Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; Sp 9(4): xxx-xxx
Received: 12-05-2020
Accepted: 14-06-2020

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Review paper on different small scale sugarcane harvesting machine for a small farmer

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Abstract
Agriculture is the backbone of India. So the development of the agriculture field is considered as a development of India. But nowadays a shortage of labor found in the agriculture field. Due to mainly increased non-farm job opportunities having a higher wage, migration of labour force to cities and low status of agricultural labours in the society. This review paper is based on the different types of small scale sugarcane harvesting machines, for used harvesting methods, identify the problem after harvesting and get some useful suggestions for developing a small scale sugarcane harvesting machine aspects for economical harvesting which will help to minimize the working fatigue and to reduce labor costs.

Keywords: Harvesting, sugarcane, physical properties, engine and cutter

Introduction
India is the second-largest producer of sugar in the world after Brazil. The purpose of developing this machine is to reduce the cost and time required for sugarcane harvesting. Sugarcane harvesting machine which is economical, more efficient and cuts the sugarcane at a faster rate and it will be helpful for small scale farmers, unskilled labours can also operate without difficulty. By using this harvesting machine, we can also solve the problem of labour shortage. In manual harvesting to cut one acre of sugarcane 15-16 labors are required they take 3 days to cut one acre. By using this machine problem of the labour crises can be reduced. Comparing with manual harvesting only 18% of labours are required, it makes the process faster hence reduces most of the harvesting time and labour required to operate the machine is also less. This machine is helpful for both small and big farmers. (Ratod *et al.* 2013) [1]. The various types of harvester were available in the market, but they are costly (about 1.2 crore). Due to this reason, it is impossible to affordable by a small and marginal farmer

Different review was studies carried out by different researchers relegated to the physical properties and development of small scale type sugarcane harvester, which are discussed below.
Blackburn (1984) [10] described the sugarcane as a tall tropical grass with a single un-branched stem of average height in the range of 3 to 4 m with a stem diameter ranges from 3 to 5cm depending on the species.
Hunsigi (1993) [8] reported that the optimum spacing for planting of sugarcane is 0.9 to 1.0 m between rows. In subtropical India, where growth of the plant is restricted due to climatic parameters, a row spacing of 0.75 m is adopted. Even though there are different planting systems for sugarcane, the ridges and furrows system of planting is very common in South India. The fields at different locations are studied for finding out the existing row spacing of the crop, to decide the optimum spacing of the crop divider and the effective width of the base cutter. Bastian, and Shridar, (2014) [9] Conducted the physical properties of sugarcane pertaining to de-topping, de-trashing and conveyance are stdudied for the designing of a whole stalk sugarcane harvester. The various physical parameters for the major varieties of sugarcane are measured in the farmers' field. The farmers' grow CO 86032 sugarcane at a row spacing of 75 to 100cm, and the spacing is increased to 150 and 200 cm wherever harvesting is done by self-propelled combine harvesters. The average number of cane per meter varied from 27 to 30. The length of the millable cane varies between 1200 mm and 2700 mm. The maximum and minimum diameters are 40 and 20 mm respectively. The trash content at the time of harvesting was 38.56 percent where the regular de-trashing processes were completely skipped by farmers. Moontree *et al.* (2012) [5] developed sugarcane harvester using small engine in order to focus on its appropriateness in sugarcane farming for farmers who are encountering problems of labor shortage and sugar factories lack sugar cane for producing sugar. It is operated by 180 hp (134.28 kW) at 2500 rpm.

Sugarcane was harvested at 12 months after planting with an average-stalk length of 1.8 m, and average-stalk diameter of 0.0254 m, each clump consisted of 8 to 12 stalks, the distance of each sugarcane row was 1.20 m. The sugarcane harvester using small engine can perform at an average speed of 1109.73 m^2/h with fuel consumption of 20.03 l/h and at a mobile speed of 0.25 km/h. The percentage of sugarcane-cut stalks is 100%.

