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Performance of tractor operated two row sugarcane cutter planter for sugarcane planting in Andhra Pradesh State, India

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■ **ABSTRACT :** Sugarcane is an important agro-industrial crop requiring more labour force for planting. Presently, in traditional cultivation of sugarcane, all the operations are being done manually or semi mechanized stage, 60 per cent of the cost incurred towards labour charges. Sugarcane planting involves cutting of setts, opening of furrows, placing the setts in furrows and covering the setts with soil which is tedious, time consuming process and labour intensive. Introduction of mechanized planter will perform all these operations simultaneously and reduce dependency on labour and complete the farm operations in time. A field experiment was conducted at Regional Agricultural Research Station, Anakapalle, Andhra Pradesh to evaluate the performance of tractor mounted two row sugarcane cutter planter. The field capacity of the equipment was found to be 0.16 ha/h. The biometric parameters *viz.*, diameter of the cane, height of the cane and yield of mechanically planted sugarcane was on par with the manually planted sugarcane where as single cane weight and root spread area were found to be significantly different ($p<0.05$). Similarly, the juice quality of mechanically planted sugarcane in terms of degree Brix, sucrose per cent was on par with conventionally planted sugarcane. Economic analysis revealed that cost of planting with sugarcane cutter planter was Rs.15,400 per ha as against Rs. 6750 with traditional method of planting. The saving in labour cost, seed quantity and planting time with sugarcane cutter planter were to the tune of 51 per cent, 68 per cent and 58 per cent, respectively compared to conventional method of planting.

■ **KEY WORDS :** Sugarcane cutter planter, Traditional planting, Labour cost

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India is the second largest producer of sugarcane after Brazil producing about 352.16 MT in the year 2015-16 (Agriculture Statistics at a Glance, 2016). The major sugarcane growing areas in India lies in subtropical belt comprising Uttar Pradesh, Bihar, Punjab, Haryana and Madhya Pradesh (Anonymous, 2001; Bahri and Bansal, 1992 and Baker, 1983) which accounts for 70 per cent cane area and 50 per cent of cane production. Uttar Pradesh and Uttaranchal states collectively contribute 49.74 per cent of the total cane and 44.34 per cent of the total cane production in India. The contribution of other states such as Maharashtra is 12.67 per cent in area, 15.1 per cent in production, Tamil Nadu 6.54 per cent in area, 9.9 per cent in production; Karnataka 6.29 per cent in area, 8 per cent in production; Andhra Pradesh 4.91 per cent in area, 5.42 per cent in production (Barnes

and Maddux, 1991 and Bernacki *et al.,* 1972). Out of total sugar production in India, 47 per cent of cane is used for sugar manufacturing, 40 per cent is diverted for Guar and Khandasari production and 13 per cent is used for seed and juice purpose (Chaoudhary *et al.*, 1990). The demand for sugar in the country by 2030 will be 36 MT for which the sugarcane production has to be 500 MT (Nair, 2012). This amount for 40 per cent increases over the current production and has to be achieved through vertical improvement in productivity. Already significant attempts were made to increase the sugarcane yield through varietal development, control of pests and diseases, improved cultural practices etc. However, to improve potential yield, engineering inputs such as introduction of improved machinery in sugarcane cultivation play a vital role. Sugarcane crop is highly labour intensive crop requiring about 3300 man hours for various operations (Murali and Balakrishnan, 2012). Out of total cost of cultivation, 60 per cent of the cost incurred towards labour charges (Yadav *et al.,* 2003).

Andhra Pradesh occupies sixth place in area (0.21 million hectares) and seventh position in productivity (66 tonnes/ha) among cane growing states in the country during 2014-15 (Anonymous, 2016). Sugarcane cultivation requires various operations like land preparation, planting, irrigation, intercultural, earthing-up, harvesting, transportation and ratoon management. In Andhra Pradesh state, all these operations are being done manually or semi mechanized stage and shortage of labour together with availability of labour at peak season is a major constraint. Due to high cost of labour and inputs, the area under sugarcane cultivation in Andhra Pradesh is declining and the average sugarcane yields have been hovering between 74.9t/ha (2004-05) and 66t/ha (2014-15) (Anonymous, 2016). Hence, there is an urgent need for shifting from traditional to mechanized sugarcane cultivation.

