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Sustainable Sugarcane Initiative (SSI), An Approach to Enhance Sugarcane Production: A Review

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ABSTRACT

Celebrations without sweets and cakes and a cup of coffee or tea without sugar are unthinkable. Sugar which adds sweetness to our life is extracted from the juice of the sugarcane. The thick stalks of canes store energy as sucrose in the sap. The cultivation of sugarcane dates back to the vedic period. The most ancient reference to sugarcane is in `Athervaveda' which is 5000years old, and the word 'sugar' is derived from the Sanskrit word Sankkara/Sarkara. Different species of sugarcane likely originated in different locations with Saccharum barberi originating in India and S. edule and S. officinarum coming from New Guinea. Plateauing yield level, declining factor productivity, increasing production cost, slashing sugar prices in international market and decreasing profitability in recent years indeed pose the real concerns before cane growers and mill owners. These necessitated resource saving methods of sugarcane cultivation. SSI is an alternative method for present day cutivation of sugarcane.

Key words: *SSI, wider spacing, inter cropping, Integrated nutrient management and Integrated plant protection*

INTRODUCTION

Sugarcane (*Saccharum officinarun*) is an important commercial crop in India. Globally, it is cultivated on area 24.5 m ha with an annual production of 1850 m t with an average productivity of 75.5 t ha^{-1}. India ranks 2nd in the world next to Brazil in terms of area (5.30 m ha) and production (366 m t) with an average productivity of 69.1 t ha^{-1} (27.1 m t sugar) contributing 19.98 per cent in world's total sugarcane production (Anon., 2015). India is 2nd largest consumer of sugar in the world (15.59 m t) and ranks 14th in exports (0.21 m t) and 5th in the world for imports (0.67 m t). In India, Uttar Pradesh nearly occupies half (2.25 m ha) of the total area followed by Maharashtra (1.04 m ha). Tamil Nadu has highest productivity (105 t ha^{-1}) followed by Karnataka (85.5 t ha^{-1}) and Andhra Pradesh (71.8 t ha^{-1}).Sugarcane is in great demand for various other uses like fodder, fibre, bio-fuels and co-generation. Sugar industry is 2nd largest industry (Rs. 30, 000 crore industry) in the agro-processing sector, next to textiles and represents the principal livelihood of 35 million farmers.

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By 2030 AD, India will require nearly 33 million tonnes of white sugar for domestic consumption alone. It is estimated that by 2030 AD, about 520 million tonnes of sugarcane with average sugar recovery of 10.75 per cent (60 per cent cane will be utilized for white sugar, and 15 per cent will go for ethanol production) will be required. The population of the country is expected to swell to 1.65 billion by 2050, which needs 51 m t of white sugar [considering per capita consumption of sweetener - 35 kg (28 kg white sugar and 7 kg gur).To meet the growing demand of sugar and energy by 2050 in India, around 630 m t of sugarcane with a recovery of 11.5 per cent will be required. Production of alcohol for partial replacement of fossil fuel and use of bagasse in cogeneration of electricity has great potential in future and thus requirement of cane will increase further. This will entail an average cane productivity requirement of 105 t ha^{-1}, as the area under sugarcane cultivation may not increase beyond 6.0 million hectares. So, it is high time we amend our usual, high inputs intensive method of sugarcane cultivation and lookout for some innovative, resource saving methods of sugarcane cultivation. Sustainable Sugarcane Initiative (SSI) is one of such methods of sugarcane cultivation.

What is SSI?

"The Sustainable Sugarcane Initiative (SSI) is an innovative set of agronomic practices that involves using less seeds, raising seedlings in a nursery following new planting methods with wider plant spacing, better water and nutrient management to increase the cane yield significantly". This concept was introduced with a concept of "More with less". SSI is an alternate to conventional seed, water and space intensive Sugarcane cultivation (Principle of LEISA). SSI is well known as "Bud Chip Technology" and it is a combination of cane planting innovations and water saving practices. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) entered into a partnership with the World Wide Fund for Nature (WWF) and introduced the concept of SSI in 2009 in A.P. and U.P under the leadership of Biksham Gujja and team.

