above)

Table 1: Village wise number of the selected farmers under different size group of farms.

S.N.	Name of Village	Size of Holding						Total	
		Marginal (below1 ha)		Small (1-2 ha)		Medium (2-4 ha & above)			
		P	S	P	S	P	S	P	S
1.	Sital Ganj	198	16	71	06	29	02	298	24
2.	Bhawajitpur	163	13	53	4	21	2	237	19
3.	Sohila	17	1	77	06	98	08	192	15
4.	Naraicha	226	18	53	04	42	03	321	25
5.	Khalegav	149	12	51	04	16	01	216	17
	Total	753	60	305	24	206	16	1264	100

Period of Study: The data pertained to agricultural year 2024-2025 to estimate costs and returns of Sugarcane.

2.4 Analytical procedure

Tabular Analysis: A tabular analysis was conducted to compare various aspects of the cost and return analysis for the various categories of sample farms (Mishra *et al.,* 2023) [8].

Average: The simplest and the most important measures of average mean and weighted mean were applied. The formula of mean and W.A. is given below.

$$X = \frac{\sum X}{N}$$

Where,

$\overline{X}$=Mean, N= Total No of observation, X = All observations

Percentage: Percentage. Is/ the number? or. ratio expressed as a fraction of hundredth. It is denoted using the percent sign “%”. It is computed as;

$$\text{Percentage (\%)} . = \frac{Part\ Value}{Total\ Value}$$

Cropping intensity: Cropping intensity refers to the quantity of crops planted on a farm throughout the year using land as a fixed resource. It is calculated as.

$$C \cdot I = \frac{Total\ Cropped\ area}{Net\ Sown\ area} \times 100$$

Where, C. I. = cropping intensity

Measures of Cost Concepts

Cost A1: It includes total cash expenses incurred by cultivators which are follows (Srivastava *et al*.2024) [11].

a) Wage of hired human labour.
b) Charges for bullock labour.
c) Hired labour charges of implements and machinery.
d) Cost incurred on manures and fertilizers.
e) Setts.
f) Plant protection chemicals.
g) Irrigation charges.
h) Land revenue.
i) Depreciation.
j) Repair charges on farm assets.

Cost A2: Cost A1 + Rent paid for leased in land.
Cost B1: Cost A2 + Interest on owned fixed capital assets.

Cost B2: Cost B1 + Rental value of owned land.
Cost C1: Cost B1 + Imputed value of family labour.
Cost C2: Cost B2 + Imputed value of family labour.
Cost C3: Cost C2 + 10% of cost C2 (managerial cost)

Measures of Farm Profit
Gross Income = Yield in quintal × Price per quintal.

Net Income = Gross Income - Cost C.

Farm Business Income = Gross Income - Cost A2 or Net Income + imputed value of family labour

Family labour income = Gross Income-Cost C

Farm investment income = Net Income + Rental value of owned land+ Interest on fixed capital

Input Output ratio = Gross Income/Cost3

Benefit Cost Ratio = Net Income /Cost3

3. Results and Discussion
3.1 Land Holdings
As depicted in Table 2, the data includes 60 marginal farmers with a total gross cultivated area of 35.42 hectares, averaging 0.59 hectares per holding. Among small farms, there are 24 farmers cultivating a combined area of 31.06 hectares, with an average holding size of 1.29 hectares. For medium farms, 16 farmers collectively manage 43.66 hectares, averaging 2.73 hectares per holding. Overall, the study covers 100 farmers cultivating a total of 110.14 hectares, resulting in an average holding size of 1.10 hectares.

Table 2: Average size of holding under different size group of sample farms (ha.)

