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A tractor driven mechanism for uniform planting of sugarcane

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Abstract

The planting, cultivation and harvesting of sugarcane is highly energy, time and labour intensive. Suitable techniques, systems and implements have therefore to be developed to minimize the above. However, a suitable machine for planting of cane to suit Indian field conditions is still a very challenging job. Most of the sugarcane planters developed so far are tractor i.e. PTO driven planters, which has certain advantages and disadvantages also. The main drawback of PTO driven planter is that when tractor is stopped during planting, the planter still feeds few extra canes at the same place, which is undesirable. In this paper, a single row sugarcane planting mechanism, an attachment to the tractor has been discussed which can overcome the above drawback. During preliminary trials, it has been observed that the planting of cane is uniform and depends upon the velocity and distance traveled by the planter. The planter stops the planting of cane when the tractor stops moving, i.e. the velocity of the tractor is zero. The planter feeds nearly the same length of the cane as the distance traveled by the tractor and is independent of the speed of PTO. The planting interval of the canes is uniform all along the cane planting length.

Keywords: Planting, Tractor, Sugarcane, sett, PTO

1 Introduction

Sugarcane planting is an arduous and labor-intensive operation. Equipment has been developed in countries, such as Australia, India and Pakistan, to reduce the manual effort with varying degree of success. In 1992, a two-row sugarcane cutter-planter was designed and developed at the Indian Institute of Sugarcane Research (IISR), Lucknow, Uttar Pradesh "[1,2]". The sett cutting unit of the implement was powered through tractor power take-off (PTO), which remained constant at a given engine speed. The number of setts per unit row length varied with the change in forward speed of the tractor. The sett planting rate and overlapping between setts was not homogenous. It was difficult to maneuver a 27-kW tractor with this rear mounted relatively heavy equipment, especially so with the additional weight of ~200 kg, which was required in front of the tractor for smooth operation.
Also the Sugarcane planting machine should be suitable to Indian conditions and it should enhance the productivity of sugarcane by introduction of mechanization with uniformity in planting without wastage of planting canes. The other objective is to reduce the cost and time of manual sugarcane planting which is desirable in any mechanized operation.

A simple, highly energy efficient mechanism needs to be developed to combat all above difficulties.

1.1 State of the art survey

In Indian scenario, a number of two row, three row and multirow planters were developed by some of the leading agricultural equipments manufacturers. Following section will explain some of them w.r.t their advantages and drawbacks.

1.1.1 Tractor operated two row ridger type sugarcane cutter planter

In this planter, the perform operations involved in cane planting are sett cutting; furrow opening; placement of seed setts, fertilizer and chemicals; soil covering over setts and tamping of soil, in a single pass. It is tractor operated equipment mounted with three point linkage. The equipment is hydraulically controlled for its lifting and lowering. Power is derived through tractor PTO for operations of sett cutting and fertilizer metering while tractive power is used for other operations "[1]".

Source of Power	: 35 HP tractor
Effective field capacity	: 0.20 ha/h
Labor requirement	: 4

1.1.2 Tractor operated two row multipurpose sugarcane cutter planter

Perform operations involved are sett cutting; furrow opening; placement of seed setts, fertilizer and chemicals; soil covering over setts and tamping of soil, in a single pass but the planting is done for two rows simultaneously. Power is derived through tractor PTO for operations of sett cutting and fertilizer metering etc "[2]".

Source of Power	: 35 HP tractor
Effective field capacity	: 0.25 ha/h
Labor requirement	: 4

1.1.3 Julien planter

This planter is utilized as opening and closing fingers on a continuous chain that would grab the stalks laid flat in the wagon and discharge them into the previously opened planting furrow "[3]".

1.1.4 Drum planter :

This Design employed a drum with a spiral of flat rakes attached to its surface that served as the stalk metering mechanism "[4]".

1.1.5 Slat Type Mechanical Planter :

In this design, a parallel set of chains replaced the drum. Metal slats that hold the stalk feeding rakes are laid across the chains. A larger circumference-metering device can be utilized with this design as compared to the conventional drum.

1.1.6 Self Propelled two row Billet Planter :

This planter receives, transports and plants the seed cane. The planter tills the soil with furrow and also covers the seed cane with loose soil. Ridge-forming and fertilizer application is carried out by another tractor "[5]".

1.1.7 Bonnel Mechanical Planter :

This planter is fed by two men who introduce whole stalk cane into the cutting mechanism. The billets fall into the furrow, that is opened by the machine; a special device covers the furrow and a press wheel at the rear presses soil over the billets "[6]".

