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Research Note

Efficiency, Yield Gap and Constraints Analysis in Irrigated vis-a-vis Rainfed Sugarcane in North Coastal Zone of Andhra Pradesh

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Abstract

The economics of yield gap in irrigated and rainfed sugarcane cultivation have been studied in North Coastal Zone of Andhra Pradesh for the period 2008-09 by collecting data on various aspects of costs and returns. Budgeting techniques, cost concepts, benefit cost ratio (BCR), yield gap analysis and response-priority index have been used for the analysis. The study has shown that the value of BCR is higher for plant crop in irrigated (1.49) than in rainfed (1.43) regions. The yield gap between irrigated and rainfed regions has been found to be 67.8 per cent, in which input usage had a higher (41.86%) effect than cultural practices (25.93%). The most important constraint in sugarcane cultivation is shortage of labour during crucial operations. Therefore, irrigated sugarcane is more remunerative and yields can be sustainable if constraints are addressed and a proper package of practices is followed.

Keywords: Sugarcane, yield gap analysis, response-priority index, north coastal zone, Andhra Pradesh

JEL Classification: Q11, Q15

Introduction

India ranks second in the world in sugarcane cultivation and with average production of 273.93 Mt in 2008-09, it had a share of 22 per cent in world's sugarcane production. The area under sugarcane is about 4.4 Mha (2.7% of total cropped area) and productivity is 62.32 t/ha. Andhra Pradesh with its area of 0.22 Mha, ranks fifth in sugarcane area of the country with a share of 4.83 per cent. The average production of Andhra Pradesh is 20.30 Mt, which is 5.83 per cent of the total production of the country. In Andhra Pradesh, the major sugarcane growing and jaggery producing districts in the Telangana, Coastal Andhra and Rayalaseema regions are: Nizamabad, Visakhapatnam and Chittoor districts, respectively. The yields of sugarcane in the North Coastal Zone is stagnant for past two decades (hovering around 70-80 t/ha). This has been mainly because a large area is under rainfed sugarcane where, the average yield is 50 t/ha. The present study was taken up to know the causes of yield stagnation along with constraints with following objectives:

- To work out costs and returns in cultivation of sugarcane under irrigated and rainfed conditions,
- To assess the factors affecting sugarcane production under irrigated and rainfed conditions,
- To estimate the sources of yield gaps between irrigated and rainfed cultivation of sugarcane, and
- To identify the significant constraints in sugarcane cultivation.

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Materials and Methods

In the study, conducted during 2008-2009, multistage sampling technique was adopted for selecting the sampling units at various levels. The North Coastal Zone (NCZ) of Andhra Pradesh has three districts, viz. Srikakulam, Vizianagaram and Visakhapatnam. All the sugarcane-growing mandals in NCZ were listed and one mandal having largest area under sugarcane cultivation was selected. Two villages were selected from each mandal, and thus, six villages were selected. Ten growers each for irrigated and rainfed sugarcane were selected at random from each village. Thus, the sample size was of 120 farmers (60 for irrigated and 60 for rainfed).

Analytical Tools

Apart from budgeting techniques and cost concepts, following analytical tools were employed: (i) Benefit-cost ratio; (ii) Decomposition of sources of yield gaps; and (iii) Response-priority index. The mode of calculation followed was same as has been provided in Rama Rao (2011).

Results and Discussion

A Comparison of Costs and Returns in Irrigated and Rain-fed Sugarcane Cultivation

The costs of cultivation of irrigated and rain-fed sugarcane crop are given in Table 1. A perusal of Table 1 reveals that the total cost of cultivation of sugarcane was highest in plant irrigated conditions (₹ 1,47,454/ha), followed by rain-fed (₹ 90,939/ha) and was least in ratoon irrigated crop (₹ 81,106/ha). Out of the total operational cost, under plant irrigated conditions, 76 per cent (₹ 72,569) was incurred on labour charges and 24 per cent (₹ 22,917) was on materials, whereas under rainfed condition 65 per cent

Table 1. A comparison of costs on cultivation of irrigated and rainfed sugarcane in 2008-09

(₹/ha)

