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Economic Impact of UAS-B Released Sugarcane Variety (VCF 0517) in Southern Dry Zone of Karnataka

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ABSTRACT

Sugarcane is the main source of sugar which accounts for 80 per cent of global sugar requirement and holds a prominent position as a cash crop. It is one of the main commercial crops of earning foreign exchange and plays a pivotal role in the agro-industrial economy of India. Because of its commercial importance, there has been lot of focus and support for its research and extension activities in order to improve its production and productivity. Research institutes are coming out with more technological innovations in sugarcane in order to improve its productivity. Assessing the economic impact of these technologies is an important task for economists. With this background, the present study focuses on finding out the economic impact of technological innovation in sugarcane (VCF 0517) on the income of sugarcane growing farmers vis-à-vis efficiency of resources used in sugarcane production by collecting primary data from 100 respondents growing VCF 0517 released by UAS-B and Co 86032 as a control variety from Mandya and Mysuru districts of Karnataka. The results indicated that the VCF 0517 growing farmers obtained higher cane yield (189 t/ha) than Co- 86032 farms (153 t/ha). The net returns from sugarcane cultivation was also higher for VCF 0517 farms (Rs.1,99,580) compared to Co- 86032 farms (Rs.1,35,540). The results of partial budgeting reconfirmed the superiority of VCF 0517 over Co- 86032 by fetching additional net gain of Rs.67378 per hectare. The returns per rupee of expenditure was higher in case of VCF 0517 farms (1.74) than that of Co 86032 farms (1.53). The study thus concluded that adoption of new technology (variety) has substantially increased the income and inturn standard of living of farmers. Hence, adoption of these UAS-B released high yielding variety along with associated better management practices for sustainable use of resources.

Keywords : Sugarcane, Cost and returns, VCF 0517, Resource use efficiency, Partial budgeting

SUGARCANE (*Saccharum officinarum* L.) is indigenous to tropical South and Southeast Asia and is one of the most important commercial crops of the tropics. The top ten producing countries (India, Brazil, Thailand, China, the US, Mexico, Russia, Pakistan, France, Australia) together accounted for nearly 70 per cent of global output (Anonymous, 2020).

Sugarcane plays a pivotal role in the agro-industrial economy of India. Sugarcane production for the year 2019-20 stood at 370 million tonnes from an area of 4.6 million hectares and productivity of 80.50 tonnes per hectare (Indiastat, 2020). India consumed about 27 million tonnes with per capita consumption of 19 kg and exported about 5.65 million tonnes of sugar during 2019-20 (Anonymous, 2020).

Karnataka is one among the major sugarcane and sugar-producing states in the country. It is being cultivated on large areas since many years for production of jaggery, khandsari and white sugar. It is also a major provider of livelihood to millions of agricultural families and their dependents in rural areas. In Karnataka, the sugarcane is cultivated over an area of 4.29 lakh ha with production 38.20 million tonnes of sugarcane and productivity of 89 tonnes per hectare during the year 2019-20 (Indiastat, 2020).

Sugarcane is the main source of sugar (80 %) globally and holds a prominent position as a cash crop. It is one of the main crops of earning foreign exchange. The main by-products of sugarcane industry are bagasse and molasses. Bagasse is mainly used as fuel,

besides its use for production of compressed fibre board paper, plastic and others, while molasses is used in distilleries for the manufacturing of ethyl alcohol, butyl alcohol, citric acid etc. Rum is the best potable spirit made from molasses. Molasses is also used as an additive to feeds for livestock. Press mud can be used as soil amendment in saline and alkali soils. Green tops of cane are good source of fodder for cattle.

Realizing the commercial importance of sugarcane with its wider uses of by products, there has been lot of focus on research and extension activities in sugarcane production in order to improve the production and productivity of sugarcane. All India Coordinated Research Project on Sugarcane is coordinating research work in the country since 1970 through a network of sugarcane research stations of ICAR (Indian Council of Agricultural Research), State Agricultural Universities, State Government Departments and Non-Government Organization (Shukla *et al.,* 2017). The main emphasis is laid on the development of new innovations in agriculture such as improved sugarcane varieties, crop production and protection technologies suited to commercial cultivation under different agro-climatic conditions of the country. These new technologies and interventions in agriculture that are developed by Government and private institutes, will help target farmers with primary objective of increasing agricultural production, productivity and profitability with the purpose of increasing agricultural income of farmers.