S.N.	Size of farms	No. of. Farmers	Net Cultivated Area (ha)	Average/size of holdings
1.	Marginal	60	35.42 (32.16)	0.59
2.	Small	24	31.06 (28.20)	1.29
3.	Medium	16	43.66 (39.64)	2.73
	Total	100	110.14 (100.00)	1.10*

3.2 Cropping pattern
Table 3, Provides the cropping pattern of the sample farms. It is clear from Table 2 that the net cultivated area of marginal, small, and medium-sized farms was 0.77, 1.62, and 2.47 ha, respectively. The gross cropped area of marginal, small, and medium-sized farms was 1.49, 3.07, and 4.47 ha, respectively. The area under sugarcane on marginal, small, and medium-sized farms was determined to be 0.13, 0.28, and 0.73 ha, respectively. The total percentage proportion of sugarcane among all commodities was observed to be 10.38%.

Table 3: Cropping pattern under/various. size group of farms. (area in ha.)

S.N.	Crops	The average. size. of sample farms.			Overall average
		Marginal	Small	Medium	
A.	**Kharif**				
1.	Paddy	0.49 (33.84)	0.92 (32.62)	1.76 (31.54)	0.80 (33.32)
2.	Til	0.01 (0.73)	0.05 (1.77)	0.16 (2.87)	0.04 (1.82)
3.	Urad	0.02 (1.46)	0.10 (3.55)	0.23 (4.12)	0.07 (3.05)
4.	Pigean Pea	0.01 (0.93)	0.15 (5.70)	0.14 (2.64)	0.07 (3.27)
	Total	0.54 (39.50)	1.15 (40.78)	2.52 (45.16)	1.00 (41.98)
B.	**Rabi**				
1.	Wheat	0.32 (23.41)	0.64 (22.70)	1.19(21.33)	0.54 (22.43)
2.	Mustard	0.12 (8.78)	0.22 (7.80)	0.38 (6.81)	0.19 (7.77)
3.	Potato	0.03 (2.19)	0.05 (1.77)	0.05 (0.90)	0.04 (1.59)
4.	Gram	0.03 (2.19)	0.07 (2.48)	0.16 (2.87)	0.06 (2.53)
5.	Pea	0.02 (1.46)	0.04 (1.42)	0.11 (1.97)	0.04 (1.64)
	Total	0.52 (38.04)	1.02 (36.17)	1.89 (33.87)	0.86 (35.95)
C.	**Zaid**				
1.	Sugarcane	0.26 (19.02)	0.54(19.15)	1.02(18.28)	0.45 (18.78)
2.	Vegetable	0.02(1.24)	0.04(1.42)	0.05(0.90)	0.03 (1.16)
3.	Maize	0.02(1.46)	0.03(1.06)	0.06(1.08)	0.03 (1.21)
4.	Sorghum	0.01(0.73)	0.04(1.42)	0.04 (0.72)	0.02 (0.92)
	Total	0.21(19.63)	0.58(22.05)	0.83 (15.63)	0.41 (19.16)
	Gross cropped area (ha)	1.37(100.00)	2.82(100.00)	5.58(100.00)	2.39(100.00)

3.3 Cropping intensity: Cropping intensity of sample farms were calculated & given in Table 4. The cropping intensity of various farm size groups is presented in Table 4. The maximum cropping intensity was observed on marginal farms (232.20%), followed by small farms (218.60%) and medium farms (204.40%), respectively. The average cropping intensity across the sample farms was calculated to be (217%) percent. A negative correlation between cropping intensity and farm size group was identified.

Table 4: Cropping/ intensity on various size group of sample farms.

S.N.	Size of farms	Farms	Net Cultivated area (ha)	Gross cultivated area (ha)	Cropping intensity
1.	Marginal	60	0.59	1.37	232.20
2.	Small	24	1.29	2.82	218.60
3.	Medium	16	2.73	5.58	204.40
	Total/overall average	100	1.10	2.39	217.27

3.4 Economics of Sugarcane

3.4.1 Cost of Cultivation of sugarcane: Per hectare costs on various input factors in sugarcane production were worked out. The details of input costs are shown in Table 5. This part of the results outlines a summary of the cost and return analysis. In addition to the total estimated expenditure, costs have been evaluated based on six different concepts: Cost A1/A2, B1, B2, C1, C2, and C3. Likewise, several indicators of farm profitability for the Sugarcane crop have been assessed, including net income, family labour income, farm investment income, farm business income, input-output ratio, and resource use

Table 5: Costs of cultivation of Sugarcane crop on different size group of sample farms (Rs.)

