International Journal of Agricultural Sciences ☞DOI:10.15740/HAS/IJAS/15.1/222-226
Volume 15 | Issue 1 | January, 2019 | 222-226 ■ ISSN : 0973-130X Visit us : *www.researchjournal.co.in*

RESEARCH NOTE

Sustainable sugarcane initiative (SSI)-an approach to enhance sugarcane cultivation and input use efficiency and sustainable yield of sugarcane in India

Tulsi Parajuli[1], Dharmendra Kumar Kurre[1] **and** Sanjay Kumar Jangde*
Department of Agronomy, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya,
Gwalior (M.P.) India

Abstract : Sugar industry in India is the second largest agro-based industry in rural areas. Availability of sufficient sugarcane to sugar mills is pre-requisite for their efficient functioning. About 50 million farmers including their dependents and large number of agricultural labourers constituting 7.5 per cent of rural population are involved in sugarcane production which is utilized in 538 sugar mills with installed sugar production capacity of 32.93 million tonnes in 18 states. Sugarcane cultivation and the sugar industry in India are facing serious social, economic and environmental challenges. The increasing costs of cultivation and poor yields are making sugarcane cultivation economically unviable for farmers. Environmental issues like declining water table and degradation of soil pose other major threats to cane farmers and ecosystems. The productivity at the farm level has been stagnant at around 65–70 tonnes/ha over the last two decades. Unless we come up with a creative solution for our farmers, the crisis of water availability will keep intensifying and there will be a severe strain on our water sources. The sustainable sugarcane initiative (SSI) is a method of better management practices that involves use of less seeds, less water and optimum utilization of fertilizers and land to achieve more yield and profit for farmers and millers alike. It is an alternative to the conventional seed, water and space intensive sugarcane cultivation. Sustainable sugarcane initiative (SSI) has already helped over 5,000 farmers across India to improve their water productivity by 40 per cent, profits by 30 per cent, while reducing their ecological footprint. Several sugar mills and industries have begun to show great interest in this new and innovative method of sugarcane cultivation and are planning/ proposing to form into larger partnerships and networks with the proactive support of governments, banks, research institutions and civil society organizations.

Key Words : SSI, Wider spacing, Inter cropping, Integrated nutrient management, Integrated plant protection

View Point Article : Parajuli, Tulsi, Kurre, Dharmendra Kumar and Jangde, Sanjay Kumar (2019). Sustainable sugarcane initiative (SSI)-an approach to enhance sugarcane cultivation and input use efficiency and sustainable yield of sugarcane in India. *Internat. J. agric. Sci.*, **15** (1) : 222-226, **DOI:10.15740/HAS/IJAS/15.1/222-226.**

Article History : Received : 08.11.2018**; Accepted :** 29.12.2018

INTRODUCTION

Sugarcane (*Saccharum officinarun* L.) 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}.

*** Author for correspondence:**
[1]Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (Bihar) India

India ranks 2nd in the world next to Brazil in terms of area (5.0 m ha) and production (355 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 (Anonymous, 2016). 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. 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 % cane will be utilized for white sugar and 15% 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 sustainable sugarcane initiative (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. It aims at providing practical options to the farmers in improving the productivity of land, water and labour, all at the same time. SSI is also expected to reduce the overall pressure on water resources and contribute to recovery of ecosystems. 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.

The major principles that govern SSI:

– Raising nursery in portrays using single budded chips

– Transplanting young seedlings (25-35 days old)

– Maintaining wider spacing (5x2 feet) in the main field

– Providing sufficient moisture through efficient water management technologies *viz.*, drip fertigation (sub

Table 1: Comparison between SSI and conventional method

Particulars	Conventional	SSI
Seed/Setts/acre	60,000 single buds(30,000 two budded sett) 4000 kg of cane per acre	5000 single budded chips(500 kg of cane per 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 (Row to row)	1.5 to 2.5 ft	5.0 ft. minimum
Water requirement	More (flooding of field)	Less (maintenance of moisture in the furrows)
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

or sub surface)

– Encouraging organic method of nutrient and plant protection measures

– Practicing intercropping with effective utilization of land.

Raising nursery using single budded chips and transplanting young seedlings:

In the conventional method, 2-3 budded sugarcane setts are used for planting. In SSI,single budded chips, carefully removed from healthy canes (Select healthy canes that are 7 to 9 months old. The inter node length should be about 15 cm and girth about 10-15 cm.) 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 and Srivastava (2011) 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 (Anonymous, 2016) cane length, cane girth, single cane weight, Inter nodal 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 (Mohanty *et al.*,2014).

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 1,12,5001,37,500 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 (Shanthy and Ramanjaneyulu, 2014). 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 (Rehman *et al.,* 2013).