Sugarcane planting is an important operation in sugarcane cultivation and accounts to 16 per cent of the total cost of cultivation. Timely planting with proper application of nutrients and plant protection improves crop growth as well as sugar yield. Sugarcane is planted in the form of cut setts of 2-3 buds by cutting the setts manually using knives. However, to reduce cost of planting, drudgery and proper placement of fertilizer, machinery for sugarcane planting was developed in India. These machines are basically of two types; one is drop planters and the other cutter planter (Patil *et al.,* 2004). In drop planters, pre-cut sugarcane setts of desired length are fed in to the machine whereas in cutter planter, whole cane is fed which performs the job of sett cutting, furrow opening, fungicidal and anti termite treatment of setts, placement of fertilizer in furrows, covering and pressing the setts. Presently, most common design of mechanical planter is cutter planter. In conventional planting, after preparatory cultivation using rotary plough and cultivator, ridger is used to form furrows while in mechanized system, cutting of setts and planting is done simultaneously. This will save time, labour and moisture loss in setts and helps for higher germination percentage. It was reported by Yadav *et al.* (2001) that conventional planting of sugarcane requires 337 man-hours and 30.6 bullock pair hours with a cost of Rs. 3,987/ha while mechanical planting amounts to Rs. 2,200/- with engagement of 20 man-hours. Quasrani *et al.* (1992) reported that a three-row tractor mounted sugarcane cutter planter was able to plant 53,000 to 87,000 setts of cane per hectare and saved 80 man–hours per hectare. Using sugarcane cutter planter there was saving of 40 per cent in cost compared to traditional planting (Srivastava, 1995). Bahl and Sharma (2001) reported that there was substantial reduction of labour requirement from 130 to 150 man-hours per hectare by conventional method to 35-40 man-hours per hectare by machine planting in Haryana. However, no detailed study on testing of mechanical sugarcane cutter planter under coastal conditions in Andhra Pradesh is available. Hence, the performance of tractor mounted two-row sugarcane cutter planter was evaluated in comparison with conventional method of planting at Regional Agricultural Research Station, Anakapalle, Andhra Pradesh.

METHODOLOGY

A field experiment was conducted during the year 2015 at Regional Agricultural Research Station, Anakapalle, Visakhapatnam district, Andhra Pradesh (16^0 30'N latitude and 18^0 20' E longitude) with a variety 93A145 (Sarada) developed by Regional Agricultural Research Station Anakapalle. Sarada is an early maturity variety of sugarcane possessing characteristics such as drought tolerance, resistant to red rot, tolerant to smut and good productivity. The adjacent field was planted with sugarcane following conventional practices for comparison. The planting was done with a spacing of

150 x 60 cm in both conventional and mechanical methods.

Field performance evaluation of sugarcane cutter planter:

The two row cutter planter (Make: Farm implements India Pvt. Ltd., Chennai) evaluated in the field consists of two way mould board shaped furrowers for opening of furrows and slanting chutes for sliding of whole cane to cutting unit through gravitational force. A provision has been made to the sugarcane cutter planter to accommodate two persons for feeding of cane to the chute during planting. The row to row spacing in sugarcane cutter planter was fixed to 150 cm and the plant to plant distance was 30 cm. In a plot of 16.9 × 52.6 size, the seed bed was prepared by two ploughings followed by roto tilling to make fine tilth and recommended dose of urea and super phosphate was broadcast.

Operation of cutter planter:

The machine was calibrated before operation in the field. The calibration of cutter planter was done by mounting the planter on tractor by three-point linkage system and the planter was powered by tractor PTO as per the procedure mentioned elsewhere (Patil *et al.*, 2004).

The field was well leveled with fine tilth for proper functioning of the cutter planter without missing of setts. The well trashed cane seed was loaded in the two seed boxes of cutter planter. A tractor of 45 HP was operated at a speed of 1.4 km/h choosing the best gear (Naik *et al.*, 2013). During the movement of the tractor in the forward direction, shoe type soil opener opens the soil to form furrows. Two persons seated on the rear of the equipment, constantly place the single cane in the chute (Fig. A). While passing the cane through the chute, due to gravitational force, the rotating blades cut the cane at an angle of 65° giving rise to setts of about 32cm length, drop the cane into the furrow and were covered with soil by soil covering rollers. Making of furrows, cutting setts, distribution of setts in furrows, application of fungicide/insecticide will be done in single action with the use of planter. A field of the same size (16.9 m × 52.6 m) was prepared for comparative evaluation of conventional planting by following the procedure described for cutter planter.

