MECHANIZATION OF SUGARCANE HARVESTING IN INDIA

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Abstract

Harvesting of sugarcane is an energy and labour intensive operation which involves human drudgery when the operation is performed manually. Mechanization assumes importance in view of the present scenario of labour scarcity in the agriculture sector. In this paper, we discuss the efforts made at both national and international level for mechanization of sugarcane harvesting. Internationally, whole canes as well as combine chopper harvesters are used commercially. Combine chopper harvesters are more common in developed countries like Australia and USA due to their ability to handle even a heavy tonnage recumbent crop. In India, major efforts have been made to develop whole cane harvesters for partial mechanization. These harvesters are intended to cut mainly the cane stalks and in some cases to chop the green tops also. The remaining operations such as detrashing, bundling and loading are to be performed manually. However, these harvesters are still not available for commercial exploitation. Recently, combine chopper harvesters have been imported at a few places in Tamil Nadu and Maharashtra. These harvesters perform all the operations involved in sugarcane harvesting viz. cutting, cleaning and loading in a single pass of the row. The major constraints in the adoption of imported sugarcane harvesters in general and combine chopper harvesters in particular are high initial cost of the machine, wider row spacing requirement, high trash content in the harvested cane pieces, piecemeal cane harvesting system prevalent in the country and other socio-economical issues.

Key words: Sugarcane, harvesting, mechanization, chopper harvester, whole cane harvester

Introduction

Sugarcane is an important industrial crop of India. Harvesting of sugarcane and its transportation to sugar mills is energy and labour intensive, and involves human drudgery when performed manually. In India, harvesting is performed manually using different types of knives. The harvested cane is transported to sugar mills for processing by different modes of transportation, viz. bullock carts, tractor operated trailers and trucks. Harvesting of cane involves cutting of cane stalks, detopping and detrashing of cane stalks, making bundles of 10-12 stalks and finally loading of clean cane bundles into transport vehicles.

Basically, two types of harvesting systems are prevalent worldwide, namely green cane harvesting and burnt cane harvesting. The green cane harvesting, performed without burning the standing crop, is preferred as it yields superior quality juice. Also, this method allows green tops to be used as fodder and incorporation of trash into the soil. In the case of burnt cane harvesting, the cane field is first burned and the cane is harvested once the temperature goes down to the comfortable operating level. In India, generally green cane harvesting is practiced. As the availability of labour is precarious and varies with the season, the availability of cane to the mills becomes uncertain. This necessitates the adoption of mechanization of harvesting operation of sugarcane along with suitable transportation system. In the present compilation, the efforts made in India for mechanization of sugarcane harvesting are discussed.

Present scenario

Presently, harvesting of sugarcane is done manually using different types of knives. The mechanization
efforts in the country have been basically limited to the development of whole stalk harvesters for partial mechanization of sugarcane harvest. These harvesters were basically designed to cut the cane and in some cases to detop the green top also. The remaining operations such as detrashing, bundling and loading are to be performed manually. In a few states such as Andhra Pradesh and Maharashtra, whole stalk harvesters were imported and evaluated for partial mechanization of sugarcane. However, these harvesters are still under development and evaluation stage. Of late, combine chopper harvesters have been imported at few places in Tamil Nadu and Maharashtra. These harvesters are intended to mechanize the whole operation of sugarcane and have found acceptability at a few places on a limited scale. Combine chopper harvesters are not only capable of harvesting green as well as burnt crops but can also handle heavy yielding and lodged crops whereas whole stalk harvesters are suitable for harvesting erect and medium tonnage crops.

The available sugarcane harvesting options can be categorised into manual harvesting and mechanical harvesting either as whole stalk harvesters through linear windrowing or transverse windrowing, or as chopper type harvesters.

**Manual harvesting**

In India, harvesting of sugarcane is done manually using conventional harvesting tools. The productivity of manual cutters can be improved by giving proper training and balance diet to the labourers, through use of correct cane knife, etc. On an average an output of 0.8 to 1.0 tonne per man per day is obtained. Human drudgery involved in cane cutting, detrashing, detopping and carrying head loads to the transport wagon, together with shortage of labour during harvest season, is compelling the cane growers to look for the alternative viable option of mechanizing the harvesting operation.

**Mechanical harvesting**

Attempts have been made at different places to develop and adopt mechanical harvesters which can be grouped into (i) whole cane and (ii) combine chopper harvester.

