Socio-Economic Performance Analysis of Sugarcane Cultivation Under Sustainable Sugarcane Initiative Method

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ABSTRACT

As the chances of horizontal expansion in the area under sugarcane in India are bleak, the only solution is to increase the productivity by adopting innovative technologies. As such there are few technologies in sugarcane that can minimize cultivation cost. Bud chip planting popularly known as Sustainable Sugarcane Initiative (SSI) is a novel conglomeration of many viable technologies put together so as to increase the productivity. This technology is gaining momentum among cane growers and the present study was conducted to get the feedback of farmers about the various issues concerned with this technology. The study was conducted using ex-post-facto research with 60 cane growers chosen from five mandals of Chittoor district in Andhra Pradesh. The reasons for adoption of SSI technology include reduced seed rate, possibility of intercropping, reduced cost of cultivation and increase in cane yield. The other positive factors as perceived by the farmers are synchronized tillers, more number of millable canes, good root establishment, ease of intercultural operations and possibility of multiratooning. The major constraints in adoption of this technology were non-availability of buds of the required sugarcane variety, scarcity of trained labourers and dearth of settlings when needed for planting. Tests of comparison of SSI technology with conventional method of planting using setts indicated a significant't' value. This technology offers scope for introduction of a wide variety of intercrops mainly groundnut, beans, cauliflower, cabbage, capsicum, tomato and potato which could fetch considerable returns. Farmers realized increased net returns through increased cane productivity apart from the economic benefit of growing intercrops. The study helps to get a better understanding of the performance of sustainable sugarcane initiative in farmer's fields appraised in terms of their own reference and farmers' observations of this unique technology in South India.

Keywords: *Sustainable sugarcane initiative; Sugarcane; Socio-economic analysis; Constraints; Perception;*

Sugarcane is grown under a wide range of agro-climatic conditions in India extending from the tropics to sub tropics. The crop is subjected to various types of biotic and abiotic stress, which affect the productivity. The tropical India has even sunshine all through the year and well distributed rainfall and ideal conditions for the good growth of the crop leading to high productivity. There had been considerable improvement in the productivity levels in the past, but have more or less stagnated over the last two decades (*Sundara, 2011*). The cane production in the country is dependent on rainfall and drought spells appearing in regular intervals leading to wide fluctuations in the cane area and production. Due to extremely favorable weather conditions, sugarcane and sugar production reaches a high level and subsequently comes down with a typical surplus and deficit cycle (*Nagendran, 2009*).

Sustainable Sugarcane Initiative, popularly referred as SSI is a novel conglomeration of many viable technologies put together so as to increase the productivity. Scientific studies conducted in Research Stations indicate that SSI cultivation in sugarcane gives better yield; but not many studies on the impact per se of the technology in farmers' fields have been conducted and large scale adoption of this technology is still a reservation. Hence, the present study was conducted to get feedback about the performance of this technology in farmers' fields with the following objectives: to study to study the advantages of SSI, to analyze the feasibility of intercropping under SSI, to work

out the economics involved and to analyze the constraints involved in cultivation of sugarcane under SSI method.

METHODOLOGY

The study was conducted by using descriptive type of research design applying ex-post facto approach and the respondents were selected among farmers growing sugarcane using bud chip seedlings, therein referred as SSI cultivation. The KBD Sugars & Distilleries Ltd. is located at Mudipapanapalle village, Punganur mandal, Chittoor district of Andhra Pradesh. The area of operation spreads over villages in Andhra Pradesh and border villages of Karnataka. The study was purposively carried out in KBD Sugars & Distilleries Ltd Unit IV since it has a sizeable area cultivated under SSI cultivation which is in vogue since 2007. The average cane yield level recorded in the reserved area of the mill was 68.50 t/ha close to the state average yield of 70 t/ha during 2010–2011.The KBD Sugar mill has an operational area covering 20 mandals under five cane divisions. Sixty registered cane growers practicing SSI cultivation were selected at random from the five divisions *viz.*, Punganoor (28), Gangavaram (15), Chowdepalle (2), Madanapalle (5) and V.Kotta (10) for conducting the study.

