

## RESEARCH ARTICLE

# Productivity and profitability analysis of Sustainable Sugarcane Initiative (SSI) method of sugarcane cultivation

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### Abstract

Sugarcane is an important cash crop cultivated worldwide for its economical sugar product. Increasing the productivity of sugarcane is the need of the hour to meet the demand of ever increasing population. The sustainable sugarcane initiative (SSI) is a method of good management practices that involves new planting techniques with wider plant spacing, less water, drip fertigation, nutrient management and plant protection measures. Hence, to promote the Sustainable Sugarcane Initiative technology, off campus training, awareness creation meeting, field demonstration and field day were organized for sugarcane growers during 2020-21 & 2021-22 at Pazhanchanallur, Kondasamuthiram, Karunakaranallur, Mamangalam, Vanamadevi, Vattathur, Pudaiyur villages of Cuddalore district, Tamil Nadu. The outcome of the promotion activity revealed that the interventions had enhanced the knowledge and adoption of scientific practices which resulted in the yield increase under SSI method from 68.94 to 89.41% over the yield obtained under farmer's practices during the year 2020-21 & 2021-22. The extension gap (68.25-87.80 ton/ha) and technological gap (40.81-47.20%) exhibited the feasibility of the technology demonstrated.

**Keywords:** Sustainable Sugarcane Initiative; Wider spacing; Productivity; Adoption; Impact; Technology dissemination; Training

### Introduction

Sugarcane (*Saccharum officinarum* L.) is an economically important multipurpose crop cultivated in tropical and sub tropical regions of the world (Sathyabhama et al. 2022). Sugarcane juice is the prime product used for making white sugar, brown sugar, Jaggery and ethanol. The main by-products after the juice extraction are bagasse and molasses. India ranks second in the world in terms of area (5.5 m ha) and production (465 mt) with an average productivity of 85 t/ha (Directorate of Economics & Statistics, Ministry of Agriculture & Farmers Welfare - 2022- 23). India is the largest consumer and the second-largest producer of sugar in the world accounting for about 18.8 percent of world sugar production and 16.2 percent of world sugar consumption. Nowadays sugarcane farmers are facing several challenges due to increasing cost of input and labor (Loganandhan et al. 2013).

Sustainable sugarcane initiative (SSI) is an innovative package of agronomic practices that involves use of less seeds, raising seedlings in a nursery using new planting techniques with wider plant spacing, less water and nutrient management to increase the cane yield significantly. Sustainable Sugarcane Initiative (SSI) under Sub Surface Drip Irrigation (SSDI) is becoming popular among the farmers because of high output with minimum input (Manikandan and Thiyagarajan 2021). Hence, promotion of Sustainable sugarcane initiative (SSI) was promoted through the Tamil Nadu Irrigated Agriculture Modernization project (TN-IAMP) funded by the world Bank.

### Materials and methods

The intervention of TNIAMP project is aimed at increasing productivity of key crops, promoting diversification of agriculture production systems,

enhancing resilience and improving farmers access to markets in project sub basins. The project will adopt climate-resilient approaches that promote sustainable use of land and water resources.

The field demonstration on Sustainable Sugarcane Initiative (SSI) method of cultivation under precision farming approach was conducted at farmer's fields of Lower Coleroon sub basin in different villages of Pazhanchanallur, Kondasamuthiram, Karunakaranallur, Mamangalam, Vanamadevi, Vattathur, Pudaiyur of Cuddalore randomly selected for the purpose, during 2020-21 and 2021-22. Lower Coleroon sub basin is one of the sub basins in Cauvery basin and spreads in Ariyalur, Cuddalore and Nagapattinam districts of Tamil Nadu. The Lower Coleroon sub basin is surrounded by Bay of Bengal in the east, Maruthaiyaru sub basin in the west, Lower Vellar sub basin in the north and Cauvery delta in the south. The soils of the demonstration area under study were clay loam medium in fertility status and water holding capacity. Various awareness programme, trainings on Promotion of Sustainable Sugarcane Initiative (SSI) in sub basin under Precision Farming approach were conducted at Pazhachanallur, Kondasamuthiram, Karunakaranallur, Mamangalam, Vanamadevi, Vattathur, Pudaiyur, Kattumannarkoil and Keerapalayam block in which 375 farmers participated (Table 1). Training schedule was arranged for 6 hours/day by four experts involving plant breeder, agronomist, entomologist and plant pathologist. The trainees for the study were selected through equal allocation from each block using purposive sampling technique for representing the whole area.