Jain *et al*. (2013) [1] designed and fabricated small scale Sugarcane harvesting machine which on testing in the field it is found that the front wheels are struck in mud, due to that the machine was not moving. The machine has a capacity to cut 3.75 ton of sugarcane per hour. Comparing with manual harvesting 50% of harvesting time and 60% of labors are reduced (in manual sugarcane harvesting 15-16 labors are required).The cost of harvesting is reduced by 34% when compare to manual harvesting. When comparing with the large scale, though the harvesting time and fuel consumption is less in large scale, but the cost machine is very high (1.85 crore) and the cost of the small scale machine is Rs. 30000/ So it will be helpful to our farmer. By comparing with manual harvesting, Rs.10,000/ for an acre can be saved by small scale harvesting machine.

Ranveer and Tambuskar (2015) [6] design and developed, Sugarcane harvesting by a machine has a more capacity to cut the sugarcane faster compared to the manual one. Hence, need of using sugarcane harvester in India is necessary for faster rate of production of sugarcane products as well as harvesters take less time to cut the cane and cuts cane in smaller parts so that it becomes easy to transport with larger amount of quantity in one trolley. These Cutting machine has conveying and collecting methodology of a sugarcane harvester as an attachment to the tractor which takes the power from tractor only through its for sugarcane harvesting to reduce farmer's effort and to increase production of agricultural products of sugarcane harvester at the lower cost which can be affordable to Indian farmers or a group of farmers. The cost of an attachments goes up to Rs.35000/.

Siddaling and Ravaikiran (2015) [4] were carried out the study on agriculture is the backbone of India. In India there is scarcity of labours in agriculture. Day by day labour wages are increasing and in the same way demand of agriculture products are also increasing and today's world need large scale of production of agriculture products due to huge population. In today's world there is a heavy demand for sugar and it's by-products.

The major states growing sugarcane are Maharashtra, Uttar Pradesh and Karnataka. Now India is the leading producer of sugarcane in the world, then Design and fabricate small scale sugarcane harvesting machine for sugarcane harvesting to reduce farmer's effort and to increase the output of agricultural products and this machine is easy to operate, low cost with more efficiency and having less maintenance. The machine is helpful for farmers and it is economical.

Yadav *et al*. (2002) carried out the performance evaluation of sugarcane chopper harvester, most of the large-scale imported harvesters and the current price is very expensive. In addition, the large-scale imported harvesters are designed for large-scale farming areas, which require 1.50 m of the distance of each sugarcane row. Some of the small-scale Thai farming areas employed the sugarcane row distance of 1.2 m. Therefore, it is not possible for the large-scale harvester to drive through the row. Thus, solving these problems by designed and developed a sugarcane harvester using small engine. This would be benefit for small-scale farmers in our country.

For Physical properties of sugarcane crop

Physical properties of sugarcane at the time of harvesting are very important for the development of a small scale type sugarcane harvester. Hence the various physical parameters such as length and diameter of millable cane, node distance, row to row and plant to plant for the different varieties (Such as Co-80036, Co-86032, COVSI-9805, Co-8014 and COM-0265.) of sugarcane.

Length of the cane

The length of cane plays a significant role in the design of the de-topper mechanism for a small scale sugarcane harvester. The de-topper blade assembly has to be raised or lowered to cut the top of the cane precisely to avoid the loss of the millable cane at the time of harvest. The millable cane length in the farmers' field is measured using a 3m measuring tape and is recorded. The maximum and minimum length of the millable cane was selected from the observed data for the design of the de-topper lifting and lowering mechanism, such that the harvester was able to de-top the sugarcane at different heights in the field.

The average length of sugarcane varieties at kwardha distric shows in table:1.

Table 1: Length of different variety of sugarcane crop

Variety	Co-80036	Co-86032	COVS I-9805
length, cm	206.0	159.7	176.4
Range, cm	140-300	132-200	150-205
S.D.	55.16	20.16	19.35

Diameter of the cane

The diameter of sugarcane varies from bottom to top and this variation depends upon the variety and the climatic condition which prevailed in the growth phase of the sugarcane.The diameter has an important role in the determination of base cutting and de-topping cutting force requirement. The diameter of the sugarcane is determined at three different locations of the cane viz., top, middle and bottom. The data are tabulated and the maximum value is considered in the design of de-topper system, whereas as the maximum and minimum values are considered in the design of the cutting system to accommodate the variations in the sugarcane diameter.