Sl. No	Particulars	Marginal (60)	Small (24)	Medium (16)	Overall average
1	Human Labour	17220.5 (16.16)	19411.35 (17.07)	22375.57 (18.52)	18571.17 (16.80)
a.	Family Labour	10075.34 (9.46)	8156.8 (7.17)	6550.27 (5.42)	9050.88 (8.19)
b.	Hired Labour	7145.25 (6.71)	11254.55 (9.90)	15825.3 (13.10)	9520.29 (8.61)
2.	Machinery Charges	9075.54 (8.52)	10300.75 (9.06)	10755.41 (8.90)	9638.37 (8.72)
3.	Setts/Planting Material	17800.02 (16.71)	18581.13 (16.34)	19034.3 (15.76)	18184.97 (16.45)
4.	Manure and fertilizer	13585.32 (12.75)	13860.74 (12.19)	14789.52 (12.24)	13844.09 (12.52)
5.	Irrigation	12006.43 (11.27)	13352.65 (11.74)	14098.58 (11.67)	12664.27 (11.46)
6.	Plant Protection/Interculture	3580.39 (3.36)	3895.81 (3.43)	4165.75 (3.45)	3749.75 (3.39)
7.	Total working capital	73268.29 (68.76)	79402.43 (69.83)	85219.13 (70.54)	76652.62 (69.34)
8.	Interest on working capital	2930.7316 (2.75)	3176.0972 (2.79)	3408.7652 (2.82)	3066.10 (2.77)
9.	Rental value of land	18000 (16.89)	18000 (15.83)	18000 (14.90)	18000.00 (16.28)
10.	Interest on fixed capital	2665.9 (2.50)	2788.72 (2.45)	3191.9 (2.64)	2779.54 (2.51)
11.	Sub total	96864.92 (90.91)	103367.25 (90.91)	109819.80 (90.91)	100498.26 (90.91)
12.	Managerial Cost@10% of sub-total	9686.49 (9.09)	10336.72 (9.09)	10981.98 (9.09)	10049.83 (9.09)
13.	Grand total	106551.41 (100.00)	113703.97 (100.00)	120801.77 (100.00)	110548.09 (100.00)

Table 5 reveals that medium-sized farms had the highest cost of sugarcane cultivation at Rs. 1,20,801.77 per hectare, followed by small farms at Rs. 1,13,703.97 and marginal farms at Rs. 1,06,551.41. The average cultivation cost across all farm sizes was Rs. 1,10,548.09, showing a positive correlation between farm size and overall expenditure. Among the major cost components, human labour constituted the largest share at 16.80%, followed by planting material (16.45%), land rental value (16.28%), fertilizers and manure (12.52%), irrigation (11.46%), and machinery use (8.72%). The data also indicate that as farm size increases, the reliance on family labour tends to decrease, whereas the use of hired labour, machinery, planting inputs, and irrigation tends to rise.