Field demonstrations were conducted to study the gap between the demonstration yield, technological gap and technology index. In demonstration plots, a few critical inputs in the form of quality chip bud seedlings, balanced fertilizers, bio-inputs were

provided and non-monetary inputs like timely sowing, line planting and timely weeding were also performed. Conventional practices were adopted as a control check. The demonstration farmers were guided by the scientists of Regional Research Station, Vriddhachalam of Tamil Nadu Agricultural University in performing field operations like nursery in portraits, planting in wider spacing, water management, drip fertigation, integrated nutrient management, integrated plant protection and harvesting etc. during the course of training and visits. A field day was organized at pre-harvest stage of the crop for popularization of improved agro-techniques among sugarcane growers. The materials of the present study with respect to field demonstration and farmers' practices are presented in Table 2. In the productivity analysis study, the data on sugarcane yield were collected from field demonstration plots and control plots for comparison study. Economic analysis was done on the basis of prevailing market price of input used and the output obtained from farmer's practice and demonstration plot.

To estimate the extension gap, technology gap and the technology index the following formula was used.

Extension gap = Demonstration yield – Farmer's yield

$$\text{Technology gap} = \frac{R-A}{R} \times 100$$

Where

R = Recommended technology

A = Technology adopted by the farmers

## Results and discussion

### Exploitable productivity of sugarcane under Sustainable Sugarcane Initiative (SSI)

The demonstration on Sustainable Sugarcane Initiative (SSI) method of sugarcane cultivation showed remarkable cane yield difference (Table 3).

**Table 1.** Details of the trainings, awareness meeting and field days conducted to promote Sustainable Sugarcane Initiative method of sugarcane cultivation

| Village           | Name of the extension activity | Number of participant farmers |       |       |
|-------------------|--------------------------------|-------------------------------|-------|-------|
|                   |                                | Men                           | Women | Total |
| Pazhachanallur    | Training                       | 49                            | 0     | 49    |
| Kondasamuthiram   | Training                       | 45                            | 6     | 51    |
| Karuna karanallur | Training                       | 50                            | 2     | 52    |
|                   | Awareness meeting              | 20                            | 2     | 22    |
|                   | Field day                      | 35                            | 0     | 35    |
| Mamangalam        | Training                       | 45                            | 8     | 53    |
| Vanamadevi        | Training                       | 55                            | 8     | 63    |
| Pudaiyur          | Training                       | 50                            | 0     | 50    |
| Total             |                                | 349                           | 26    | 375   |

**Table 2.** Comparison between conventional and SSI methods of sugarcane cultivation in the study area

| Particulars                       | Conventional method                        | SSI method                                                                    |
|-----------------------------------|--------------------------------------------|-------------------------------------------------------------------------------|
| Seeds/Setts                       | 48,000 buds<br>(16,000 three budded setts) | 5000 single budded chips<br>(5,000 buds per acre)                             |
| Nursery preparation               | No                                         | Yes                                                                           |
| Planting                          | Direct planting of setts in the main field | Transplanting of 25-35 days old young seedlings raised from bud chips         |
| 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 and adoption of drip irrigation) |
| Mortality rate among plants       | High                                       | Low                                                                           |
| No. of tillers per plant          | Less (10-15)                               | More (15-20)                                                                  |
| Accessibility to air and sunlight | Low                                        | High                                                                          |
| Scope for intercrop               | Less                                       | More                                                                          |