Fig. A : Planting of sugarcane using cutter planter

The field was prepared by ploughing with tractor mounted mould board plough followed by roto tilling to make fine tilth. The soil was then leveled using tractor mounted leveling blade. Recommended dose of urea and super phosphate was broadcast before planting three budded setts.

Machine parameters :

Machine parameters like field capacity (Naik *et al.*, 2013) and fuel consumption (Stevens, 1982) were measured and recorded. For calculation of slip percentage, a mark was placed on the side of the rear wheel of the tractor before the test. The tractor with and without cutter planter was operated with usual gear from the starting point to final set point in the field having 12 per cent moisture content (dry basis). Then the number of revolutions taken by the tractor to reach the final set point from starting point with and without the cutter planter was measured and the slip percentage was calculated using the formula given below:

$$\text{Slip percentage} = \frac{\text{No. of revolutions with load} - \text{No. of revolutions without load}}{\text{No. of revolutions with load}} \times 100$$

Soil moisture and bulk density :

Soil samples were collected randomly from four different locations at a depth of 0-30 cm for each treatment. The moisture content of the soil was determined on dry weight basis by keeping known weight of the soil sample in the oven at 105^0 C for 24 h. Bulk density of the soil on dry weight basis was determined using a core sampler (100 mm dia and 150 mm length) (Kumar and Tripati, 2015). The soil parameters are presented in Table A.

Table A : Soil conditions in the experimental plots

Parameter	Status
Moisture % (dry basis)	12.0
Bulk density (g/cc)	1.32

Biometric parameters :

The biometric parameters *viz*., cane height, single cane weight, diameter of the cane, root geometry and juice quality and yield in sugarcane planted with cutter planter and conventional method of planting were recorded. The root spread area of the cane was calculated following the procedure given by Mukunda Rao *et al*. (2017). About 20 canes were selected at random from each plot at harvest and the diameter of the cane was measured using vernier calipers at three different heights *viz.,* one foot above the bottom end, one foot below the top end and middle of cane, and the average was calculated. Cane yield was measured by harvesting the canes plot-wise leaving boundary rows and the weight of the canes was recorded after detrashing for each treatment plot and yield was calculated on hectare basis (Kumar and Tripati, 2015).

Sugarcane juice quality analysis :

Ten canes were collected at random. The canes were de-trashed and the tops were removed. The canes were washed with clean water and the juice was extracted using a clean three roller power operated crusher with a minimum of 60 per cent of juice extraction within 12 h of harvest. The basic parameters of sugarcane juice *viz*., Brix and Sucrose (%) were measured using hand refractometer (Make: Atago; Model: PAL-1) and saccharimeter (Make: Anton paar; Model: MCP 500 Sucromat), respectively.

Economics :

The total cost of operation for sugarcane cutter planter for planting sugarcane setts was calculated. The fixed and variable cost for operating cutter planter with tractor per hour was calculated (Anonymous, 1983). The performance of the cutter planter was compared with the conventional planting in terms of savings in labour cost, seed and time.

Statistical analysis :

The data were analyzed using two sample t-test and significant differences were evaluated at 5 per cent probability level (Gomez and Gomez, 1984). All the statistical calculations were done using Microsoft Excel (Anonymous, 2003).