An interview schedule was developed for this purpose and pilot tested with non-sample farmers. Detailed survey was undertaken by personal interview using the pre-tested interview schedule during 2009–2011. The yield data of the plots was recorded from the individual farms and the sociological appraisal was done through technographic approach primarily through focus group discussions, participant-observation of tasks and individual informal personal interview. Their responses were tabulated and the data were analyzed using statistical tools such as mean, simple percentage analysis, percentage mean score and paired 't' test.

RESULTS AND DISCUSSION

Advantages of SSI technology: For any new innovation, there are some advantages and disadvantages during and after adoption. If the farmers perceived that the advantages of the new technology are more than its disadvantages, then it leads to adoption of that technology. In this study, the respondents were asked to enlist the advantages in SSI technology with an open ended schedule (Table 1).

Table 1. Advantages of SSI technology (N=60)

Advantages	No.	%	Rank
Increased cane yield	56	93.33	I
Interim income due to intercropping	56	93.33	I
Increased net returns	54	90.00	II
Saving in seed cost, labour & other inputs	53	88.33	III
Synchronized tillers	50	83.33	IV
High recovery	50	83.33	IV
Possibility of mechanization	47	78.33	V
Raising seedlings is an income generating activity	46	76.67	VI
Easy & cost effective transport	44	73.33	VII
Ease of bud treatment	44	73.33	VII
Saving in water	43	71.67	VIII
Reduced crop duration (up to 40 days)	41	68.33	IX
Less incidence of weeds	39	65.00	X
Easy gap filling	38	63.33	XI
Possibility of grading of seedlings	35	58.33	XII
Good crop stand	34	56.67	XIII
Possibility of multiple rationing	31	51.67	XIV
Soil enrichment (intercropping & trash mulching)	24	40.00	XV
Effective utilization of sunshine & air	13	21.67	XVI

SSI technology was popularized by mainly highlighting on increased yield, low seed rate and reduced cost of cultivation. Accordingly, the respondents perceived its main advantages as yield increase, low seed rate, reduced cost of cultivation and labour saving. Increased cane yield was ranked first among the advantages of SSI technology (93.33%). In Chowdepalli and Madanapalli divisions, extreme labour shortage for agricultural operations prevails due to labour migration to the nearby cosmopolitan cities. So the respondents perceived labour saving as one of the main advantages and it reduces drudgery of the agricultural labourers as well as labour cost.

Increased yield: SSI technology has a definite economic advantage over the conventional method of cultivation. Through this technology the average yield was 118.14 tons per hectare where as the yield from the conventional one was 64.74 tons per hectare. More number of millable canes with uniform girth (i.e. synchronization of tillers) increases the cane yield.

Interim income due to intercropping: All the farmers grow one or more intercrops like cabbage, cauliflower, pulses, marigold etc. along with sugarcane and thereby get an interim income by 90-100 days of planting. When pulses are grown as intercrops, it improves the soil fertility by adding organic matter and nitrogen fixation in the soil.

Increased net returns: This is made possible through increased cane productivity as well as additional income from intercrops. There is considerable saving in the cost incurred on seed, labour and other inputs. In conventional method, the cost of setts occupies a major part of the cost of cultivation. By adopting intercropping and proper intercultural operations in sugarcane, per unit profitability can be improved (*Panghal 2010*).

Synchronized tillers: It was observed that synchronized tillering as high as 10-18 is possible under SSI planting and this leads to homogenous population. This in turn leads to high recovery in the sugar factories.

Possibility of mechanization: The availability of large interspace between the wide rows of 150 cm under SSI planting facilitates the use of power tiller and other small machinery for operations like weeding and earthing up and helps to improve land and labour productivity. Mechanization of sugarcane farming is an important requirement in the country in view of the labour shortages increasingly felt throughout the country. Mechanization would help to reduce dependence on manual labour, facilitate timely farm operations and help to improve the quality of various operations thereby improving yield (*Sundara 2011*).

Raising seedlings as an income generating activity: As such, avenues for retaining youth in agriculture and income generation are dwindling. SSI offers a prospect for raising seedlings under nursery and this can be taken up in rural areas as an income generating activity with minimum investment.

Ease of sett treatment and transport: A huge quantity of 6-8 tons of cane per hectare is needed for planting under conventional method whereas under SSI, we need hardly 1200 canes from which 12000 bud chips can be taken. Sugarcane bud chips are easy for transport compared to huge quantities of setts and the amount spent towards transport is also less. Sugarcane setts / buds are to be treated in fungicides before planting. Compared to setts, it is quite easy to treat buds since the quantity is less and manageable.