3.4.2 Measures of costs and income of sugarcane Costs of cultivation

Table 6 outlines the per-hectare costs and returns associated with sugarcane cultivation. The average costs under different cost concepts were estimated as follows: A1/A2 - Rs. 70,667.84, B1 - Rs. 73,447.38, B2 - Rs. 91,447.38, C1 - Rs. 82,498.26, C2 - Rs. 1,00,498.26, and C3 - Rs. 1,10,548.09. The mean gross income per hectare was Rs. 2,52,257.86, with a net income of Rs. 1,41,709.77. Marginal farms achieved the highest gross return of Rs. 2,55,096.5, followed by small farms at Rs. 2,49,220.9 and medium farms at Rs. 2,46,168.4. Similarly, net income was greatest on marginal farms (Rs. 1,48,545.09), with small and medium farms earning Rs. 1,35,516.93 and Rs. 1,25,336.63, respectively. In terms of family labour income, marginal farms led with Rs. 1,69,830.92, followed by small (Rs. 1,54,010.45) and medium farms (Rs. 1,42,898.87). Investment income was also highest among marginal farms (Rs. 1,69,210.99), followed by small (Rs. 1,56,305.65) and medium (Rs. 1,46,558.53) farms. On average, the yield per hectare was 681.78 quintals, and the cost of production per quintal was Rs. 162.29. Input-output ratios based on cost concepts ranged from 1:3.60 (A1/A2) to 1:2.29 (C3). Marginal farms showed the highest input-output ratio (1:2.39), with small and medium farms following at 1:2.19 and 1:2.04, respectively. The benefit-cost ratio was also most favourable on marginal farms (1:1.39), compared to 1:1.19 on small farms and 1:1.03 on medium farms, indicating greater profitability for smaller farm sizes.

Table 6: The per-hectare costs and income from the production of Sugarcane crop on different costs concept (Rs.)

S.N.	Particular	Farm sample sizes			
		Marginal.	Small.	Medium.	Overall average.
1.	Cost A1/A2	66123.68	74421.73	82077.63	70667.84
2.	Cost B1.	68789.58	77210.45	85269.53	73447.38
3.	Cost B2.	86789.58	95210.45	103269.53	91447.38
4.	Cost C1.	78864.92	85367.25	91819.80	82498.26
5.	Cost C2	96864.92	103367.25	109819.80	100498.26
6.	Cost C3.	106551.41	113703.97	120801.77	110548.09
7.	Yield	689.45	673.57	665.32	681.78
8.	Gross Income	255096.5	249220.9	246168.4	252257.86
9.	Net return over	148545.09	135516.93	125366.63	141709.77
10.	Family labour Income	168306.92	154010.45	142898.87	160810.48
11.	Farm Business Income	188972.82	174799.17	164090.77	181590.02
12.	Farm Investment Income	169210.99	156305.65	146558.53	162489.31
13.	Cost of production (Rs./Qtl.)	154.55	168.81	181.57	162.29
	Input-output relationship				
14.	On the basis of A1/A2	3.86	3.35	3.00	3.60
15.	On the basis of B1	3.71	3.23	2.89	3.46
16.	On the basis B2	2.94	2.62	2.38	2.77
17.	On the basis of C1	3.23	2.92	2.68	3.07
18.	On the basis of C2	2.63	2.41	2.24	2.52
19.	On the basis of C3	2.39	2.19	2.04	2.29
20.	B:C Ratio	1.39	1.19	1.03	1.28

4. Conclusion

The analysis shows that medium-sized farms bear the highest sugarcane cultivation costs—averaging Rs. 110,548.09 per hectare—mainly due to elevated *labour* charges. Marginal farms achieved the highest total income per hectare at Rs. 255,096.50, followed by small farms (Rs. 249,220.90) and then medium farms at Rs. 246,168.40. Marginal farms' superior revenues are linked to efficient use of *labour*, planting materials, manure, fertilizer, and irrigation, complemented by improved farm management practices.

On average, gross income stood at Rs. 252,257.86 per hectare with a net income of Rs. 141,709.77. Including family *labour*, farm business, and investment income, total figures were Rs. 160,810.48, Rs. 181,590.02, and Rs. 162,489.31 respectively. The cost per quintal of sugarcane rose from Rs. 154.55 on marginal farms to Rs. 181.57 on medium farms. Input-output ratios (Cost C3) declined with increasing farm size: 1:2.39 (marginal), 1:2.19 (small), and 1:2.04 (medium). Corresponding benefit-cost ratios were 1:1.39, 1:1.19, and 1:1.03—highlighting diminishing returns as scale increases.

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