Principles of SSI

1. Raising nursery using single budded chips and transplanting young seedlings:-
2. Maintaining wider spacing in the main field
3. Providing sufficient moisture and avoiding inundation of water
4. Intercropping for effective utilization of land
5. Integrated nutrient Management and
6. Integrated plant protection measures

Table 1: Comparison between Conventional and SSI methods of Sugarcane Cultivation

Particulars	Conventional method	SSI method
Seeds/Setts	48,000 buds (16,000 three budded setts/acre)	5000 buds (5000 single budded chips/acre)
Nursery preparation	No	Yes
Planting	Direct planting of setts in the main field	Transplanting of 25-35 days old young seedlings raised in a nursery
Spacing	1.5 to 2.5 ft between rows	5 ft between rows
Water requirement	More (flooding of field)	Less (maintenance of moisture in the furrows)
Mortality rate among plants	High	Low
No. of tillers per plant	Less (10-15)	More (20-25)
No. of millable canes achieved per clump	4.5	9-10
Accessibility to air and light	Low	High
Scope for intercrop	Less	More

Raising nursery using single budded chips and transplanting young seedlings:

Single budded chips, carefully removed from healthy canes are used for raising nursery. The selected buds are placed in trays filled with coco-pith (coconut coir waste) to raise the seedlings. By raising nursery, high percentage of germination can be achieved within a week depending on the agro climatic conditions. The young seedlings raised in the nursery are transplanted to main field at the age of 25 – 35 days. It is important to note here that this one month growth of seedlings achieved under SSI method cannot be achieved even after two months in conventional method. Singh *et al*.[14]revealed that among the different methods of planting materials, poly bag culture planting recorded significantly higher germination of buds (%) at 40 DAP (86.34 %), bud multiplication ratio (34.54) , number of millable canes (1,34, 000) , cane yield (78.42 t ha^{-1}), commercial cane sugar (11.55 %) as compared to other planting material. Among the SSI technology and conventional 3-bud setts planting method, sustainable sugarcane initiative treatment recorded higher per cent survival/ germination, number of millable canes $clump^{-1}$, cane length, cane girth, single cane weight, Internodal length, number of internodes per cane and cane yield as compared to Conventional 3 bud setts planting and recoded 18 per cent increase in yield over conventional method[7].

Table 2: Expected outcomes of the Sustainable Sugarcane Initiative

From farmers point of view	From factory point of view	From Government point of view
Saving in seed (setts).	Higher cane recovery.	Employment generation in rural areas.
Higher cane yield with net return.	Increase in crushing day.	Electricity saved can be used for some other purposes
Bringing additional area under cane.	Reduction in production cost	Ground water exploitation can be reduced.
More crops in unit area and time	Potential for cogeneration	Higher returns to government through tax collection from sugarcane industries.
Saving on water, labour and electricity.	Additional ethanol production.	
Raising cane crop with poor quality water.		
Cultivation cane in marginal and problem soils.		
Timely and need based fertilizer application.		

Maintaining wider spacing in the main field:

Wider spacing drastically reduces the seed requirement from 48,000 buds to 5,000 buds per acre. In the SSI, wide spacing of 5 x 2 feet maintained in the main field leads to 1,12,500-1,37,500 millable canes/ha because of more tillering. It supports easy air and sunlight penetration in the crop canopy for healthy cane growth. Karthikeyan, stated that wider spacing recorded higher values for yield parameters, this might be due to the fact that there is no competition for nutrient, light and water during germination time as there was enough space for germination. Further, the setts provided most of food for germination. It might be due to better crop stand and more number of tillers resulting in better growth of plant and resulted in higher yield. The wider spacing facilitates efficiency of light interception and its utilization. Higher efficiency of light interception could be achieved through rapid development of leaf area index (LAI) and maintaining the optimum LAI for a longer duration. Cane yield is a function of the stalk population per unit area (number of millable canes) and single cane weight and hence increase in the yield[11]. Significantly maximum cane yield of 96.67 t ha^{-1} was recorded in 120 cm apart rows. It was followed by cane planted at 90 cm apart rows (85.05 t ha^{-1}) which was at par with 75 cm apart rows (78.85 t ha^{-1}). At early growth stage, crop canopy is less developed and there is no problem of sunlight penetration which might be a reason for same number of tillers. Higher cane weight recorded in row spacing of 120 cm may be due to the fact that wider