Operations	Irrigated		Rainfed
	Plant	Ratoon	plant
Land preparation	4513	831	3563
Ridge formation	1188	0	0
Seed planting	18050	1425	18050
FYM and fertilizers	7101	4429	6413
Intercultivation and weeding	10450	4750	1425
Irrigation charges	10688	8313	0
Trash twist (TT) propping	11400	5463	6888
Plant protection	2375	2375	2375
Harvesting and transport	25175	18240	18050
Cost A1	90939	45826	56763
Interest on working capital	4547	2291	2838
Cost A	95486	48117	59601
A2 (A1+Rent paid for leased-in land)	90939	45826	56763
A2+Family labour	96627	48951	59695
B1 (A1+Interest on capital assets)	90939	45826	56763
B2 (B1+RVOL)	126939	69826	78363
C1 (B1+Family labour)	96627	48951	59695
C2 (B2+Family labour)	134049	73733	82029
C3 (C2+10% of C2)	147454	81106	90231
Yield (t/ha)	75	50	45
Cost (₹ /t)	1600	1600	1600
Total returns	120000	80000	72000
B-C ratio (on operating cost)	1.32	1.75	1.27
BC (on total cost)	0.81	0.99	0.80
Net returns (on operating cost)	29061	34174	15238

Table 2. Operation-wise human labour utilization in sugarcane

(humandays / ha)

S. No.	Particulars	Irrigated		Rainfed
		Plant	Ratoon	plant
1	Land preparation/ Stubble shaving	15.17	3.28	7.96
		(3.14)	(1.21)	(3.06)
2	Planting /Gap filling	53.13	2.76	28.26
		(11.00)	(1.02)	(10.87)
3	Fertilizer application	11.54	11.76	8.50
		(2.39)	(4.34)	(3.27)
4	Weeding and intercultivation	142.24	87.26	90.01
		(29.45)	(32.2)	(34.62)
5	Propping	93.31	40.98	46.33
		(19.32)	(15.12)	(17.82)
6	Plant protection	4.50	8.90	3.30
		(0.93)	(3.30)	(1.27)
7	Irrigation	37.53	31.46	0
		(7.77)	(14.61)	
8	Harvesting and transporting	125.58	84.55	75.63
		(17.89)	(31.2)	(29.09)
	Total	483.00	271.00	260.00

Note: Figures within parentheses denote percentages under respective columns

(₹ 11,733) was incurred on labour charges and 35 per cent (₹ 6,318) on materials. This shows the labour-intensive nature of sugarcane under irrigated as well as rainfed conditions. It also reveals the importance of labour in sugarcane cultivation.

The operational cost on the cultivation of sugarcane in the North Coastal Zone had increased from was ₹ 39,398 in 2001-02 (Alibaba, 2005) to ₹ 90,939/ha in 2008-09 (present study), i.e. by about 230 per cent in a period of 7 years. The major contributor to this increase was labour wages, which had increased 3-times (from ₹ 40/day to ₹ 120/day).

Human Labour Utilization in Sugarcane Cultivation

Human labour plays a significant role in sugarcane production. Whatever may be the plant type, i.e. plant or ratoon and growing situations, i.e. irrigated or rainfed, human labour utilization was maximum for weeding and intercultivation, followed by harvesting and transportation. A comparison between plant crop of irrigated and rainfed sugarcane revealed that in all operations more labour was utilized in irrigated than rainfed condition. In percentage terms, more labour was utilized in rainfed than irrigated conditions.

Inputs-use Pattern in Cultivation of Irrigated and Rainfed Sugarcane

The crop productivity was 75 t/ha under irrigated and 45 t/ha rainfed conditions. So, there was 67.8 per cent higher yield under irrigated than rainfed conditions. Except potassium, inputs-use was higher under irrigated than rainfed conditions. It was also reflected in the cost of cultivation of sugarcane. Usage of potassium was higher in rainfed condition since potassium provides crop resistance under drought condition (Table 3).

Production Function Estimates in Cultivation of Irrigated and Rainfed Sugarcane

The Cobb-Douglas type of production function was fitted for the estimation of elasticities of important variables contributing to the yield of sugarcane plant crop under both irrigated and rainfed conditions (Table 4). The value of coefficient of multiple determinations (R^2) was found 0.86 under irrigated conditions and 0.77

Table 3. Input-use in irrigated and rainfed sugarcane

(per ha)

Inputs	Irrigated		Rainfed
	Plant	Ratoon	Plant
Human labour (human days)	483	271	260
Manure (q)	125	7.5	50
Nitrogen (kg)	183	253	183
Phosphorus (kg)	173	58	173
Potassium (kg)	68	14	68
Seed rate (kg)	10,000	500	10,000
Productivity (q/ha)	750	500	450

Table 4. Cobb-Douglas production function estimates for irrigated and rainfed sugarcane (plant crop)

