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Planting Methods Enhanced the Cane Yield and Input Use Efficiency in Sugarcane- An Overview

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ABSTRACT

Planting method is the one of the important agronomic interventions for enhancing productivity and quality of sugarcane. Right technique could enhance not only the cane yield but also input use efficiency. Increased use of better technologies, such as planting techniques, is essential to maintaining the production and productivity of the sugar industry in an ethical way. Additionally, it is necessary to improve the efficiency of the inputs used in sugarcane farming, particularly the prudent utilization of water and site-specific nutrient management. Planting techniques in sugarcane play a significant role in determining the overall productivity and sustainability of sugarcane cultivation. Proper planting techniques ensure that the sugarcane crop establishes well and produces higher yields. New planting techniques must be made widely known to producers to make sugarcane cultivation a sustainable and lucrative sector that contributes to national food security. Therefore, the development and adoption of enhanced planting methods and its impact on cane productivity and input usage efficiency for sustainable sugarcane farming system are described in this review in order to maintain cane production and its sustainability towards national food security. This review aims to enlist the impact of different planting methods on sugarcane productivity and input use efficiency.

KEYWORDS: Input usage efficiency, planting methods, sugarcane productivity

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1. INTRODUCTION

Sugarcane is an important industrial crop of India. Sugar industry is heavily relies on sugarcane crop. Sugarcane is often grown via stalk cuttings with 2 to 3 bud setts. Under standard planting methods, 60-80 quintal seed cane/ha can be used as planting material for one hectare of land. This huge mass of planting material is difficult to carry, handle, and store, and it deteriorates quickly, inhibiting the viability of buds and, as a consequence, preventing their sprouting. As a result, improved planting methods are required. Sugarcane farming is experiencing many obstacles as input and labour costs rise (Loganandhan et al., 2013). Depending on the species and manner of cultivation, a large number of seed cane is required for sugarcane planting. The need for a large number of seed materials also offers a significant difficulty in terms of transportation, processing, and planting (Kumar, 2020). Researchers all over the world have recently improved or innovated sugarcane planting methods, which have a significant impact on cane productivity, resource and input usage efficiency. According to Manimaran et al. (2009), the only viable alternative to the limited horizontal development of sugarcane area caused by industrialization of cultivable lands is the development of growing crops vertically through the implementation of proper crop management techniques. In addition to this, it can be demonstrated by the fact that planting tactics are based on the site, and that performance varies depending on the circumstances. Throughout this time period, a variety of planting approaches have been created with the goal of increasing cane output (Singh, 2012). Further, planting techniques do not perform uniformly across the situation and are location specific as indicated by Yadav and Kumar (2005). Differential response of sugarcane to planting technique is attributed to soil moisture storage and its depletion rate (Singh, 2002). Bhullar (2008) concluded that precise planting technique is important for improving sugarcane productivity as it plays a crucial role in sustaining higher number of millable canes. The conventional flat method takes significantly less time, but it has a poor germination of sugarcane (30–35%) because to the rapid depletion of soil moisture and a smaller plant population, both of which lead to a lower cane yield. Changing the microenvironment with planting methods like pit planting and paired-row trench planting can result in higher yields than the usual method (Yadav and Kumar, 2005). Several studies found that this benefit was due to the fact that the microenvironment was altered. The long-term viability of a sugarcane crop depends on careful planning and execution during planting to ensure that the crop plants take full advantage of ideal growing conditions. Maximum population of plants and plenty of sunlight accessibility result in a larger number of millable canes per hectare with maximum millable cane height, cane girth, number of internodes, and average cane weight (Khandagave, 2011, Gouri et al., 2014; Khalid et al., 2015; Chaudhari et al., 2018). Sugarcane output and sugar yield, in particular, are affected by crop varieties (genotypes), growing conditions, and management practices, all of which have an impact on sugarcane yield and sucrose content (Zhao et al., 2020; Thorburn et al., 2017). For this reason, it's important to refine planting techniques that facilitate light entrance, plant population establishment, water conservation, air circulation, inters tillage, and lodging. The focus of this analysis is on the role that planting techniques have in maximizing both cane output and resource productivity. Furthermore, the review emphasizes their beneficial impact in plant development and cost reduction. Since conventional systems are more expensive than innovative planting technology, the information obtained by this review could be valuable for implementing sustainable agriculture practices through the combination of multiple technologies.