Saving in water: Required amount of water for the plant activities need to be given rather than flooding the field with water which would hinder the growth. There is a considerable saving of water in the nursery stage and in the main field, thereby at least 30-40% water is saved.

Reduced crop duration (up to 40 days): Since seedlings of 30-35 days are transplanted in the main field, the crop can be harvested by 11 months which is otherwise an annual crop of 12 months duration.

Less incidence of weeds: SSI supports intercropping in sugarcane by utilizing the large inter row space available during the initial 100 days of planting. Due to coverage of land area with foliage and limited wetting of soil due to drip irrigation, incidence of weeds is reduced up to 60 per cent. Comprehension of this advantage among respondents was low because of the normal weed growth later during monsoon months.

Easy gap filling: SSI system provides the advantage of easy gap filling due to the wider spacing and ready availability of grown up seedlings for gap filling. Generally, farmers procure 200-300 additional seedlings per acre so that it can be used for gap filling or for use in case of any damage during transport, if procured from outside.

Possibility of grading of seedlings: Grading of the seedlings is done at two stages – in the nurseries and during transplanting. This ensures good vigour of the seedlings and is reflected in the crop stand in the field.

Possibility of multiple ratooning: Under SSI, bud chip seedlings are planted in furrows at a depth of 15-20 cm. Earthing up is given twice and this promotes better root growth and crop establishment. Adequate rooting is a prime factor for ratoon crop and this paves way for better ratoon cropping and multiple ratoons under SSI method.

Effective utilization of sunshine, air & water: Since the seedlings are planted at wider spacing of 5×2 feet, ample space is left between the rows. This permits easy air and sunlight penetration in the crop canopy leading to more photosynthesis. Enrichment of soil fertility due to incorporation of the intercrop after harvest and trash mulching is another advantage expressed by SSI farmers.

Constraints in SSI technology: To introduce any new technology into a social system, the technology must perform better than the prevailing technology. The system members must observe its performance directly in their own situation and evaluate them in terms of their own reference. It the members of the system are convinced with the performance of the new technology,

and also if the calculated negative factor percentage (constraints) is less than the positive factor percentage (advantages), then the technology can be easily diffused among the members of a social system.

Studies on SSI conducted in research stations state that it leads to higher yield and net returns to prove its economic validity (*Gujja et al, 2009*). However, farmers practicing SSI cultivation face problems both in the nursery stage and in the main field as given in Tables 2 and 3.

Table 2. Constraints in nursery

Constraints	No.	%
Non-availability of buds of required varieties	22	36.67
Skill and patience is needed in selecting buds	21	35.00
Improper chipping of buds	19	31.67
All the seedlings have to be sold by 30-35 days	17	28.33
Intensive care is needed in nursery	15	25.00
Non-availability of good quality medium	13	21.67
Poor germination of buds	12	20.00
Yellowing of shoots after 15-20 days	9	15.00
Poor market value of the bud removed canes during off season	5	8.33

Table 3. Constraints in main field

Constraints	No.	%
Non-availability of seedlings at the right time	27	45.00
Skilled labour is needed for transplanting	22	36.67
Ideal soil conditions is needed	21	35.00
Problem with intercrops	15	25.00
Initial care for establishment of seedlings	10	16.67
Damage during transport	4	6.67

Constraints in nursery: Though many sugarcane varieties are grown by the farmers, only few popular varieties like Co 86032 and 2003 V 46 are in high demand among the farmers. Canes of required age (6-8 months) of such varieties are not available in some areas for which initiatives can be taken by the factory management and nursery agencies. Skilled labourers are required for scooping the buds from canes and selection of healthy buds for planting in protrays. Even a slight damage to the bud affects the quality. Selection of quality buds ensures better germination, crop growth and ultimately a better harvest. Availability of good quality coir pith and compost is another threat to the growth of seedlings in the trays. Due to excess watering or poor quality compost and coir pith, yellowing of leaves is also seen in the nursery stage. The seed cane used, when is of six to eight months age contain very low sucrose. In such cases, the left over canes from the nursery after cutting of buds are used as cattle feed. However, it favours good germination due to more glucose content. When the buds are taken from mature canes, the left over canes are supplied to the sugar factories or jaggery making units and this has to coincide with the crushing season in the respective factory zones.

