

Development and Performance Evaluation of Tractor Operated Sorghum and Pearl Millet Ear Head Separator

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Abstract

The harvesting and threshing of these cereal crops by conventional method involves number of manual operations such as cutting of crop plants by sickles, tying of bundles to yard, separation of earheads and threshing. Out of total labourer involved for harvesting and threshing, nearly 42 to 45% is required for separation of ear heads which is done by breaking the stem at the neck by hand or cutting by sickle. It is time consuming and labour intensive operation. Because of involvement of too much human labour (80 man hours per hectare), separation of ear head becomes of costly operation resulting in sizable increase in the ultimate profit of the farmer. Some sort of mechanical means to relieve cereal growers from this tedious and labour intensive operation is felt necessary. The farmers face acute problem of load shedding hence they need tractor operated sorghum and pearl millet ear head separator. Besides, the farmers can make use of this machine for chaff cutting of sorghum, pearl millet, maize and sugarcane crops for feeding to their milch animals. The performance evaluation of implement showed that the output capacity of the machine is 1.00. ha per hour and Ear head cutting efficiency was found to be 95%. The machine reduced the time, cost and labour required for sorghum and pearl millet ear head cutting operation as well as it reduced the drudgery and arduousness of the ear head cutting by manual method.

Key words : Sorghum ear head separation, Pearl Millet, Mechanization, Cutting.

Sorghum is one of the main coarse cereal crop of India. India is the second largest producer of sorghum in the world. Only 5% of the area under sorghum is irrigated in India and over 48% of the area under sorghum cultivation is in Maharashtra and Karnataka.

Out of the total labour involved for various operations, nearly 45 to 55 per cent is required for post harvest operations. The harvesting and threshing of these cereal crops by conventional method involves number of manual operations such as cutting of crop plants by sickles, tying of bundles, transport of bundles to yard, separation of earheads and threshing. Out of total laborers involved for harvesting and threshing, nearly 42 to 45% is required for separation of ear heads which is done by breaking the stem at the neck by hand or cutting by sickle. It is time consuming and labour intensive operation.

Because of involvement of too much human labour (80 man hours per hectare), separation of ear head becomes of costly operation resulting in sizable increase in the ultimate profit of the farmer. Some sort of mechanical means to relieve cereal growers from this tedious and labour intensive operation is felt necessary. The farmers face acute problem of load shedding hence they need tractor operated sorghum and pearl millet ear head separator. Besides, the farmers can make use of this machine for chaff cutting of sorghum, pearl millet, maize and sugarcane crops for feeding to their milch animals.

Materials and Method

Theoretical considerations

1. To use some kind of rotating tool preferably saw cutter type which would cut ear heads by combination of shear and impact forces.

2. Since the ear head cutting operation is to be performed in the yard as well as field is stationary, the power source would be 35 hp tractors.
3. The feeding of the material to the cutter would be automatic and continuous so that desired output capacity could be achieved.
4. To provide suitable power transmission mechanism to rotate the cutter and conveyor this would also act as safety device.
5. To provide some sort of spring loaded guides to compress the feed material at the point of cutting for effective cutting. Besides, this unit would control the rate of feeding.
6. The ear head separator to be designed and developed would be a low cost machine, simpler in mechanism, easy to manufacture and should have a low operating cost.

Design Parameters

- i. **Crop Parameters** : This parameter is essential for deciding the width of the feeding zone i.e. width of conveyor belt. Generally, the height of cereal crops range from 1450 to 2000 mm and ear head length ranges from 200 to 300 mm.
- ii. **Moisture Content of Stem** : Moisture content of stem influences the force required for cutting and thereby affects the fuel consumption of the tractor. Stems having more moisture content consume more power for its cutting.
- iii. **Machine parameters** :
 - a. **Cutter diameter and speed** : The past work done convincingly decide the suitability of a serrated circular cutter in cutting most of the thick stemmed crops like sorghum and pearl millet etc. Further, it is decided that such a cutter has to have a minimum linear speed of $6.00 \text{ mtr sec}^{-1}$ for efficient cutting.