Table 2: Diameter, cm of different variety of sugarcane crop

Variety	Particular	Average diameter, cm	Range,cm	S.D. (σ)
Co-80036	Top	2.632	2.16 to 3.34	0.472
	Middle	2.811	2.3 to 3.5	0.462
	Bottom	3.103	2.54 to 3.18	0.483
Co-86032	Top	2.854	2.2 to 3.5	0.519
	Middle	3.15	2.5 to 3.91	0.533
	Bottom	3.38	2.7 to 4.13	0.509
COVSI-9805	Top	2.613	2.0 to 3.2	0.421
	Middle	3.091	2.5 to 3.82	0.483
	Bottom	3.28	2.76 to 3.97	0.470

The diameter of sugarcane of three verities were measured from the field and interpreted in the Table 2. Diameter of sugarcane is measured in three different positions viz., top middle and bottom. The diameter varied from top to bottom and the variations depend upon the soil type and the weather conditions.

Row spacing

The optimum spacing for planting of sugarcane as reported by Hunsigi (1993) [8] is 0.9 to 1.0m between rows. In subtropical India, where growth of the plant is restricted due to climatic parameters, a row spacing of 0.75m is adopted. Even though there are different planting systems for sugarcane, the ridges and furrows system of planting is very common in South India. The fields at different locations are studied for finding out the existing row spacing of the crop, to decide the optimum spacing of the crop divider and the effective width of the base cutter.

Table 3: Row to row and plant to plant spacing

S.No.	Variety	Row to row spacing (cm)	Plant to plant spacing (cm)
1	Co-80036	70 to 100	40 to 45
2	Co-86032	120 to 135	65 to 75
3	COVSI-9805	130 to 135	70 to 80

The row to row of sugarcane of 3 verities were measured from the field and interpreted in the Table:3. Traditional practice consist of closer row spacing of 60 to 90cm in areas where harvesting was done manually. In order to accommodate mechanical harvesters, farmers have adopted wider row spacing of 120 to 150cm

For development of small scale sugarcane harvester for small farmer

Development of sugarcane harvester in this particular section of the paper five different deigns of small scale sugarcane harvesters are discussed in brief.

Design of Sugarcane Harvesting Machine by Zode *et al.*

Zode *et al.* designed of Sugarcane Harvesting Machine, because in India every farmer can't afford tractor and other high cost machine equipment for the harvesting. Day by day labour wages are increasing and in the same way demand of agriculture products are also increasing and today"s world need faster rate of production of agriculture products. This machine does the work with fewer efforts and in less time so it reduces cost of labour.

Design and fabrication of small scale sugarcane harvesting machine by Jain *et al.*

Jain *et al*. designed and fabricated small scale Sugarcane harvesting machine which on testing in the field it is found that the front wheels are struck in mud, due to that the machine was not moving. The machine has a capacity to cut 3.75 ton of sugarcane per hour. Comparing with manual harvesting 50% of harvesting time and 60% of labors are reduced (in manual sugarcane harvesting 15-16 labors are required).The cost of harvesting is reduced by 34% when compare to manual harvesting. When comparing with the large scale, though the harvesting time and fuel consumption is less in large scale, but the cost machine is very high (1.85 crore) and the cost of the small scale machine is Rs. 30000/ So it will be helpful to our farmer. By comparing with manual harvesting, Rs.10,000/ for an acre can be saved by small scale harvesting machine.

Sugarcane Cutting Machine by Jamadar *V. et al.*

Jamdar V. *et al* designed and fabricate a small scale sugarcane cutting machine for sugarcane to reduce farmer's effort and to increase production of agricultural goods. Compared to manual harvesting this machine has a capacity to cut canes in faster rate. It was economical. This paper helps in laying design foundation for any aspiring user to fabricate a machine for application in their farms. It helps improve economic growth of the nation.