Sl. No.	Particulars	Method of cultivation	
		Irrigated	Rainfed
1	Human labour (X_1)	0.67**	1.25**
		(0.1324)	(0.2801)
2	Seed rate (X_2)	0.44**	-0.16
		(0.0579)	(0.1752)
3	Manure (X_3)	0.56**	0.33**
		(0.0196)	(0.0273)
4	Nitrogen (X_4)	0.39**	0.23**
		(0.0428)	(0.0320)
5	Phosphorus (X_5)	0.20**	-0.01**
		(0.0334)	(0.0358)
6	Potassium (X_6)	-0.10**	0.16
		(0.0121)	(0.0265)
7	Intercept	-2.52**	-2.61**
		(0.4243)	(0.7816)
	R^2	0.86	0.77
	F value	130	338

Note: * and ** indicate significance at 5 per cent and 1 per cent, respectively

Figures within the parentheses are standard errors for the respective regression coefficients

under rainfed conditions. It shows that these variables were more crucial in irrigated than rainfed conditions. This is because irrigated sugarcane is under more controlled conditions than under rainfed, which is vulnerable to natural vagaries.

Except, seed rate under rainfed condition all other variables were found significant. A negative significance was noticed for phosphorus in rainfed and potassium in irrigated conditions. The coefficients of all variables were higher in irrigated than rainfed, except human labour and potassium. It shows that more response of rainfed sugarcane for potassium than other nutrients in comparison with irrigated conditions.

Sources of Yield Gap between Irrigated and Rainfed Sugarcane

The decomposition analysis of yield gaps showed that 67.79 per cent of the potential farm yield of sugarcane was left untapped under the rainfed method (Table 5). Among different sources of yield gap, input-usage (41.86%) turned out to be the major contributor than cultural practices (25.93%). This shows that irrigation is an important factor in the sugarcane cultivation. In input-use, manure turned out to be a crucial factor. The next important factors were potassium and labour. But, nitrogen (-1.54) and phosphorus (-3.67) contributed negatively, indicating higher dose of these nutrients than requirement. Therefore, appropriate usage of inputs can reduce the yield gap between rainfed and irrigated methods to the tune of 67.79 per cent.

Table 5. Decomposition of yield gap between irrigated and rainfed sugarcane (plant)

Sources of yield gap	Per cent
Cultural practices	25.93
Input-use	41.86
Human labour	1.50
Seed rate	34.83
Manure	3.93
Nitrogen	-1.54
Phosphorus	-3.67
Potassium	1.65
Total	67.79

Patole *et al.* (2008) by using the Bislaih (1977) model of decomposition, estimated that yield gap in chickpea in Ahmednagar district of Maharashtra to be 52.99 per cent. Out of which, input-use (29%) had a higher role than cultural practices (24.33%). A similar trend was noticed in the present study. The yield gap between irrigated and rainfed methods of sugarcane was to the tune of 67.79 per cent, in which input-usage (41.86%) had a higher role than cultural practices (25.93%).

Table 6. Responses Priority Index (RPI) for constraints in cultivation of sugarcane

S.No.	Constraint	RPI	Rank
1	Remunerative price	0.67	III
2	High cost of machinery	0.28	IV
3	Labour shortage	0.83	I
4	Irrigation water	0.71	II
5	Seed material availability	0.27	V
6	Infestation by pests and diseases	0.25	VI

Major Constraints

The farmers were asked to list priority-wise five major constraints they were facing in sugarcane cultivation. On the analysis of repetitiveness, six major constraints were identified.. By considering the total responses it was concluded that 'remunerative price' was the major constraint. Maximum responses in respective priorities were enumerated and a Responses-Priority Index (RPI) was constructed by taking into the consideration of maximum responses and their respective priorities (Table 6). The highest value of RPI was for 'labour shortage', therefore most important constraint in sugarcane cultivation in the North Coastal Zone was difficulty in getting labour during period of important operations. The other constraints were shortage of irrigation water, not getting remunerative prices, high cost of machines, difficulty in getting good quality seed material and infestation by pests and diseases.

Following policy implications have emerged from the study:

- Though there is a higher yield in plant crop than 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 yields, farmers should be encouraged to take-up fresh plantings after one or two ratoons. To encourage it, seed material may be supplied at subsidized rates.
- Input-use (41.86%) being a major contributor to yield gap than cultural practices (25.93%) between irrigated and rainfed methods, farmers should be trained on proper use of irrigation water and inputs so as to increase the yields of sugarcane.
- The major constraint in sugarcane cultivation is labour shortage; it necessitates the urgency of mechanization in sugarcane.

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