2 Specification of the developed machine

Drive	: Wheel driven
Source of power	: 35 HP tractor
Type of furrow opener	: Ridger
Number of furrow openers	: 1
Row to row distance	: 75/90 cm
Type	: Tractor rear mounted
Attachment	: Planter attached to three point linkage.

2.1 Sequence of operations

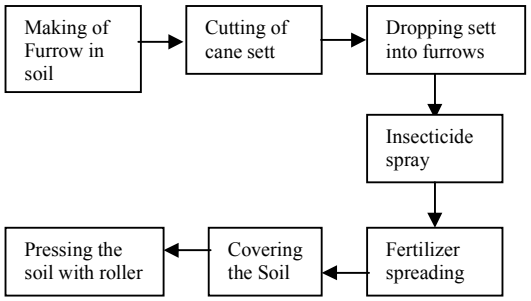

Figure 1: flowchart showing sequence of operations.

Before loading the sett on the planter, the canes that are to be planted needs proper preparation. The brief sequence of operation involved in this machine are making of furrow in soil through plough, cutting the prepared cane setts through a blade, dropping them into soil (cavity formed by plough), Insecticide and fertilizer spreading, covering the sett and pressing the soil with roller.

3 Description of the machine

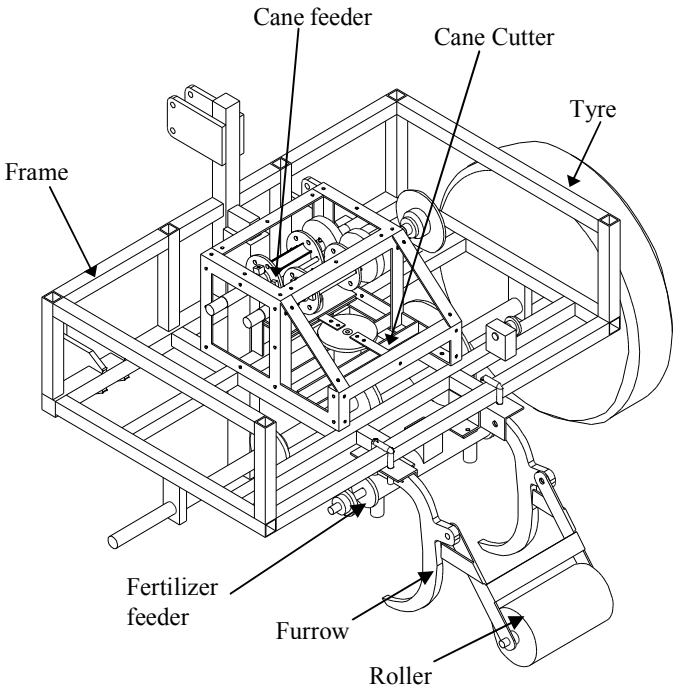

Figure 2: Single row sugarcane planter at design stage. (One of rear wheel, Cage for supporting cane and insecticide spraying unit is not shown)

First of all the sugarcane to be planted needs to well prepared by shaving all their leaves, roots if any so that the eyes on the cane are well exposed. Then these well prepared canes are loaded on the planter as per requirement. One person can be deployed for feeding the canes to the planter cutting mechanism.

Once the planter is attached to the tractor, it will be ready to plant the cane. The plough provided at the bottom of the planter digs the required cavity of about 2 ft deep for planting the canes. The canes are feed manually one by one to the cane feeder as shown in fig.1. The cane feeder arrangement consists of two rubberized rollers moving in opposite direction such that the cane feed will move downwards upto cutting blade. (The drive for rubberized roller is given through chain drive by axel of the planter on which wheels of planter are mounted.) The cutting blade assembly consists of two blades mounted exactly 180 degree apart and rotated by bevel gear arrangement and drive is provided by ground wheel axel. The cutting blade arrangement is shown in fig.3.

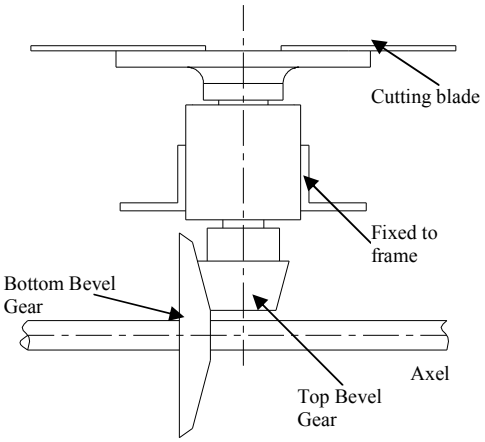

Figure 3: Cutting blade arrangement. Here bottom bevel gear is not shown in this figure.