These technological interventions not only lead to the intended result, but also to unanticipated positive or negative effects. Therefore, to identify the consequences of the proposed action, impact assessment is done to ensure whether the intervention is technically feasible, economically viable, socially acceptable and environmentally sustainable.

With this backdrop the present study sheds light on the economic impact of technological innovations in sugarcane production by choosing the University of Agricultural Sciences, Bangalore (UAS-B) released variety of sugarcane *i.e.,* VCF 0517 for in-depth analysis. VCF 0517 sugarcane variety which was released in the year 2017 has occupied 80 per cent of the area in Southern Karnataka (Anonymous, 2019). The VCF 0517 is popularly called as 'Bahubali" because of its high cane yield, high sugar recovery, high jaggery yield and good quality sugar which was chosen for the study to estimate costs and returns, resource use efficiency over other popular check variety (Co 86032) in the study area. The study would help in assessing the performance of new innovation developed by the university and its impact on farmer's income. This would in turn help to advisethe farmer to adopt to such technologies with better production management practices and sustainable use of resources.

METHODOLOGY

Study Area, Sampling Framework and Sources of Data

The present study was undertaken in Mandya and Mysuru districts of Karnataka. These districts were purposively chosen based on the predominance of sugarcane area in the jurisdiction of UAS, Bengaluru. The respondents were chosen randomly from predominantly sugarcane growing villages in consultation with scientists and extension workers working in the study area. The data were collected from 100 sample farmers which constituted 50 farmers who adopted UAS, Bangalore released VCF 0517 sugarcane variety and 50 farmers who adopted a check variety (Co 86032).

The primary data pertaining to socio-economic characteristics, resources used, yield, price realized and other relevant information were collected from sample farmers related to the agriculture year 2020-21 using the pre-tested, well-structured interview schedule in selected villages of Mandya and Mysuru districts in Karnataka.

Analytical Tools

Estimation of Costs and Returns of Sugarcane Production

Cost of cultivation was estimated in terms of variable costs and fixed costs using information related to each of these standard cost concepts. In addition, interest

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on working capital, different items of fixed costs like rental value of land, depreciation (straight line method was used), land revenue and interest on fixed capital were included. The gross returns from sugarcane cultivation, net returns over total cost and returns per rupee of expenditure were calculated.

Partial Budgeting

A simple yet powerful tool of partial geting technique was used to estimate the direct economic benefit (or loss) at farm-level by adoption of VCF 0517 variety over check variety. This technique focuses on the changes in income and expenses that would result from implementing an alternative practice or technology. All components of farm profits which remain unchanged by the decision were not considered. In this study, the impact of using VCF 0517 sugarcane variety on income of farmers was evaluated by considering the additional costs incurred in adoption of VCF 0517 sugarcane variety and decrease in gross returns (if any) were used under debit side of the Partial budgeting template. Decrease in cost if any by adoption of VCF 0517 sugarcane variety and incremental returns realized (if any) were taken on credit side as shown in following template. Sum of credits were subtracted from the sum of debit side to arrive at net gain or loss from the modification for the farm enterprise.

Partial Budgeting

Debit		Credit	
Increase in cost due to adoption of VCF-0517 variety	=A	Decrease in cost due to adoption of VCF-0517 variety	=C
Decrease in gross returns due to adoption of VCF-0517 variety	=B	Increase in gross returns due to adoption of VCF-0517 variety	=D
Total	=A+B	Total	=C+D

Credit-Debit = Net gain / loss

Resource Use Efficiency

The Cobb-Douglas type of production function as specified below was used to assess the resource use efficiency in sugarcane cultivation.

$$Y = a\ X_1^{bl}\ X_2^{b2}\ X_3^{b3}\ X_4^{b4}\ X_5^{b5} X_6^{b6} X_7^{b7} e^{u} \ldots\ldots\ldots (1)$$

Where,

Y = Yield of sugarcane (tonnes)

X_1 = Human labour (Man days)

X_2 = Bullock labour (Pair days)

X_3 = Machine labour (Tractor hours)

X_4 = Seed material (tonnes)

X_5 = Fertilizer (Rs.)