2. IMPACT OF PLANTING METHODS ON SUGARCANE PRODUCTIVITY

Yields of sugarcane crops have decreased due to the decrease in resources in this century. The land, water etc., is one of the important resources which are going to limit for the crop production.Under the situations of limited resources maximization of yield and optimization of resource use efficiency there is a need to focus on the various aspects of crop production techniques such as adoption of improved practices such as method of planting, land configuration, selection of crop, varieties, and improved cropping system and moisture conservation practices in different agro-climatic zones of the country. Several scientists and researchers studied the effect of planting methods in sugarcane either alone or in combination with other factors for enhancing productivity and resource use efficiency. Unlike transplanting cane seedlings, which produces millable canes due to the inherent tillering capacity of the buds planted, Natarajan (2011) found that tillering is rather low in normal systems. Numerous cane stalks, called tillers, emerge from the ground to form a sugarcane cluster and mature into usable canes for processing. In a study (Subhashisa et al., 2017) when compared to three budded setts (97.9 t ha^{-1}), single node seedlings planted in dual rows of 150 cm 45 cm (103.6 t ha^{-1}) or paired rows of 60/120 60 cm (102.4 t ha^{-1}) produced considerably more cane. According to Selvan (2000), planting sugarcane with single node seedlings improved cane yield by 5.0%, while planting with bud chip seedlings increased cane yield by 1.2%. The same findings were published by Pannerselvam and Durai in 2011. Results from different experiment shows feasibility of planting methods in sugarcane. Improved planting methods over conventional method were found superior in terms of

germination %, yield and production efficiency as shown in Table 1. This might be owing to higher tiller and millable canes production. Experiment conducted on planting method under waterlogged conditions shows that trench method was better than conventional method of planting. When compared to standard planting methods, under flooded conditions, the trench method of sugarcane planting is significantly more effective, profitable, and lodging resistant. Trench planting results in a higher proportion of densely packed primary shoot, which contributes more to the final population and output. Kumar (2012) discovered that the trench method outperformed traditional planting methods in terms of cane lodging, millable stalks, and stalk weight and cane yield and it was accounting 31.55, 15.89, 1.22 and 16.13 % higher over conventional planting. Also found gross and net returns with higher B: C ratio, it was increased by 16.1, 18.59 and 6.71 under trench method (Table 2) Singh et al. (2008) also showed improved productivity and yield characteristics while using the ring technique of planting with *Sugarcane* hybrid complex in Lucknow's subtropical environment. According to Bell and Garside (2005), weight of stalk and millable cane population account for more than 98% of the difference in cane output.

Katiyar et al. (2013) also demonstrated that germination percentage, mother shoots/ha and yield was higher under trench planting over farmers practice and it was to the tune of 40.63, 48.28 and 5.02 %. Gulati (2015) observed that single cane weight had non-significant effect due to planting methods. Number of millable cane, yield, gross and net returns was maximum when planted in small pit followed by mega pit. However, highest B:C ratio was observed in conventional method (Table 3). Chattha (2007) concluded that Planting in 120 cm apart trenches recorded highest cane height (cm), millable canes ($\times 10^3$ ha^{-1}), cane yield (t ha^{-1}) which is 236, 135.1 and 104.4 respectively (Figure 1a).

We reviewed that DTS 50/135-double trench system (DTS) with 50 cm distance between trench and 135 cm distance between double trenches observed highest values in Initial planting, first and second sugarcane ratoon over the single trench system (STS) with 120 cm distance of center to center (CTC) followed by STS110 Single trench system with 110 cm distance of CTC (Table 4). It was increased by 28.89, 33.38 and 39.23% initial, first and second ratoon over STS120 and STS110 respectively (Wingate et al., 2021). Katiyar et al. (2013) also observed high cane yield in trench planting method as compared to farmer practice planting method. Samiullah (2015) also find out that taller plant was observed when planted at 180 cm spaced trenches with triple row strips and also revealed that maximum stripped cane weight (g) and yield (t ha^{-1}) under same treatment. Gouri et al. (2019) demonstrated that highest NMC, cane yield, sucrose and CCS percentage paired row planting with single node seedlings was 93.46 × 10^3 ha^{-1} (Figure 1) 102.4 t ha^{-1} (Figure 2) 18.1% (Figure 3) and 13.2% (Figure 4) respectively.