(i) Whole cane harvester

A power tiller operated whole cane harvester was developed (Singh, 1983). The harvester has a circular cutting blade which can cut one row of cane at a time (Fig. 1). Kubota power tiller was used as prime mover. The cane cutting and windrowing mechanism was mounted in the front of the power tiller (12.5 hp) as close as possible. A positive drive by chain and sprockets was used to transmit power from the prime mover to the cutting blade. An auto-tensioner was also provided to maintain the required tension in the chain. Weight balancing was done by putting dead weights on the handles of the power tiller, close to the operator. A solid rubber gauge wheel of 15 cm diameter was provided at the back side of the cutter blade for regulating the height of cut of cane stalks. Guards were provided to hold the cane clump and then to guide harvested cane to one direction for windrowing. During field trials, the windrowing system worked well in fairly straight cane crop. Since cane lodged in the direction of the row fell lengthwise in front of the machine obstructing cutting, the machine got lifted from the front side leading to cutting of canes leaving long stubbles. Besides, some of the harvested cane fell in front of the power tiller’s wheel resulting in obstruction to the movement of the machine.

![Fig. 1. IISR tractor operated front mounted sugarcane harvester (windrowing one row linearly between the tractor and one row transversely)](image_url)
cut cane stalks for windrowing. The equipment needed space for the tractor and could be operated only in one direction. The harvested cane needed to be lifted prior to cutting the next row of the cane. Due to these problems the equipment could not be taken for further trial.

Sharma and Singh (1992) developed a tractor front-mounted sugarcane windrower harvester at the Indian Institute of Sugarcane Research (IISR), Lucknow. It was reported that with the help of this harvester two rows of sugarcane were cut simultaneously and windrowed at the centre of the rows. Removal of green tops and dry trash, and bundling and loading into transport vehicles were performed manually. The major components of the harvester were main frame, drive system, base cutters and rotating crop dividers and front reels. The drive from the tractor PTO was through double chain and sprockets. Base cutters consisted of a disc carrying three cutting blades. Crop dividers having spirals, rotating in opposite directions were provided to facilitate harvesting of lodged crop and proper windrowing.

Yadav et al. (1998) reported on the performance of whole stalk sugarcane harvesters. The imported sugarcane harvesters were Bonnel, Carib and Cameco, and the indigenous model was VSI-Merado. Bonnel sugarcane harvester consists of a front mounted and three point link mounted, side harvesting cum windrowing unit on a standard tractor chassis. The detopped cane is cut at the base by twin disc blades and windrowed with the help of a conveyor along the direction of motion. Carib whole stalk harvester is a single row harvester on a standard tractor base, having two spiral scrolls to separate standing canes which are either lodged or bent and for gathering canes towards the centre of the cutting row for base cutting. The base cutter is a twin blade cutter having adjustable depth wheels to take care of field undulation and maintain a constant height of cut. The cut cane stalks are windrowed beneath the harvester along the direction of motion thereby overlaying harvested canes over each other. Cameco whole cane harvester is a single row machine having a single spiral scroll at the left to separate entangled and lodged cane stalks from the adjoining rows of standing crops. It has upper and lower conveyors to gather and convey standing cane stalks for base cutting along the row. The height of these conveyors can be adjusted independently. Base cutter height can be adjusted by hydraulic power and is always inclined to the ground. Windrowing unit has a conveyor which can discharge detopped and base cut canes at any angle, to a maximum, perpendicular to the direction of travel. The topper detops and shreds immature green tops and leaves. All the functional components and sub-systems are hydraulically powered. The VSI-Merado prototype is similar to Carib model having a detopper at the front to cut the immature green tops. It has a twin base cutter powered by tractor power take off. A front detrashing roller is mounted to remove dried and loose leaves adhering to the cane stalks. The base cut canes are windrowed underneath the harvesting machine along the forward motion. It has twin spiral scrolls to separate entangled stalks and gather lodged or bent cane stalks towards base cutter.

A tractor front-mounted sugarcane harvester was developed for cutting and windrowing of two rows of cane. While one row is windrowed in transverse direction, the other row is windrowed linearly to the direction of travel of the tractor (Singh et al. 2009). Attachments, consisting of a M.S. frame and hydraulically controlled arms through hydraulic cylinders, raise and lower the harvester during transportation as well as field operation. Power to the cutting blades was provided through tractor PTO. Attachments were also provided with the main frame for windrowing of harvested cane by guiding the cane towards cutting blades during harvesting operation and up to some extent for raising the partially lodged canes. The harvester was tested at IISR farm at different speeds of cutting blades (300-350, 450-500 and 600-650 rpm). The cutting was clean without any splitting and rupture of cane stubbles at cutting blade speed of 450-500 rpm. The cutting and windrowing was satisfactory for crops which were not lodged and where the canopy was not intermingled with the other rows. The equipment needed free space towards right hand side to facilitate transverse windrowing of cut cane stalks. Due to this it could be operated in one direction only and could not be engaged in cutting during return.
Due to these limitations, the equipment was not taken for commercial exploitation.