X_6 = Farm yard manure (Bullock loads)

X_7 = Plant protection chemical cost (Rs.)

a = Constant

u = random variable.

b_1 to b_7 indicate regression coefficients of respective inputs and implicitly represents the elasticity of production of respective inputs.

The Cobb-Douglas production function was converted into natural log linear form and estimated using the OLS technique. The log linear form of equation was

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + u \ln e \ldots. (2)$$

Marginal Value Product (MVP): The estimated coefficients were used to compute the MVP. We can assess the relative importance of factors of production by studying the marginal value product. Marginal Value Product of X_i, *i.e.* for the i^{th} input, it is estimated by the following formula (equation 2)

$$MVP = bi \times \frac{GM(Y)}{GM(Xi)} \times P_y \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

GM (Y) and GM (Xi) represent the geometric means of output and input, respectively, b_i is the regression coefficient of i^{th} input and P_y is price of output. The efficiency of input use was estimated using the following equation 3.

$$r = MVP/MFC \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, 'r' is the efficiency ratio, MVP is the marginal value product of variable input and MFC is the marginal factor cost (price per unit input).

Based on economic theory, a firm maximizes profits with regards to resource use when the ratio of the marginal return to the opportunity cost is one. The values of 'r' less than unity indicate excess use of resource (there exist scope for the reduction). If 'r' is greater than one, indicates underutilization of the resource (there is a scope to increase). If 'r' is equal to unity indicate optimum utilization of resource.

RESULTS AND DISCUSSION

Cost of Cultivation

The details on per hectare cost of cultivation of sugarcane of UAS-B released variety VCF 0517 and Check variety (Co 86032) during the crop year 2020-21 are given in Table 1.

Among the different items of cost, harvesting and marketing cost was found to be the prominent item of cost in the cultivation of both VCF 0517 (Rs.1,54,980)

TABLE 1

Cost incurred in cultivation of VCF 0517 and Co 86035 varieties of sugarcanein the study area

Particulars	VCF 0517				Check (Co 86032)			
	Quantity	Rate (Rs.)	Cost (Rs.)	Per cent	Quantity	Rate (Rs.)	Cost (Rs.)	Per cent
A Variable Cost (Rs.)			**243770**	**89.32**			**217809**	**88.20**
Human labour (md)	72	400	28800	10.55	89	400	35600	14.42
Sets (tons)	7.00	3000	21000	7.69	6.20	2500	15500	6.28
Tractor (hrs)	3.50	800	2800	1.03	5.00	800	4000	1.62
Bullock (Pair days)	7.41	700	5187	1.90	7.00	700	4900	1.98
Fertilizer (Rs.)			7125	2.61			8250	3.34
FYM (Cart loads)	7.20	400	2880	1.06	9.39	400	3750	1.52
Plant protection chemicals (Rs.)			1050	0.38			1280	0.52
Micro nutrient and Bio fertilizer (Rs.)			350	0.13			230	0.09
Irrigation charges (Rs.)			3650	1.34			4590	1.86
Harvesting &Marketing (Contract) (Rs.)		820	154980	56.79		820	125460	50.80
Interest on working capital @ 7 per cent			15948	5.84			14249	5.77
Fixed Cost (Rs.)			**29150**	**10.68**			**29151**	**11.80**
Land revenue			50.00	0.02			50.00	0.02
Depreciation cost			1450	0.53			1450	0.59
Rental value of land			25000	9.16			25000	10.12
Interest on fixed capital @ 10 per cent			2650	0.97			2650	1.07
Total Cost (Rs.)			**272920**	**100**			**246960**	**100**

and Check variety (Rs.1,25,460). Human labour cost was the second highest cost incurred by farmers with corresponding cost of Rs.28,800 (10.55 %) and Rs.35,600 (14.45 %). The cost of seed material was relatively higher for VCF-0517 farms (Rs.21000) compared to Check variety farms (Rs.15500). This higher seed cost was attributable to the use of more quantity of seed material by VCF 0517 growing farms. While, the fertilizer cost was higher (Rs.8,250) for check variety farms than VCF 0517 farms (Rs.7,125) as they have applied more quantity for chemical fertilizers. The cost of FYM (Farm Yard Manure) was also higher for check variety farms (Rs.3750) than that of VCF 0517 farms (Rs.2880). The similar trend was observed with respect to irrigation cost (water cess+Human labour) incurred in sugarcane cultivation, as farmers growing check variety farms incurred comparatively more cost (Rs.4590) than VCF 0517 growing farms (Rs.3650).