The exploitable productivity of sugarcane under SSI techniques is high at Karunakaranallur village with 186 t/ha which is 89.41 % yield increase over farmer practice. On an average higher cane yield was recorded under SSI method (171.81 t/ha) which is 74.37 yield increase over farmer's practice. The results showed that due to promotion of Sustainable Sugarcane Initiative (SSI) in sub basin under precision farming approach, the yield of SSI increased by 74.37% over the yield obtained under farmers' practices during the year 2020-21 and 2021-22. In SSI, much emphasize is to provide adequate moisture at required stages rather than inundating the field with water as flooded condition will hinder the growth of the plant and production of tillers, which might result in less can yield (Tulsi Parajuli et al. 2019). Measures like using chip bud seedlings, transplanting at optimum age at wider spacing with integrated nutrient management would have been the reason for higher cane yield under SSI method of sugarcane cultivation. Providing optimal wide spacing of plants to minimize competition between plants for available nutrients, water, air and sunlight which enables each plant to attain close to its maximum genetic potential (Prabhakar et al. 2018). Removal of mother shoot is one the important technique in SSI which enhances the number of tillers and millable

cane yield. Similar technique of nipping which improves the productive branches and productivity in other crops was reported Harisudan and Vincent, (2019).

### Profitability of Sustainable Sugarcane Initiative (SSI) technique

The yield performance of sugarcane under Sustainable Sugarcane Initiative (SSI) method of cultivation has shown a remarkable difference in economics of sugarcane (Table 4). Economic analysis of the field demonstration revealed that SSI method of sugarcane cultivation recorded higher gross monetary return (4,94,998/ha), net return (3,40,139/ha), net return /rupee invested (2.20/rupee) and additional net monetary return (1,69,229/ha) and benefit cost ratio (3.20) as compared to farmers practices. The results on economics of SSI adopted fields indicated that the B:C ratio has enhanced up to 3.15, 3.37, 3.14, 3.15, 3.12, 3.27 and 3.19 in comparison to 2.36, 2.54, 2.59, 2.50, 2.52, 2.51, and 2.58 in local check at Pazhachanallur, Kondasamuthiram, Karunakaranallur, Mamangalam, Vanamadevi, Vattathur and Pudaiyur respectively. The SSI method of sugarcane cultivation requires less external inputs. The use of chip bud seedling could save large quantity of seed cane and cost. In addition,

**Table 3** Effect of Sustainable Sugarcane Initiative method of cultivation on yield of sugarcane

| Name of the village | Demonstration Area (in ha.) | Mean yield (t/ha) |       | YIOFP (%) |
|---------------------|-----------------------------|-------------------|-------|-----------|
|                     |                             | IP                | FP    |           |
| Pazhachanallur      | 0.99                        | 169.60            | 99.00 | 71.31     |
| Kondasamuthiram     | 3.23                        | 169.73            | 98.43 | 72.44     |
| Karunakaranallur    | 2.67                        | 186.00            | 98.20 | 89.41     |
| Mamangalam          | 4.61                        | 170.10            | 98.40 | 72.87     |
| Vanamadevi          | 3.30                        | 169.47            | 98.87 | 71.41     |
| Vattathur           | 2.00                        | 167.25            | 99.00 | 68.94     |
| Pudaiyur            | 2.14                        | 170.50            | 97.85 | 74.25     |
| Mean                | 2.71                        | 171.81            | 98.54 | 74.37     |

YIOFP: Yield increase over farmers practice

inclusion of leguminous intercrops in the wide spaced inter row adds nutrient to the base crop and suppress the weed growth until the critical period of weed competition which would have paved way for less expenditure towards weed and nutrient management. Similar results of higher economic returns were reported by Mohanty et al., 2014. Under, SSI method intercropping is much emphasized in wider spaced inter row. Intercropping of legumes is an important aspect for biological farming systems not only for weed control but also reducing the leaching of nutrients and pest control which in turn reduce the cost on input requirement.