The synchronization of the Cane feeder and cutting blade is achieved such that exactly 9 inch of cane is cut. The feeding angle and cutting blade are such adjusted that the canes are cut with some angle and are cut very sharply. Then the cut sett is dropped by gravity and supported by chute into the cavity formed by plough initially. Immediately after cutting, a insecticide spraying nozzle kept close to the blades sprays insecticide solution on the cut cane to prevent any decaying under the soil. Once the cut sett is dropped in the cavity, fertilizer needs to be spread around. The mechanism for spreading fertilizer is also attached to the planter which is as shown in fig.4.

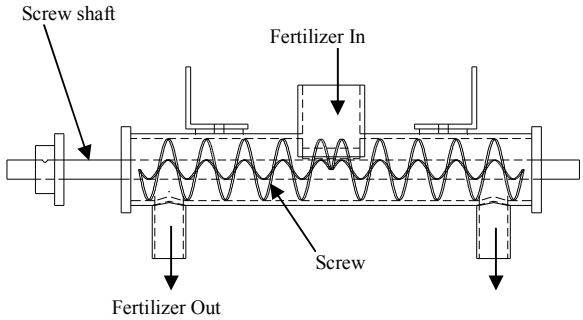

Figure 4: Shows the schematic of fertilizer feeding arrangement employed for this planter just above furrow arrangement.

After fertilizer is spread, the cut sett needs to be covered with soil which is done by furrow as shown in fig.2. Once the cut sett are covered with soil is further pressed by light roller provided after furrow. There is no drive provided for roller.

4 Results and discussion

The tractor operated two row ridger type sugarcane cutter planter developed by IISR Lucknow is mounted with three point linkage. The equipment is hydraulically controlled for its lifting and lowering. Power is derived through tractor PTO for operations of sett cutting and fertilizer metering while tractive power is used for other operations.

Also, for tractor operated two row multipurpose sugarcane cutter planters, the planting is done for two rows simultaneously. Power is derived through tractor PTO for operations of sett cutting and fertilizer metering. In both planters as discussed above the main drawback of PTO driven system is that when tractor is stopped during planting, the planter still feeds few extra canes at the same place, which is undesirable.

The Julien mechanical planter has too many moving parts, a lack of consistency in planting rate and other problems limited the initial usage of this planter.

The Drum planter has a limited maintenance as a result of few moving parts encouraged its use, but fails to so popular among farmers.

The slat type mechanical planter has increased maintenance, which limited acceptance of this planter.

Self Propelled two row Billet Planter has the disadvantage that both operation of furrow making and fertilizer spreading is done by separate tractor.

The performance of the Bonnel Mechanical Planter was not satisfactory and was not accepted by the cane growers.

A single row sugarcane planting mechanism, an

attachment to the tractor has been developed which can overcome the above drawback. Trial for the single row sugarcane planter is taken and some key results are as follows.

Sometimes overlap of cane is desirable depending on type of cane for sawing. This can also be provided by changing the sprocket mounted on feeding assembly to some range.

Uniform spaced cane placing is observed.

Source of Power	: 35 HP tractor
Effective field capacity	: 0.25 ha/h (though it is single row planter)
Labor requirement	: 2 (which is 2 less than other planters including tractor driver)

5 Conclusions

The main drawback of PTO driven planter is that when tractor is stopped during planting, the planter still feeds few extra canes at the same place, which is undesirable. A planting mechanism, an attachment to the tractor which is discussed can overcome the above drawback of overlapping of canes. During preliminary trials, it has been observed that the planting of cane is uniform and depends upon the velocity and distance traveled by the planter. The planter stops the planting of cane when the tractor stops moving, i.e. the velocity of the tractor is zero. The planter feeds nearly the same length of the cane as the distance traveled by the tractor and is independent of the speed of PTO. The planting interval of the canes is uniform all along the cane planting length.
As compared to the manual planting, the area planted per day by the Sugarcane Planting machine will be three times.

The cost of planting with Sugarcane Planting Machine would be reduced to one third of the existing rates of manual planting.

Depth of planting can be adjusted in the mechanical device in accordance with the soil condition.

As fresh canes are planted, the germination rate is high. It will also reduce the lodging of crop by increasing the depth of planting in certain conditions

It will enhance both production and productivity.

Sugarcane Planting Machine will streamline the crop production system of sugarcane on scientific basis & leads to effective use of mechanical harvesting.

Acknowledgment

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