Proportion of working expenses was relatively more than fixed cost in the cultivation of both the VCF 0517 and Check variety farms, which accounted for 89.32 and 88.20 per cent, respectively. Respondents incurred a total cost of Rs.272920 and Rs.246960 in the cultivation of VCF 0517 and Check variety, respectively. The cost of cultivation was higher for VCF 0517 variety because of more number of labour use for crop maintenance and expenditure towards harvesting due to higher cane yield.

Yield and Returns

Yield and returns structure of sugarcane growing farmers is given in Table 2. The average per hectare yield realized on respondents' farms was higher (189 tonnes) in the case of VCF 0517 variety compared to check variety (Co 86032) farms (153 tonnes), thus they could able to realize higher gross returns from VCF 0517 variety (Rs.2,72,920) than from check variety (Rs.3,82,500). The differences gross returns were found statistically significant at ten per cent level of significance. Consequently, net returns from sugarcane cultivation from VCF 0517 variety were more (Rs.1,99,580) compared to check variety (Rs.1,35,540). These results are in line with study conducted by Raghupathi, *et al.* (2020) which revealed that, net returns from cultivation of Arka Kamini variety of China aster was the higher (Rs.1 69985 per acre) than that of check variety farms (Rs.142241 per acre), as an attempt to evaluate technology (variety) released from Indian Institute of Horticultural Research (IIHR).

This difference in returns between the two categories of farms can be attributed to the higher yield realization by the farmers cultivating for VCF 0517 (23.52 %) than that of Co 86032 farmers. This higher returns from sugarcane cultivation by VCF 0517 farms due to higher yield level subsumed their high cost of cultivation. The returns per rupee of expenditure for VCF 0517 farms and check variety farms were Rs.1.74

TABLE 2

Production and returns from VCF-0517 and Co-86035 varieties of sugarcanein the study area

Particulars	VCF-0517			Check variety (Co-86032)		
	Quantity	Price (Rs.)	Returns (Rs.)	Quantity	Price (Rs.)	Returns (Rs.)
Main product (Tons)	189	2500	472500	153	2500	382500
Gross returns (Rs.)			472500			382500
Net returns (Rs.)			199580			135540
Returns per rupee of expenditure (Rs.)			1.74			1.55
t-test for gross returns						t=1.42*

Note: * indicates significant at ten per cent probability level

TABLE 3

Relative benefit of VCF-0517 variety over check variety of sugarcane production (Rs/ha)

	Debit	Amt (Rs.)		Credit	Amt (Rs.)
A	Increase in Cost due to VCF 0517 variety		C	Decrease in cost due to VCF 0517 variety	
i	Bullock labour	287	i	Human labour	7600
ii	Micronutrients	60	ii	Machine labour	1000
iii	Harvesting and marketing	34650	iii	Fertilizer	1125
B	Decrease in returns due to VCF 0517 variety	0	iv	FYM (Bullock loads)	750
			v	PPC	200
	Total debits	34997	vi	Irrigation	1200
				Increase in returns due to VCF 0517 variety	90500
				Total credits	102375

Net gain per hectare (Total credits -Total debits) = Rs. 67378

Resource use efficiency in sugarcane production

and Rs.1.55, respectively. This indicated that, every rupee spent in sugarcane cultivation would fetch a net return of Rs.0.74 and Rs.0.55, respectively for farms growing VCF 0517 and Co 86032. These findings are in line with the study conducted by Raghupathi *et al.* (2021) on economic impact of research in French bean, which revealed that, the per acre gross returns realized by the Arka Sharath French bean variety (Rs.2,62,500) was 29 per cent higher (Rs.7,7510) than check variety Ashoka (Rs.1,84,990) in Karnataka.