spacing had improved the efficiency of plants to use the nutrients, space and light[9].

Providing sufficient moisture and avoiding inundation of water

In SSI, emphasize is to provide sufficient moisture rather than inundating the field with water as flooded condition will actually hinder the growth of the plant. Measures like raising of nursery, following alternate furrow irrigation, optimum application of water through drip irrigation should be followed. So, by giving only required quantity of water about 40% of water is saved. Irrigation water used recorded highest with normal furrow (90 cm) furrow irrigation. Irrigation Water use efficiency recorded higher with drip with paired row planting and recoded saving in irrigation water about 56.82 per cent. Gouri *et al.*[4], Sarala *et al.*[10] revealed that the sub surface drip irrigation recorded higher number of millable canes, length of millable cane at harvest and also cane yield. Surface drip recorded marginally higher values for the number of millable canes and cane diameter. The highest cane yield was recorded in surface drip method indicating that the method supplied adequate moisture for cane growth. The sub surface drip irrigation also gave significantly higher cane yield than the furrow irrigation. Sub surface drip Irrigation recorded water saving of 34.1 per cent and higher water use efficiency (1.24 t /ha –cm). Paired row with subsurface drip + Rec. NPK (based on soil test) recorded higher cane yield (220 t ha^{-1}). Paired row with subsurface drip + Rec. NPK (based on soil test) recorded 78.9 per cent increase in yield over farmers practice and higher water productivity (1517.2 Kg $ha\text{-}cm^{-1}$).

Intercropping for effective utilization of land

SSI supports intercropping in sugarcane with crops like wheat, potato, cowpea, French bean, chickpea, water melon, brinjal *etc*. In addition to effective utilization of land, this practice will reduce the weed growth up to 60% (in the initial stage) and give extra income to farmers.They act as live mulch and preserve moisture and improve the soil fertility. Sugarcane intercropped with radish recorded the highest number of shoots and was at par with sugarcane intercropped with garlic, turnip as vegetable, turnip and radish as vegetable followed by seed, metha as vegetable followed by onion as vegetable and Averaged over two years, single bud vertical planting produced 34.2 per cent higher cane yield than standard treatment of wheat intercropped three budded setts planted sugarcane[15]. Singh *et al.*[13], revealed that the number of millable canes, average cane length, cane girth and cane yield under sole sugarcane were on a par with those recorded in sugarcane + rajmash intercropping system. . Intercropping did not influence germination (%) at 45 days after planting. All the intercrops, except *Sesbania*, led to significant reduction in cane yield, being 14.0, 8.9 and 11.4% with cowpea, mungbean and urdbean as intercrops respectively. Reduction in cane yield might be due to shading effect of intercrops on sugarcane at initial stage. Number of millable canes also followed similar trend, being highest in sole sugarcane (101,000 ha^{-1}) which declined by 13.9, 7.9 and 10.9% with cowpea, mungbean and urdbean intercropping respectively. Reduction in number of millable canes led to less shoot production under intercropping conditions. The heaviest cane (1,150 g) produced under sugarcane + *Sesbania* intercropping, which was mainly attributed to taller and thicker cane. Commercial cane sugar, a product of sucrose content and cane yield, exhibited a trend similar to that of cane yield having maximum of 11.5 tonnes ha^{-1} with sole sugarcane. Sugar yield was reduced by 14.8, 8.7 and 13% with cowpea, mungbean and urdbean, respectively, grown as intercrops[6].