#### Technology and extension gap

The output (Table 5) of demonstration on SSI method of sugarcane cultivation revealed an

extension gap of 70.60 ton/ha in Pazhachanallur, 71.30 ton/ha in Kondasamuthiram, 87.80 ton/ha in Karunakaranallur, 71.70 ton/ha in Mamangalam, 70.60 ton/ha in Vanamadevi, 68.25 ton/ha in Vattathur, 72.65 ton/ha in Pudaiyur. Promotion of Sustainable Sugarcane Initiative (SSI) in sub basin under Precision Farming approach will consequently change the alarming trend of high extension gap. The results of the present study were in consonance with the findings of Khajuria et al. 2016 in chilli and Mehriya et al. 2020 in mustard who reported the need to create awareness among the farmers through various means for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap.

The technology gap of 41.63% at Pazhachanallur, 42.01% at Kondasamuthiram, 47.20% at Karunakaranallur, 42.15% at Mamangalam,

**Table 4.** Effect of Sustainable Sugarcane Initiative (SSI) technique on the economics of sugarcane

| Name of the village | Demonstration area | COC (Rs/ha) |        | GMR (Rs/ha) |        | Net return (Rs/ha) |        | Net return/ Rupee |      | ANMR (Rs/ha) | B:C Ratio |      |
|---------------------|--------------------|-------------|--------|-------------|--------|--------------------|--------|-------------------|------|--------------|-----------|------|
|                     |                    | IP          | FP     | IP          | FP     | IP                 | FP     | IP                | FP   |              | IP        | FP   |
| Pazhachanallur      | 0.99               | 159000      | 123785 | 500320      | 292035 | 41320              | 168250 | 2.15              | 1.36 | 173070       | 3.15      | 2.36 |
| Kondasamuthiram     | 3.23               | 148467      | 114237 | 500758      | 290378 | 352291             | 176141 | 2.37              | 1.54 | 176150       | 3.37      | 2.54 |
| Karunakaranallur    | 2.67               | 165755      | 106300 | 520898      | 274904 | 355143             | 168604 | 2.14              | 1.59 | 186539       | 3.14      | 2.59 |
| Mamangalam          | 4.61               | 155070      | 113298 | 488952      | 282820 | 333882             | 169522 | 2.15              | 1.50 | 164360       | 3.15      | 2.50 |
| Vanamadevi          | 3.30               | 154852      | 111768 | 482837      | 281772 | 327985             | 170004 | 2.12              | 1.52 | 157981       | 3.12      | 2.52 |
| Vattathur           | 2.00               | 143228      | 110213 | 468258      | 277172 | 325030             | 166959 | 2.27              | 1.51 | 158071       | 3.27      | 2.51 |
| Pudaiyur            | 2.14               | 157638      | 111720 | 502961      | 288614 | 345323             | 176894 | 2.19              | 1.58 | 168429       | 3.19      | 2.58 |
| Mean                | 2.71               | 154859      | 113046 | 494998      | 283956 | 340139             | 170911 | 2.20              | 1.51 | 169229       | 3.20      | 2.51 |

Abbreviations used IP: Improved practices, FP: Farmers Practices, CoC: Cost of cultivation, GMR: Gross monetary return, ANMR: Additional Net Monetary Return, B:C ratio : Benefit cost ratio.

**Table 5.** Adoption level of improved sugarcane cultivation practices

| <b>Name of the village</b> | <b>Demonstration area (in ha.)</b> | <b>Demonstration yield (ton/ha)</b> | <b>Farmers yield (ton/ha)</b> | <b>Extension gap (ton/ha)</b> | <b>Technology gap (%)</b> |
|----------------------------|------------------------------------|-------------------------------------|-------------------------------|-------------------------------|---------------------------|
| Pazhachanallur             | 0.99                               | 169.60                              | 99.00                         | 70.60                         | 41.63                     |
| Kondasamuthiram            | 3.23                               | 169.73                              | 98.43                         | 71.30                         | 42.01                     |
| Karunakaranallur           | 2.67                               | 186.00                              | 98.20                         | 87.80                         | 47.20                     |
| Mamangalam                 | 4.61                               | 170.10                              | 98.40                         | 71.70                         | 42.15                     |
| Vanamadevi                 | 3.30                               | 169.47                              | 98.87                         | 70.60                         | 41.66                     |
| Vattathur                  | 2.00                               | 167.25                              | 99.00                         | 68.25                         | 40.81                     |
| Pudaiyur                   | 2.14                               | 170.50                              | 97.85                         | 72.65                         | 42.61                     |
| <b>Mean</b>                | <b>2.71</b>                        | <b>171.81</b>                       | <b>98.54</b>                  | <b>73.27</b>                  | <b>42.58</b>              |