Partial Budgeting Analysis

Partial budgeting technique was used to estimate the relative benefit of UAS-B released variety (VCF 0517) over the control variety in terms of output and income level of farmers in sugarcane cultivation. It is evident from Table 3 that, farmers realised net gain of Rs.67378 per hectare from VCF 0517 variety over check variety of sugarcane. The cultivation of UAS-B released variety VCF 0517 has given higher yield level and income level. The results obtained using partial budgeting indicated higher profitableness of UAS-B released variety of sugarcane. These findings are on par with the study conducted by Pramod and Mahadevaiah (2021) which revealed that, among various improved varieties and new crops introduced in the study area under the NAIP project, farmers have realized the highest additional returns in cultivation of cotton and redgram (BRG 2) which accounted to Rs.8000 per acre and Rs.5780 per acre, over their respective check varieties.

Resource Use Efficiency in Sugarcane Production

Resource use efficiency in agriculture plays an important role in determining the farm production and income. The size of farm income depends on the efficiency with which farmers are able to utilize the available resources. With higher efficiency in the use of scare resources, farmers can augment their income and savings. Therefore, besides estimating the superiority of UAS-B variety over check variety an attempt was also made to study the resource use efficiency in sugarcane production using the functional analysis presented in previous section. The estimates of Cobb-Douglas (CD) function are presented in Table 4. The estimated production function revealed that independent variables included in the model explained 85 per cent and 79 per cent of variation yield of VCF 0517 and check varieties of sugarcane.

The analysis of resource use efficiency on VCF 0517 variety cultivating farm revealed that the MVP to MFC

TABLE 4
Resource use efficiency in sugarcane production

Particulars	VCF-0517		Check (Co-86032)	
	Coefficients	MVP/ MFC	Coefficients	MVP/ MFC
Intercept	1.779 *		1.924 ***	
Human labour	0.183 (0.026)	1.050	0.072 (0.091)	0.296
Bullock labour	0.078 (0.064)	0.750	-0.028 (0.129)	-0.776
Machine labour	0.041 (0.026)	1.373	0.056 (0.050)	1.749
Seed material	0.387 *** (1.084)	1.084	0.485 *** (0.065)	2.941
Fertilizer	0.036 (1.720)	1.726	-0.041 (0.005)	-1.248
Farm Yard Manure	0.108 ** (0.043)	2.829	0.068 (0.073)	0.786
Plant Protection Chemicals	0.009 NS (0.014)	4.859	0.003 *** (0.001)	1.275
R^2	0.85		0.79	
F-value	28.63 ***		75.91 ***	

Note:

1. ***, ** and * indicates significant at one per cent, five per centand ten per cent probability level, respectively.
2. Figures in parenthesis indicate standard error values

ratio was less than one for bullock labour (0.750) indicating that bullock labour was over used in sugarcane production and there is a need to reduce the use of it to attain optimum sugarcane production. The MVP to MFC ratio was more than one for human labour (1.050), machine labour (1.373), seed material (1.084), fertilizer (1.762), FYM (2.829), PPC (4.859), which indicated underutilization of these resources. Thus results indicated scope for reallocation of expenditure among these resource and optimize sugarcane production.

While in the case of check variety growing farms, the MVP to MFC ratio analysis revealed that human labour (0.296), bullock labour (-0.776), fertilizer (-1.248) and FYM (0.786) resources were over used in sugarcane cultivation, as the ratio of MVP : MFC was less than unity. Use of these resources need to be reduced to attain optimum sugarcane production. The MVP to MFC ratio was more than one for machine labour (1.749), seed material (2.941) and PPC (1.275) indicating underutilization of these resources and there exist scope for higher use of these resources from their existing level to reach optimum production of sugarcane.

The study revealed that VCF 0517 sugarcane variety is performing well in field conditions and offering higher returns to farmers compared to the check variety. The VCF 0517 cultivating farms have realized 23.50 per cent higher yield and additional benefit of Rs.67378 per hectare over check variety. Therefore, the Department of Agriculture, Government of Karnataka and UAS-B can make further intensive efforts to popularize and encourage the widespread adoption of VCF 0517 variety to realize full potential of the crop productivity, for better resource use and higher farm income.

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