

Design and Fabrication of Power Operated Sugarcane Sett Cutting Machine

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ABSTRACT

A power operated sugarcane sett cutting machine was designed and fabricated in the Agricultural Engineering Workshop of Sugarcane Research and Training Institute for cutting sugarcane stalks into setts of desired length. The test performance were investigated and compared with the conventional sett cutting method, i.e. manual cutting of cane stalks with knife by labourer. Cost involvement for the fabrication and operation of the machine were estimated. Average single and two budded sett cutting rates in the sett cutting machine were found 3785 setts/h-man and 4360 setts/h-man respectively. But in the conventional method the average single and two budded sett cutting rates were found 1195 setts/h-man and 1993 setts/h-man respectively. The operational cost of the sett cutting machine was found Tk. 15.86/h and that of the conventional method was found Tk. 6.25/h. For cutting 1000 setts in the sett cutting machine the operational costs were found Tk. 2.10 and Tk. 1.82 for single and two budded setts respectively. But in the conventional method the operational cost for cutting 1000 setts were found Tk. 5.23 and Tk. 3.14 for single and two budded setts respectively. Better germination and ease of operation indicated the superiority of the machine over conventional knife method of sugarcane sett preparation.

INTRODUCTION

In spaced transplanting (STP) technology one or two budded pregerminated sugarcane setts are planted in furrows in the main field. These one budded or two budded setts are prepared conventionally by cutting the sugarcane stalks with a knife (keeping the stalks on a piece of round wood or bamboo). This is sometimes a very rough and slow method. More than 12% setts are damaged during sett preparation and around 1200 setts can be prepared per hour by a skilled labourer. Srivastava and Sharma (1978) developed a power operated sugarcane sett cutting machine in Indian Institute of Sugarcane Research (IISR), India and it was propelled by 5 HP engine or tractor driven p. t. o. pulley. Four labourers were required for the operation of the machine with two blades and 12000 - 13000 setts can be prepared per hour. At present there is no power operated sett cutting machine in Bangladesh and no research work has so far been done in this regard. Hence an electric motor operated sugarcane sett cutting machine has been designed and fabricated in the Agricultural Engineering Workshop of Sugarcane Research & Training Institute (SRTI). The machine has been tested in the workshop and found effective for single or double budded sett preparation.

MATERIALS AND METHODS

DEVELOPMENT CONSIDERATION AND DETAILS OF THE MACHINE

Physiological and agronomical requirements

Miah *et al.* (1987) started in detail on bag and sett size upon germination and vigour of sugarcane seedlings. For the production of STP seedlings, single budded setts of

4-5 cm (1.5 - 2") long is cut for polythene bag (Poly bag) settlings and two budded setts of 25 - 30 cm (10 - 12") long depending on the length of internode of cane are cut for soil bed settlings. In case of two budded setts the sugarcane stalk is cut in the middle of every alternate internode which does not require much precaution. But in case of single budded sett preparation, the sugarcane stalk is cut in such a way that every sett contains a alive eye bud with 1.5 - 2.5 cm stalk above and below the eye bud and the total length of the sett is confined to 4 to 5 cm which can be easily placed in a 10 cm x 12.75 cm (4 - 5") size polybag with adequate soil. Hence sufficient precautions are required to produce single budded setts.

Design and functional requirements

The salient design and functional requirements of the machine are :

- a) The machine is a stationary type.
- b) Two fine toothed circular blades are used to cut the seed cane on a steel framed table.
- c) One, two or three whole stalks of sugarcane are used as experimental material for cutting into setts.
- d) Two chutes are fitted below two blades to carry the setts into the container.
- e) Blades are covered to avoid any danger/accident.
- f) The blades are fitted with a wooden board in such a way that cutting seed cane will not be obstructed in the gap between blade and wooden board.
- g) Different sizes of idle/drive pulleys are used to increase the speed of the blades.
- h) Power is transmitted from the motor to the blades by flat belt through drive pulleys.
- i) Three phase 1 hp motor with starter, main switch etc are provided for operating the machine.