Design and fabrication of small scale sugarcane harvesting machine by Siddaling and Ravaikiran

Siddaling and Ravaikiran were carried out the study on agriculture is the backbone of India.

In India there is scarcity of labours in agriculture, then Design and fabricate small scale sugarcane harvesting machine for sugarcane harvesting to reduce farmer's effort and to increase the output of agricultural products and this machine is easy to operate, low cost with more efficiency and having less maintenance. The machine is helpful for farmers and it is economical.

Design and fabrication of small scale sugarcane harvesting machine by Paramasivam, K. *et al.*

Paramasivam, K. *et al*. observe The small scale farmers were facing serious problems in harvesting the canes. Firstly, there is a labour scarcity for sugarcane harvesting. It is due to lesser wages or moving of the work force to the urban cities for higher wages. Moreover, the manual harvesting method is a time consuming one and also the labours face problems such as fatigue and safety concerns as they are likely to be exposed to harmful pests from plantations.

There are number of machines available for the large scale cultivation.This makes it difficult for small scale farmers to bring their canes to the market on time during the season. In order to help the small scale farmers we have designed a small scale sugarcane harvesting machine with the affordable cost.

1. **Problems identification in small scale sugarcane harvester:**
   After testing of above mention sugarcane harvesting machine which found the different problem and solve these problems by using designing and modification which make more reliable and economic.

2. **Windrowing the harvested stalk**
   During harvesting of sugarcane stalk windrow at one side of the first row and second-row sugarcane stalk falls on the machine, then faces more difficulty during harvesting.

3. **Cutting height**
   The field has undulated which effect of base cutting height of sugarcane stalk, sometimes cutting blade damage when it acts on any hard obstacle.

4. **Two-row cutting spacing**
   Sugarcane was row to row spacing in a different field, which make impossible to harvest two rows at a single operation. Then this operation was not economical for this type of machine.

5. **Handle height**
   Keep the handle height should be knee height. If the handle height below and above the knee height then more effort required during operation.

6. **High weighted machine**
   High weighted machine required extra effort for pushing the machine and also compact the soil.

7. **Cutting blade**
   Two type of blade were available in market like that plane and serrated, if the use speed plane blade which damage the ratton and also effect next year crop yield.

8. **Position of engine**
   The position of the engine is on the top side of the frame. This position is very difficult for starting the engine with the kick

Suggested design modification in small scale sugarcane harvester

We disused different types of small scale sugarcane harvester and faced different problems during harvesting time and solve this problem by a developed 5-hp engine operated sugarcane harvester(Fig-1). Windrowing problem solves by manually hug cane stalk during harvesting.

- Spacing between two-row cutting blades should be adjustable.
- Keep handle height should be one (1) m. from the ground surface.
- Weight of the machine should be minimum for easy operation
- Use rope starter cord engine, in which not required any special position of the engine

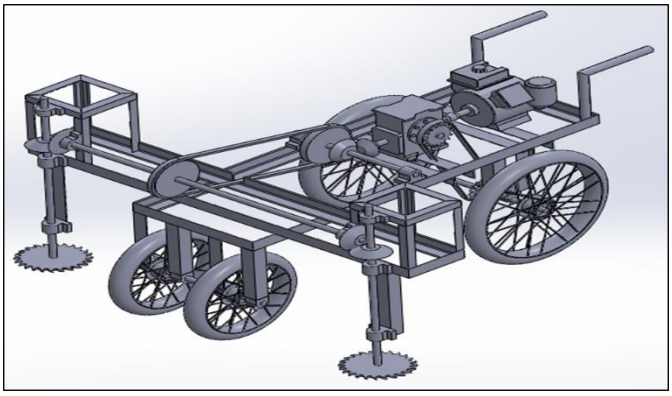

Fig 1: Isometric front view of sugarcane harvester

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