Table 1: Yield attributes and yield influenced by Bud chip method of planting of sugarcane

Particulars	Percentage of increase
Germination (%)	57.08
Tillers plant^{-1}	46.82
Millable canes clump^{-1}	40.14
Yield (t ha^{-1})	28.29
Production efficiency (kg ha^{-1} day^{-1})	32.86

Source: Modified from Samant (2017)

Table 2: Comparison between trench and conventional method of planting

	Cane lodging %	Millable stalks ($\times 10^3$ ha^{-1})	Single cane weight (g)	Cane yield (t ha^{-1})	Gross returns ($\times 10^3$ Rs. ha^{-1})	Net returns ($\times 10^3$ Rs. ha^{-1})	B:C ratio
Trench	48.5	107.6	735	78.1	199.1	114.0	1.34
Conventional method	33.2	90.5	726	65.5	167.0	92.8	1.25

Source: Modified from Kumar et al. (2018)

Table 3: Comparative study of different planting methods

	Single cane weight (g)	No. of millable cane ($\times 10^3$ ha^{-1})	Cane yield (t ha^{-1})	Gross returns ($\times 10^3$ Rs. ha^{-1})	Net returns ($\times 10^3$ Rs. ha^{-1})	B:C ratio
Conventional method	1270	83.3	128.7	276705	156584	2.3
Trench method	1270	97.7	136.1	292261	146377	2.0
Small pit	1140	118.9	149.5	339485	178430	2.11
Mega Pit	1270	102.5	141.5	304225	152796	2.01

Source: Gulati, 2015

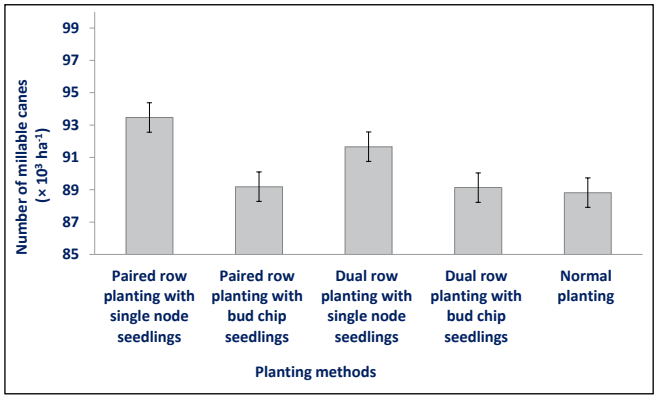

Figure 1: Number of millable canes as influenced by planting methods

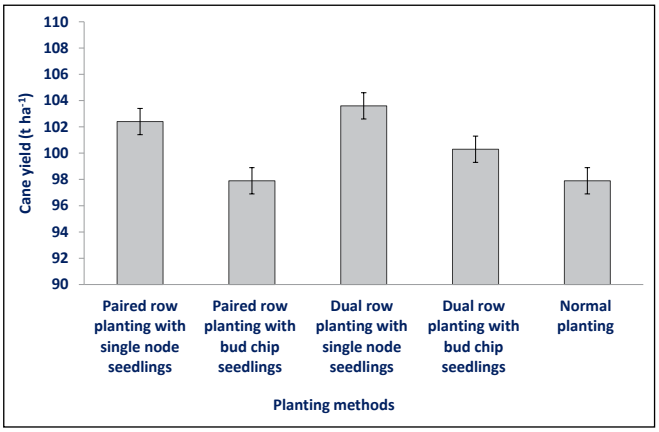

Figure 2: Cane yield as influenced by planting methods

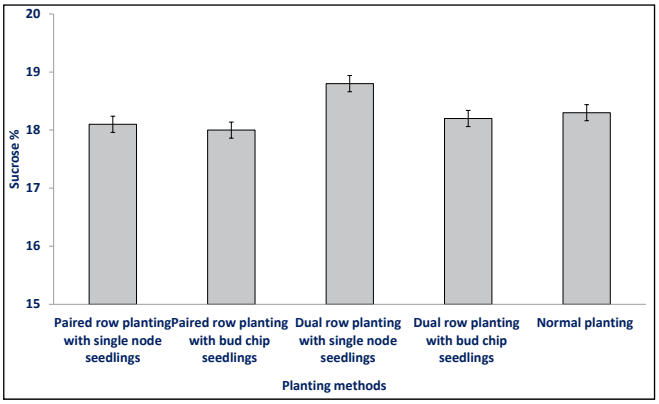

Figure 3: Sucrose % as influenced by planting methods

The development of 114% more millable canes with 14.6 cm longer cane length resulted in a 64% increase in average cane output when ring-pit planting was used instead of the traditional flat planting technique. Another scientist explained that the proportion of primary shoots in the final cane population is higher in the ring-pit planting method than it is in the standard flat planting method, where the majority of the final cane population is contributed by secondary and tertiary tillers. The increased population of these tillers (secondary and tertiary) in the final cane