Integrated Nutrient Management:

The SSI method discourages high application of chemical fertilizers and use of pesticides and herbicides. Promotion of use of organic manures, fertilizers, bio-fertilizers. A gradual reduction of inorganic and adoption of integrated methods can be tried by framers for long term benefits. 100% RDF + 25% N through (FYM) + BF recorded significantly the highest millable canes population per

hectare either in plant cane (1,31,200) or in ratoon (1,38,800) might be owing to slow release of nutrients from organics and biofertilizers in combination with inorganic fertilizers, which was instrumental in producing more millable canes[16]. Application of 250:75:190 kg $N:P_2O_5:K_2O$ respectively FYM 25 t ha $^{-1}$, Bio fertilizer *Azospirillum* and PSB are @ 10 kg ha $^{-1}$ mixing through FYM and Micronutrient $ZnSO_4$ and $FeSO_4$ @25 kg ha $^{-1}$) recorded higher number of millable canes (95.40 000 ha $^{-1}$), cane length (239.0 cm), cane weight (1.34 kg), cane girth (2.86 cm), cane yield (108.69 t ha $^{-1}$) and followed by 100% organics equivalent to RDN through FYM+VC+EPM (1/3rd each) recorded higher number of millable canes (94.70 000 ha $^{-1}$), cane length (200.6 cm), cane weight (1.24 kg), cane girth (2.85 cm), cane yield (102.14 t ha $^{-1}$) Sharanappa[12]. The pooled data of 3 years revealed that the highest number of millable canes in plant (131000 ha^{-1}) and ratoon (99300 ha^{-1}) crops were recorded with the application of recommended N through organics + bio-fertilizers + inter cropping of legumes[14].

Integrated plant protection measures:

Kaur revealed that Sugarcane + Indian mustard recoded lower *Trianthema portulacastrum*, *Chenopodium album*, *Anagallis arvensis*, *Gnaphalium pensylvanicum* at 35, 70, 105 DAS. Glyphosate-1 kg ha^{-1} at 25 DAP *fb* one hoeing at 60 DAP recorded lower number of Total weed density, Total weed dry weight over other weed management practices. Glyphosate-1 kg ha^{-1} at 25 DAP *fb* one hoeing at 60 DAP recorded higher Weed Control Efficiency, Weed Index, Cane yield and Commercial cane sugar[5]. Integrated approach management recoded lower incidence of shoot borer 2.98 per cent compared to without application of IAM. Integrated approach management recoded higher number of millable canes 113000 per ha compared to without application of IAM. Cane yield (t ha^{-1}) recoded higher with integrated approach management compared to without application of IAM. Yield increase over WIAM recoded about 23.36 per cent[2].

Economics:

Shanthy and Ramanjaneyulu[11] revealed that net income per ha was recoded higher with SSI method of sugarcane cultivation as compared to normal planting of sugarcane. Incremental income under SSI (per ha) was Rs.1,19,330.00 when compared to normal planting of sugarcane. Under SSI technology of sugarcane planting recorded higher Gross return and Net return (Rs. 2,36,250 and 84,300 respectively) as compared to Conventional method of sugarcane planting (Rs 2, 00,250 and 30, 950 respectively) Mohanty *et al.*[7].

CONCLUSION

The SSI method serves as an alternative sugarcane cultivation method in the era of water and fertilizer crisis for sustained income to the farmers. The use of single bud seedlings raised in nursery saves 60-70 % of the seed cost apart from better growth and yield. The improved practices such as wider spacing, drip irrigation, integrated nutrient management and intercropping will enhance cane yield (18 to 20 %) and income (Rs. 50,000 to 80,000 ha $^{-1}$) apart from saving scares resource like irrigation water up to 20 to 40 per cent.

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