Mechanical details of the machine

The machine consists of a frame, two circular blades, two sett chutes, one electric motor, one idle shaft, one blade shaft, four pulleys and five sets of bearing, bearing block and socket (Figure 1). The overall dimension of the machine were 1.25 m long, 0.64 m wide and 0.86 m height. The main frame is made of M. S. angle bar of 5 cm x 5 cm x 3 mm and 3.81 cm x 3.81 cm x 3 mm sizes. Both idle and blade shafts are made of M. S. shaft of 3.81 cm diameter. The details of the materials used for the fabrication of the machine with the cost involved is given in the Table 1 and the details of the two circular blades is given in the Table 2.

EXPERIMENTAL INVESTIGATIONS

Three labourers were selected from SRTI farm to test the performance of the machine. Each of the labourers was allowed to work with the conventional knife and

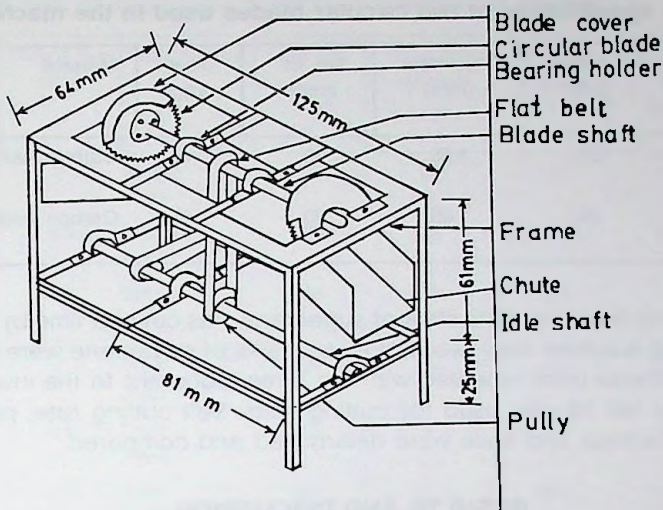


Figure 1. Power operated sugarcane sett cutting machine.

Table 1. Material requirement and cost involvement for the fabrication of the sett cutting machine.

Sl. No	Description	Specification	Quantity	Cost involved (Tk.)
1.	Electric motor	1 hp, 3 phase, 415 volts, 1400 rpm	1 No.	5500.00
2.	Electric starter	3 phase, 7.15 Amp.	1 No.	750.00
3.	M.S. shaft	3.81cm dia	2.4m	275.00
4.	Ball bearing	3.81 cm dia	5 Nos.	975.00
5.	Bearing block	3.81cm dia	5 Nos.	825.00
6.	Bearing holder	3.81cm dia	5 Nos.	250.00
7.	Circular blade	25cm dia	1 No.	300.00
8.	Circular blade	15cm dia	1 No.	250.00
9.	M. S. angle	3cm x 5cm x 3mm	14m	1610.00
10.	M.S. angle	3.81cm x 3.81cm x 3mm	7m	805.00
11.	Motor pulley	15cm dia	1 No.	200.00
12.	Idle pulley	10cm dia	2 No.	300.00
13.	Blade shaft pulley	7.6cm dia	1 No.	150.00
14.	Flat belt	7.6cm wide	3.75m	384.00
15.	Flat wood	2cm thick	0.50 m ³	300.00
16.	Labour cost	—	—	500.00
17.	Total cost	—	—	13374.00

Table 2. Details specification of two circular blades used in the machine.

Sl. No.	Blade Type	Diameter (cm)	Thickness (mm)	No. of teeth	Teeth angle	Material	Linear speed (km/hr)
1.	Circular blade	25	1.65	80	45	Carbon steel	131.95
2.	Circular blade	20	1.65	80	45	Carbon steel	105.56

with the sett cutting machine. One stalk of sugarcane was cut at a time by the knife, but by the sett cutting machine one, two and three stalks of sugarcane were cut at a time. And all these methods were repeated with the three labourers. In the investigation the sugarcane variety Isd 16 was used for cutting setts. Sett cutting rate, percent of sett damage in the machine and knife were determined and compared.

RESULTS AND DISCUSSION

The results obtained in this investigation are shown in the Tables 3, 4, 5 and 6. Sett cutting rates were found out in both single and two budded setts. By the help of knife only one stalk of sugarcane was cut at a time into single or two budded setts. In an average 1195 number of single budded setts and 1993 number of two budded setts were cut per hour per labourer (Table 3). By the help of newly fabricated sett cutting machine both single and two budded setts were cut using one, two or three sugarcane stalks at a time. However, on an average 2070, 3785 and 3150 number of single budded setts were cut per hour per labourer per blade and 2448, 4360 and 3291 number of two budded setts were cut per hour per labourer per blade respectively when one, two and tree sugarcane stalks were cut at a time (Table 4). In the both single and two budded sett preparation higher number of setts could be prepared when two stalks were cut at a time compared to the use of single stalk and three stalks at a time in the sett cutting machine. The number of two budded setts prepared per hour per labourer by both the machine and the knife were always higher over the number of single budded setts prepared per hour per labourer by both the machine and the knife. In the machine, the maximum number of single budded setts (3785) and two budded setts (4360) were produced when two stalks were cut at a time.