41.66% at Vanamadevi, 40.81% at Vattathur, 42.61% at Pudaiyur and average 42.58% was observed with respective varieties. It may be attributed to differences in the soil fertility status, agricultural practices, local climate conditions, and timeliness of availability of inputs. Hence, variety-wise location specific recommendation is necessary to minimize the technology gap for yield level in different farming situations.

### Conclusion

The field demonstration on Sustainable sugarcane initiative method of cultivation indicates that the SSI method serves as a profitable sugarcane cultivation method in the era of water and fertilizer crisis for sustained income to the farmers. The study emphasized the necessity to educate the farmers through various means like training, demonstration and exposure visit for adopting the improved cultivation practices. When more number of farmers adopt the improved technology, it will subsequently alter the extension, technological gap. The productivity gain under field demonstration over conventional practice created awareness and motivated other farmers to adopt the improved practices.

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### References

- Directorate of Economics & Statistics, Ministry of Agriculture & Farmers Welfare - 2022- 23.
- Harisudan C. 2019. Evaluation of suitable intercrop and nutrient management on weed control and seed cotton yield. *Journal of Applied Sciences*, 19: 447-452.
- Harisudan C., Vincent S. 2019. Enhancing source-sink partitioning efficiency and productivity of sesame. *Madras Agricultural Journal*, 103(7-9) : 488-491. doi:10.29321/ MAJ 2019.000301
- Loganandhan N, Gujja B, Goud VV, Natarajan US. 2013. Sustainable Sugarcane Initiative (SSI): A Methodology of 'More with Less'. *Sugar Tech*. 15(1):98-102.
- Manikandan M, Thiyagarajan G. 2021. Study on Irrigation and Fertigation Scheduling for Sustainable Sugarcane Initiative (SSI) through Subsurface Drip Irrigation. *Cutting-Edge Research in Agricultural Sciences Vol. 13*, 55–61. <https://doi.org/10.9734/bpi/cras/v13/11364>.

- Mohanty M, Das, PP 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. SugarTech. 17(2): 116–120.
- Prabhakar Hailu Araya, Gerald Aruna, Arun Balamatti, Soumik Banerjee, Baskaran Barah BC, Debaraj Behera, Tareke Berhe, Parag Boruah, Shiva Dhar, Sue Edwards, Mark Fulford, Biksham Gujja, Harouna Ibrahim, Humayun Kabir, Amir Kassam, Ram B, Khadka Y S Koma, Natarajan US, Rena Perez, Debashish Sen, Asif Sharif, Gurpreet Singh, Erika Styger, Thakur AK, Anoop Tiwari, Norman Uphoff, Anil Verma 2018 System of crop intensification for more productive, resource-conserving, climate-resilient, and sustainable agriculture: experience with diverse crops in varying agroecologies, International Journal of Agricultural Sustainability, 16:1, 1-28, DOI: 10.1080/14735903.2017.1402504.
- Sathyabhama M, Viswanathan R, Prasanth CõN, Malathi P, Ramesh Sundar A. 2022. Diferential host responses of sugarcane to *Colletotrichum falcatum* reveal activation of probable effect or triggered immunity (ETI) in defence responses. Plant Cell Reports 41:1461–1476.
- Tulsi, Dharmendra Kumar K, Sanjay Kumar J. 2019. Sustainable sugarcane initiative (SSI)-an approach to enhance sugarcane cultivation and input use efficiency and sustainable yield of sugarcane in India. International Journal of Agricultural Sciences, 15 (1) : 222-226.