Constraints in main field: Non-availability of seedlings at the right time is a major constraint faced by farmers in adopting SSI method; this is mainly due to the absence of nurseries producing sugarcane seedlings. By employing skilled labourers, damage to the seedlings can be minimized and transplanting can be done without damage to the roots of the seedlings. The recommended package of practices for sugarcane and the intercrops should not confront with each other. In such cases, the intercrop will get more importance than the main crop (sugarcane). So, one has to be prudent enough to choose the best combination of crops according to the prevailing condition and forecasts by the departmental officials. Market potential of the choice of intercrops is also crucial to get better net profit in SSI technology. Proper means of transport suited to carry the trays without any damage to the seedlings should be sought. Also, the seedlings have to be tugged out of the tray carefully while transplanting lest the root zone gets disturbed. Adequate care has to be taken during the initial stages of crop establishment and this would have a positive impact on the yield of the crop. In spite of the above constraints, farmers still prefer SSI method owing to its economic advantage of better returns.

Economics involved in SSI technology: For successful adoption of a new technology, economic advantage is the major criterion. In this study, economic advantage in terms of cane yield and remuneration from intercrops was considered. The yield increase in SSI planting was compared with yield obtained in conventional planting of 90 cm. Table 4 reveals the range of cane yield obtained under conventional planting and SSI method.

The Table indicates an apparent difference in the cane yield between conventional planting and SSI technology. The cane yield in conventional planting ranged from 38 to 96 t/ha whereas under SSI planting, cane yield ranged from 58 to190 t/ha.

Under conventional planting, 40 per cent of the respondents got a cane yield less than 60 t/ha followed

Table 4. Cane yield obtained under conventional and SSI planting (N=60)

Range of cane yield (t/ha)	Conventional planting		SSI planting	
	No.	%	No.	%
< 60	24	40.00	01	01.67
61 to 80	17	28.33	24	40.00
81 to 110	19	31.67	01	01.67
111 to 140	-	-	02	03.33
141 to 170	-	-	27	45.00
171 to 190	-	-	05	08.33

by 28.33 per cent with 61 to 80 t/ha and the rest 31.67 per cent got 81 to 110 t/ha. The same farmers when they opted for SSI technology could reap a better harvest. Almost 54 per cent of the SSI farmers obtained a cane yield of 111 to 190 t/ha followed by 42 per cent with 60 to 110 t/ha. On the whole, SSI farmers are satisfied with the technology. The low yield in some fields was mainly due to heavy soils, poor choice of intercrops and improper management.

Paired t test results: Paired 't' test was done to find the significance in variation of the yield levels. The paired t test compares the means of two paired groups. The t ratio for a paired t test is the mean of the differences between each set of pairs divided by the standard error of the differences. The two-tailed P value here is less than 0.0001. By conventional criteria, this difference is considered to be statistically significant. At 95 per cent confidence interval of this difference, the t value is 12.258 at df = 59 with standard error of difference= 4.484.

Table 5. Test of comparison using paired 't' test

Group	Conventional method	SSI method	df	SE	't'
Mean	64.74	118.14	59	4.484	12.258
SD	28.22	49.88			
SEm	3.64	6.44			
N	60	60			

Under SSI planting, there is a definite scope for reduction in cost of cultivation and additional income due to increase in cane yield. Added to this, farmers also get a considerable income from intercrops. The reduction in cost of cultivation was Rs. 13890 under SSI method compared to normal row spacing (Table 6). This was mainly due to the savings in planting material ((Rs 4250.00), intercultural operations (Rs 4000.00), weed management (2940.00) and irrigation (Rs 2700.00). With an average cane yield of 118.14 t/ha and 64.74 t/ha under SSI planting and normal

Table 6. Economics of cane cultivation under normal and SSI method

Cost of cultivation per ha	Planting	
	Normal (90 cm)	SSI (150 cm)
Land preparation	5387.00	5387.00
Setts/seedlings and planting	22125.00	17875.00 (4250.00)
Manures and manuring	11250.00	11250.00
Plant protection	3375.00	3375.00
Fertilizer application	8775.00	8775.00
Intercultural operations	9750.00	5750.00 (4000.00)
Weed management	4940.00	2000.00 (2940.00)
Irrigation	13500.00	10800.00 (2700.00)
Harvesting charge	19422.00	35442.00
Transport charge	12948.00	23628.00
Total cost	111472.0	124282.00
Saving	-	13890.00
Differences in parentheses		
Gross Income (Rs. per ha)		
From cane (Yield: Normal planting – 64.74 t/ha, SSI – 118.14 t/ha @ Rs 2100/t)	135954.0	248094.00
Av. income from intercrop	-	20000.00
Total	135954.0	268094.00
Net income per ha	24482.00	143824.00
Incremental income under SSI (per ha)		119330.00

planting respectively, farmers could get an incremental income of Rs. 119330.00.