In the conventional method the sett damage was higher and it ranged from 11.6 to 13.5% in case of single budded setts and 10 to 12.3% in case of two budded setts. On the other hand the sett damage in the machine was lower and it ranged from 1.5 to 3.3% in case of single budded setts and 0.9 to 2.0% in case of two budded setts. In this respect the sett cutting machine was found superior to conventional method of sett preparation. Germination percentage for sett cut in the machine and in the knife were found 84% and 82% respectively (Table 5). Sett produced in the machine gave higher germination over the setts produced in the knife. The operational cost of the sett cutting machine and conventional knife were found Tk. 15.86 per hour and Tk. 6.25 per hour respectively (Table 6). The operational cost for cutting 1000 setts in the sett cutting machine were found Tk. 2.10 and Tk. 1.82 for single budded and two budded setts respectively. But in the conventional method the operational cost for cutting 1000 setts

Table 3. Cutting rate of sugarcane setts by conventional method.

Sl. No.	Weight of cane (kg)	Cutting time (min)	Type of setts	Total sett	Total sett damage	% of sett damage	Sett cutting rate (No./hr /man)	Average sett cutting rate (No./hr /man)
1.	9	10	Single eyed	204	27	13.2	1224	
2.	9	9.5	Single eyed	198	22	11.11	1250	1195
3.	9	10	Single eyed	185	25	13.5	1110	
4.	9	3	Two eyed	94	10	10.6	1880	
5.	9	2.5	Two eyed	90	9	10	2160	1993
6.	9	2.75	Two eyed	89	11	12.3	1941	

Table 4. Cutting rate of sugarcane setts by sett cutting machine.

Sl. No.	Weight of cane (kg)	Type of sett	No. of cane cut at a time	Cutting time (min)	Total No. of sett cut	Total No. of sett damaged	% of sett damaged	Sett cutting rate (No./hr /man)	Sett cutting rate of machine (No./hr)
1.	10	One eyed	1	6	207	3	1.5	2070	4140
2.	10	One eyed	2	3.25	205	5	2.4	3785	7570
3.	10	One eyed	3	4	210	7	3.3	3150	6300
4.	10	Two eyed	1	2.5	102	1	0.9	2448	4896
5.	10	Two eyed	2	1.5	109	1	0.9	4360	8720
6.	10	Two eyed	3	1.75	96	2	2.0	3291	6582

Table 5. Germination percentage of setts cut in the machine and in the conventional method.

Sl. No.	Sett cut in	Sett placed for germination (No.)	Sett germinated (No.)	Germination (%)
1.	Machine	100	84	84
2.	Knife	100	82	82

Table 6. Operational cost of sett cutting machine and conventional method.

Sl. No.	Method	Fabrication cost (Tk.)	Type of sett	Cost per hour (Tk.)			cost per 100 setts (Tk.)
				Fixed cost	Variable cost	Total cost	
1.	Machine	13374.00	One eyed	1.94	13.92	15.86	2.10
			Two eyed	1.94	13.92	15.86	1.82
2.	Knife	100.00	One eyed	—	6.25	6.25	5.23
			Two eyed	—	6.25	6.25	3.14

were found Tk. 5.23 and Tk. 3.14 for single and two budded setts respectively. Hence the operational cost for cutting 1000 setts in the machine was much lower than that of in the conventional knife method of sett preparation.

From the above results the following conclusion can be made :

1. Although the initial cost of the machine is higher but it is superior and efficient than the conventional knife method of sett preparation.
2. Sett damage in the sett cutting machine is minimum and germination percentage is higher than the conventional method.
3. Maximum efficiency is obtained when two labourers were engaged for cutting setts in the machine.

Therefore, it is recommended for use of sett cutting machine for large scale sugar cane sett preparation in the commercial farms as well as farmer's level.

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