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 per cent 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.* (2006) and Sarala *et al.* (2014) 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- 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 upto 60 per cent (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 (Singh *et al*.,2010). Singh *et al*. (2008), 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 per cent 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 per cent 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 per cent with cowpea, mungbean and urdbean, respectively, grown as intercrops (Kumar *et al.*, 2006).

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 perhectare 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 (Tyagi *et al.*, 2012). 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 per cent organics equivalent to RDN through FYM+VC+EPM ($1/3^{rd}$ 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 (Shanthy, 2014). 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 + biofertilizers + inter cropping of legumes(Singh and Srivastava, 2011).

Integrated plant protection measures:

Kaur, revealed that sugarcane + Indian mustard recoded lower Trianthema portula castrum, 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 (Kumar *et al.*, 2012). 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 (Chand *et al.*, 2011).

Economics:

Shanthy and Ramanjaneyulu (2014) revealed that

net income per ha was recorded 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*. (2014).

The overall benefits of SSI are:

– Reduction in the costs of cultivation by 20-30 per cent

– Reduction in seed material by as much as 95 per cent

– Water efficiency increases with savings upto 40-70 per cent (depending on the irrigation methods applied)

– Reduction in the use of labour by 20-30 per cent

– Yield improvement of 20-50 per cent (depending on how effectively the SSI practices are implemented)

– Weed reduction by 40-60 per cent (in the first three months) by raising intercrops

– Additional income from intercrops.

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 per cent 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 upto 20 to 40 per cent.

REFERENCES

Chand, H., Kumar, A., Dwiwedi, G. P. and Paswan, S. (2011). Managenet of shoot bore, chilo infuscatellus snellen through integrated approach in North Bihar. *Indian J. Sugarcane Tech.*, **26** (2): 24-26.

Gouri, V., Devi, T.C., Kumari, M. B. G. S., Bharatalakshmi, M., Rao, K. P. and Murthy, K.V. R. (2006). Effect of surface and sub surface. drip fertigation on yield and quality of sugarcane. *Indian J. Sugarcane Tech.*, **29** (1): 35-37.

Kumar, S., Rana, N. S. Singh, R. and Adesh, Singh (2006). Production potential of spring sugarcane as influenced by intercropping of dualpurpose legumes under tarai conditions of Uttarakhand. *Indian J. Agron.*, **51**(4): 271-273.

Kumar, V., Kumar, S. and Kumar, S.(2012). Effect of fertility levels and weed management practices on weed dynamics and yield potential of spring planted sugarcane. *Indian J. Sugarcane Tech.*, **27**(2): 55-58.

Mohanty, M., Das, P. P. and Nanda, S. S. (2014). Introducing SSI (Sustainable sugarcane initiative) technology for enhanced cane production and economic returns in real farming situations under east coast climatic conditions of India. *Sugar Tech.*, **17**(2): 116–120.

Rehman, A., Ehsanullah, R. A. and Abdul, J. (2013). Interactive study of row spacings and foliar application of macro and micro-nutrients on growth, yield and quality of sugarcane (*Saccharum officinarum* L.). *Pak. J. Bot.*, **45**(2): 427-433.

Sarala, N.V., Rao, S. M., Hemanth, K.M. and Nagamadhuri, K.V. (2014). Response of sugarcane to plant geometry and irrigation methods in southern agro - climatic zone of Andhra Pradesh. *J. Sugarcane Res.*, **4** (1): 87-90.

Shanthy, T.R. and Ramanjaneyulu, S.(2014). Socio-economic performance analysis of sugarcane cultivation under sustainable sugarcane initiative method. *Indian Res. J. Extn. Edu.*, **14** (3): 93-98.

Singh, A. K., Menhi, L. and Archna, S. (2008). Effect of intercropping in sugarcane (*Saccharum complex* hybrid) on productivity of plant cane- ratoon system. *Indian J. Agron.*, **53** (2): 140-144 .

Singh, K. P. and Srivastava, T. K. (2011). Sugarcane productivity and soil fertility in plant – ratoon system under integrated and organic nutrient management in subtropics. *Indian J. Sugarcane Tech.*, **26**(10): 10-13.

Singh, K., Avtar, S., Gill, M.S., Dalip, S., Uppal, S.K. and Bhullar, M.S. (2010). Intercropping in single bud vertical planted sugarcane. *J. Res. Punjab Agric Univ.*, **47**(3 & 4): 138-142.

Tyagi, S., Vinod, K., Saini, S.K., Pathak, S.K. and Kumar, B. (2012). Impact of INM strategies on growth, yield, quality and profitability as well as soil fertility status in sugarcane. *Prog. Agric.*, **12**(1): 110- 117.

WEBLIOGRAPHY

Anonymous (2016). *www.indiastat.com*/ Ministry of Agriculture, Govt. of India .