■ RESULTS AND DISCUSSION

The performance evaluation of tractor drawn two-row cutter planter is given in Table 1. The field capacity of the cutter planter was found to be 0.16 ha/h at 75 per cent field efficiency. It was observed that depth and width of the furrow made by cutter planter ranged from 25 to 30 cm and 18-20 cm, respectively. The ridges made by sugarcane planter were effective enough due to tilled soil. The average length of the setts cut by the machine was observed to be 32.5 cm. About 81-85 per cent of the setts contained three buds. Bud damage was minimal due to least manual handling of the cane buds. Root spread area at 150 days was significantly higher in cutter planter method (1880 cm^2) than in conventional planting (1664 cm^2) (Table 2). Cane diameter and height in cutter planter method (2.45cm and 2.87m) were not significantly

Table 1 : Performance of two-row tractor drawn cutter planter

Parameter	Status
Slip % at 12 % moisture content	4.0
Field capacity (ha/h)	0.16

Table 2 : Biometric and juice quality parameters at harvest in plots using cutter planter and conventional method

Particulars	Cutter planter	Conventional planting
Root spread area at 150 days (cm^2)*	1880 ± 13.1	1664± 14.3
Cane height (m)^{ns}	2.45± 0.08	2.47± 0.2
Cane diameter (cm)^{ns}	2.87 ± 0.18	2.65 ± 0.35
Single cane weight (kg)*	1.25 ± 0.04	0.85 ± 0.04
Yield (t/ha)^{ns}	70.4 ± 5.29	67.6 ± 6.55
Brix^{ns}	21.3 ± 0.8	21.2 ± 1.0
Sucrose (%)^{ns}	19.4± 0.26	19.0± 0.40

*P<0.05; ^{ns} P>0.05

Table 3 : Economics of conventional *vis-a-vis* mechanical planting

Operations	Method of planting					
	Conventional planting			Cutter planter		
	Men	Women	Total	Men	Women	Total
Harvesting and transportation of seed material	10	20	7000	2	4	1400
Loading of sugarcane in the machine	-	-	-	-	-	
Opening of furrows with tractor	-	-	1500	-	-	-
Planting of sugarcane stalks with cutter planter and irrigation	13	15	6900	4	2	1600
Hire charges of tractor with cutter planter planter for 6.25 h @600 per hour	-	-	-			3750
Total cost			15400			6750
Savings in labour cost				15400-6750= 8650 (56%)		
Seed material requirement		10.0 t/ha			3.125 t/ha	
Savings in seed quantity				10.0- 3.125= 6.875 (68%)		
Time taken for planting		15.00 h			6.25h	
Saving in time for planting				15.0-6.25=8.75(58%)		

* Labour charges for men Rs. 300/- and women Rs. 200/- per day of 6 hours
** Tractor with sugarcane cutter planter hire charges = Rs. 600 per hour.

different from those in conventional planting (2.65cm and 2.47 m). Single cane weight at harvest was significantly higher in cutter planter method (1.25 kg) than in conventional method of planting (0.85 kg).

Cane yield in cutter planter method (70.4 t/ha) was not significantly different from that in conventional planting (67.6 t/ha). Brix and sucrose at harvest in cutter planter method (21.3 19.4 %) were not significantly different from those in conventional planting (21.2 and 19.0%). The results indicated that biometric parameters of cutter planter were on par with those of conventional planting, except root spread area and single cane weight. Though higher single cane weight was recorded in cutter planter, it was observed that corresponding yield difference was not recorded. It may be due to higher number of non-malleable canes (NMCs) recorded in conventional planting than in cutter planting method.

The economic analysis of sugarcane cutter planter over budchip planter was given in Table 3. The cost of operation of cutter planter along with tractor was worked to be Rs. 600. The cost of planting the sugarcane setts using sugarcane cutter planter was Rs. 6750/- whereas it was Rs. 15,400 with conventional method of planting at wage rate of Rs. 300 and Rs. 200 per day for men and women, respectively. The saving in labour cost, quantity of seed and planting time were found to be 56, 68 and 58 per cent, respectively over conventional planting.

Conclusion :

Feasibility testing of the cutter planter revealed that tractor drawn two-row sugarcane cutter planter for planting sugarcane setts had a field capacity 0.16ha/h at optimized speed of operation of 1.4 kmph. There were no significant differences in yield and quality parameters of sugarcane planted using cutter planter except single cane weight and root spread area. Economic analysis revealed significant saving in time, labour and seed cost and thus, planter could be used as an effective planting equipment for mechanization in sugarcane planting for sustainable sugarcane cultivation. Introduction of costly machines in sugarcane cultivation through custom hiring (by sugar factories) will help the sugarcane farmers to get rid of labour problem and improve productivity of sugarcane.

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