Intercropping with sugarcane: SSI is a farm based approach that gives options to farmers to grow intercrops pulses to improve their income, while effectively using the soil moisture. All the farmers practicing SSI method had gone for intercrops *viz.*, chillies, radish, bhendi, marigold, cabbage, cauliflower, pulses, maize etc. which gave them a substantial income (Table 7). They grow some intercrops for their own use or for sale in the local markets. The order of preference is cauliflower, cabbage, bush type beans & lablab, chillies & capsicum, bhendi & tomato, root crops like potato & radish and maize. The choice of intercrops is based on the demand in the local market. Farmers have their own choice of varieties for intercrops which are well suited to be grown beside sugarcane. The seedlings of the intercrops are planted along with planting sugarcane seedlings and the

required fertilizer for the intercrops was also applied separately in the furrows. There were few farmers who had grown 4-5 intercrops in an acre wherein each intercrop is grown in 20-25 cents. The income varied from Rs 8400 with groundnut to Rs 72,000 from cabbage when grown as an intercrop.

Table 7. Intercrops under SSI

Intercrop	Varieties	Yield (tha^{-1})	Income (Rs.)
Beans	Anupama, 207, Sevelle, Everest	2	20000
Cauliflower	Shoba, East West, Suhasini, Vigor 277	10	70000
Cabbage	Krishna, Unnati, Bheema, Equitoria	20	120000
Tomato	Siri, PKM, Red ruby, US 618, US 918, US 635, US 9005, US 3140, US 618, US 5005,	6	18000
Chillies (Green)	NS 1101, NS 1701	1.2	24000
Chillies (Dry)	NS 1101, NS 1701	0.3	42000
Potato	Kufri Jyoti, Jalandhar	10	70000
Groundnut	Narayani, Kadiri 6	0.6	8400

Factors influencing performance of SSI method of cultivation: Farmers have their own perception of any new technology introduced (Table 8). They feel that the performance of sugarcane crop grown under SSI depends on the choice of the variety. Varieties with high tillering ability and that can stand erect till harvest is preferred. The common materials used for filling the cones in the protrays are decomposed coir-pith, and vermicompost or powdered farm yard manure or enriched pressmud etc. in the ratio of 1:1. Germination and further growth of the settling depends mainly on the nutrient availability in the medium.

Chipping the buds from the canes has to be done very carefully so that the buds are not damaged. Buds should not be taken from disease infected unhealthy canes.Age of the crop has a profound saying on the germination and is also reflected on the vigour of seedling and crop growth. Canes of 6-8 months age are preferred over canes of 9-12 months. Proper tilth of the soil is essential for good establishment of the seedlings. Deep ploughing of the soil to at least 10 inches depth is needed for better aeration, root penetration and infiltration of water. Biotic factors like incidence of pests and diseases and abiotic factors like drought and water stress also influence crop growth and finally yield.

Table 8. Factors influencing performance of SSI method

Items	No.	%
Choice of the variety	51	85.00
Medium used in the pro-trays	50	83.33
Skill in scooping the buds	49	81.67
Age of the crop	43	71.67
Type of soil in the main field	41	68.33
Availability of water	21	35.00
Incidence of pests and diseases	20	33.33
Abiotic factors like drought	18	30.00

CONCLUSION

The possible ways to increase the sugarcane production to meet the need of the teeming population are: increase the area under sugarcane cultivation, improve the available water resources, increase the productivity of sugarcane and accelerate adoption and diffusion of new and improved technologies. As there are little chances to increase the area under sugarcane and increase the water resources, the only possible way is to increase the productivity of sugarcane *i.e.* the vertical dimension productivity. This can be done only through innovative technologies, of which SSI is a promising one.

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