A power operated detrasher was developed at IISR and Punjab Agricultural University (PAU), Ludhiana, for the removal of green top as well as dry trash from the harvested sugarcane (Srivastava and Singh 1990; Shukla et al. 1991; Singh and Sharma 2009). It separates the top from mature cane by breaking it and removing the green and dry leaves. Srivastava and Singh (1990) developed a tractor PTO driven sugarcane detrasher for removal of green as well as dry trash from the harvested sugarcane. It consisted of a cane feeding beater, a cane take off beater, a pair of rollers, a lower and a feeding trough. It was reported that the efficiency of detrashing was dependent upon the peripheral speed of detrashing rollers. Shukla et al. (1991) developed snapping roll type sugarcane cleaner. It separates the top from the cane by breaking it from mature cane and removing the green and dry leaves. The cleaner consists of feeding chute, cylinder, lower roller, side roller, flap roller, blower and inclined platform fitted on a rigid frame. The machine was tested on different varieties. The machine output with single cane feeding varied from 3.8 to 8.23 q/h.

A power operated detrasher (Fig. 2) was developed for removal of green top as well as dry trash from the harvested sugarcane (Singh and Sharma 2009). The equipment consisted of mechanisms for cane feeding, detrashing and delivery. It separates the top from the cane by breaking it from the natural weak point at the joint of immature top with mature cane stalks. It can be transported on three point linkage of the tractor and operated by an electric motor, diesel engine or tractor PTO. Performance of the equipment was evaluated by feeding different varieties of harvested canes, with their tops first, to the detrashing rollers through the feeding chute. The trash left on the cane after passing through the detrasher varied from 1.5 to 6.6%. Trash removal efficiency varied from 77.5 to 94.5% depending upon the variety. The output of the detrasher was 2.4 t/h with a feeding rate of 2-3 cane stalks at a time. There was a saving of about 17% in the cost of operation and 84% in labour requirement using the detrasher as compared to manual method.

(ii) Combine chopper harvester

Nagendran (1999) has reported that the Austoft 7000 sugarcane harvesters were imported from Australia at Sakthi Sugars Limited, Sakthinagar (Tamil Nadu). These combine chopper harvesters (Fig. 3) cut, clean and load cane into an articulated infield transporter. The harvested cane is transported to the mill using trucks. It has been reported that the harvester is commercially used. The average quantity of sugarcane harvested was reported as 200 tons per day. The maximum quantity harvested in a day was 405 tons.

Under NATP, different types of combine chopper and whole cane harvesters were evaluated. The net cane output of combine chopper harvester (Austoft 7000) was found to be 24 to 30 tonnes per hour (Anon 2002). The minimum working row space for this harvester was 150 cm. The cost of harvesting
varied from Rs 157 to 200 per tonne in case of mechanical harvesters, which could be further lowered by increasing the total tonnes of cane harvested per day by operating the harvester for longer hours in a day. Under NATP a combine chopper harvester was developed for harvesting of canes planted at 90 cm or more. The information on its field performance trials is not available.

Constraints in the adoption of imported models of chopper harvester

Following are the major constraints in the adoption of imported sugarcane harvesters particularly combine chopper harvesters:

i) High initial cost of the harvester

ii) Wider row spacing (1.5 m and above) requirement

iii) Piecemeal harvesting system prevalent in the country

iv) Sucrose losses due to delay in supplying billets to the mill

v) Higher trash content (7-8%)

vi) Higher non-operating time due to small size of fields resulting in low output

vii) Higher horse power prime mover (250-300 hp)

Future strategy

It can be observed that no single tailor made solution is available because of the different cane growing practices and cane supply management. A multipronged approach can be adopted keeping in view the present scenario in India. Steps proposed to be taken up in a phased manner are listed below:

1. Development of a tractor mounted single row/double row linear windrower harvester with provision of a detopper. Initially, head loading may be adopted but later on possibilities of using mechanical loadings may be considered.

2. Efforts may be made to develop a self-propelled single row unit based on Cameco design with provision for crop scrolls, gathering and conveying chains for transverse windrowing to facilitate mechanical loading into transport wagons. It should be workable in 0.9-1.0 m row spacing and effectively handle lodged/recumbent crop.

3. There is a need to develop a simple design based on Carib model for cutting, windrowing and detopping of single row of whole cane stalks. Sugar mills should also be prepared for accepting the detopped cane with leftover trash over the cane stalks.

4. Chopper harvesters can handle difficult and heavily lodged crop but the situation in India is not yet congenial for large scale adoption of such highly sophisticated equipment.

A developing country like India needs time to shift to chopper harvesting by making requisite changes and preparations in sugarcane production and supply system suiting to the chopper combine harvesters. As such, adoption of these machines may be uneconomical and practically not possible because of agronomical and other constraints. It needs the formulation of a proper strategy wherein cane growers, sugar industry, Government organizations and private entrepreneurs work together as a team.

References


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