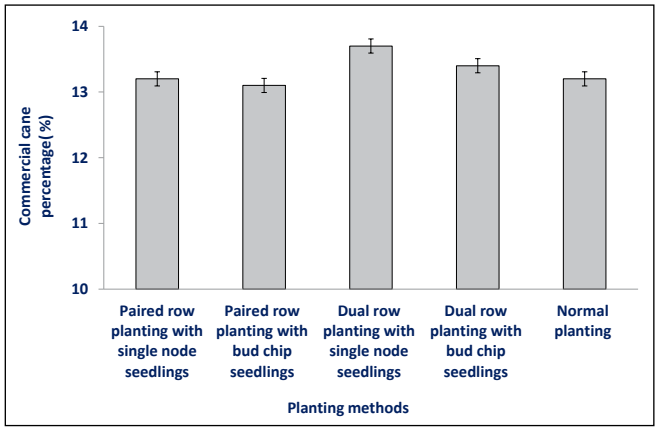

Figure 4: Commercial cane sugar percentage canes as influenced by planting methods

population may have contributed to a reduced yield under the traditional flat planting approach since they are shorter, thinner, and lighter than the primary shoots. Additionally, Singh (2012) noted a considerably higher tiller count in paired-row planting over FIRB in June (at 105). In another study, paired row planting has proved advantageous over flat planting in giving higher yield in north India (Gupta et al. 2004). Roodagi et al. (2001) also observed higher plant height in paired row planting method at all growth stages than in normal planting method.

3. IMPACT OF PLANTING METHODS ON INPUT USE EFFICIENCY

The ring pit system of planting exhibited the greatest improvement in IWUE, followed by irrigation at crucial growth phases, trash mulching, and skip furrow irrigation. The ring pit planting system increased irrigation water efficiency by 142.6 percent, while, the skip furrow irrigation system increased IWUE by 68.9%. A further investigation (Singh and Brar, 2015) found that FIRB and paired-row trench-planted crops provided the highest and statistically at par water productivity at 0.50 IW: CPE, which was significantly greater than all other combinations of planting techniques and irrigation schedules. With the increase in IW: CPE due to the increase in irrigation water used, the apparent and total crop-water productivity declined significantly in all planting types. In comparison to the traditional flat method, the ring-pit method generally resulted in significantly higher cane yield, PFP and AE (Yadav, 2004). Nutrient usage efficiency of sugarcane may have risen under continuous same cropping system, localized application of farmyard manure combined with fertilizers in pits of ring-pit method (Yadav, 2004), leading to higher cane yield. Guru et al. (2017) revealed that paired row ridge and furrow plantation method (100:120 cm spacing) showed highest water productivity (3.79) and it was increased by 34.3% over conventional method (Table 4).

Table 4: Trench system influences yield and yield parameters in initial planting, first and second ratoon of sugarcane

	No. of productive tillers plant^{-1}			Sugar cane yield (%)			Number of stalks per m trench			Sugarcane productivity (t ha^{-1})		
	IP	SR_1	SR_2	IP	SR_1	SR_2	IP	SR_1	SR_2	IP	SR_1	SR_2
DTS 50/135	6	6	6.7	8.9	8.5	8.4	14	15	13	129.1	134.2	114.2
STS 120	5	5.5	5.8	8	8	8.8	12.2	12	11	111.8	129.9	98.8
STS 110	4.5	4.8	5.2	7.7	8.7	8.7	10.6	9	8	91.8	89.4	69.4

IP: Initial planting; SR_1: First sugarcane ratoon; SR_2: Second sugarcane ratoon; DTS 50/135: double trench system (DTS) with 50 cm distance between trench and 135 cm distance between double trenches; STS120; Single trench system (STS) with 120 cm distance of canter to center (CTC) and STS110 Single trench system with 110 cm distance of CTC; Source: Modified from Wingate et al., 2021

4. CONCLUSION

Finally, several studies have successfully revealed that highest cane yield, profits and input use efficiency were observed under improved planting methods over conventional ones. Improved planting technology is one of the most effective and practical options for lowering the cost of sugarcane production. The typical strategy to sugarcane planting has a shorter turnaround time than the novel approaches. A unique planting approach is required to achieve improved cane output and input usage efficiency.

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