Accordingly, a serrated high carbon steel disc of 400 mm diameter with 6 mm pitch will be selected. This disc will be provided to have a linear speed of 12.5 m sec^{-1} .

- b. **Horse Power** : In absence of reliable data of the actual force requirement for cutting of cereal crops and therefore, of actual load, arbitrarily 35 hp tractor will be selected.
- c. **Conveyor frame and height** : The width of 1035 mm of the conveyor frame based on the average length of cereal crops would be selected. Height will be 800 mm based on power hamessive point i.e. P.T.O. of the tractor.
- d. **Conveyor speed** : The flat cotton belt conveyor speed of 0.48 m sec^{-1} will be provided to achieve maximum cutting efficiency and to avoid material clogging at the cutter.

Constructional features and working principal of tractor operated sorghum and pearl millet ear head sepearator

The dimensions of the main frame of the machine are 1500 mm width, 1010 mm length and 770 mm height. It is made from M.S .channels of size 50 x 50 x 5 mm . M.S. sheet was used to make a platform for conveying of stalks of the crops with the help of 2 nos. of lugged conveyor belts. On the main frame are mounted cutter assembly and conveyor assembly. Circular saw type cutter of 245 mm diameter was used for cutting ear heads of sorghum and pearl millet crops. Conveyor system consists of lugged flat belt conveyors of 60 mm width (2 nos.) and they run parallel to each other. Two nos. of guides made from 10 mm diameter round bar and 690 mm in length parallel to each other at 600 mm spacing have been provided and positioned on the platform in such a way that they press down the conveyed stalks on the conveyor belt and guide in pushing it towards the cutter assembly.

Power transmission system consists of 5 nos of different size pulleys. Power is taken from tractor PTO to main pulley of 300 mm diameter through pedestal block bearings by universal telescopic joint which in turns actuates the other three pulleys for transmitting power to the cutter assembly as well as it imparts power to auxiliary pulley positioned on the main platform to give motion to the conveyor assembly.

For operating circular saw cutter, power from the main pulley of 300 mm diameter is transmitted to 120 mm size auxiliary pulley through V-belt and from this auxiliary pulley, power is transmitted to through 25 mm shaft to pulley of 85 mm size.. Power from 85 mm diameter pulley is vertically transmitted to

another pulley of 40 mm diameter which in turns imparts motion to the circular saw cutter.

For operating conveyor system, power from the main pulley of 300 mm diameter is transmitted to 120 mm size auxiliary pulley through V-belt and from this auxiliary pulley through 25 mm running through shaft the driving pulleys of conveyor belts are given power.

Result and Discussion

The performance evaluation of implement revealed that the output capacity of the machine was 1.00. ha per hour and Ear head cutting efficiency was found to be 95%. The machine

Table 1. Test Results of Tractor Operated Sorghum and Pearl Millet Ear Head Separator (MPKV)

Parameter	Value
Location	Dairy Farm, MPKV, Rahuri
Date of test	29-11-2016
Name of the crop and Variety	Sorghum, local variety
Age of the crop at test, days	130
Average crop height, mm	1800
(Min. 1750 to Max. 2100)	
Average ear head length, mm	175
Average peduncle length, mm	250
Average peduncle diameter, mm	9.00 (Min. 7.00 to Max. 15)
Average stem diameter at 500 mm distance from the ear head base, mm	15.00 (Min. 10.00 to Max. 30)
Moisture content of the crop on wet basis, %	19.00
Main pulley rotational speed, rpm	504
Circular saw cutter speed, rpm	580
Circular saw cutter peripheral speed, m sec ⁻¹	12.00
Conveyor belt linear speed, m sec ⁻¹	0.48
Output capacity, ha h ⁻¹	1.00
Ear head cutting efficiency, %	95 %
Labour required	
Skilled	1
Un-skilled	2
Labour required by traditional method, Man -hrs per hectare	80.00
Cost of operation by traditional method, Rs. ha ⁻¹	2000.00
Labour required by the machine, Man -hrs per hectare	03.00
Net labour saving by using the machine over traditional method, Man-hrs per hectare	77.00
Cost of operation by using the machine, Rs. ha ⁻¹	506.00
Net saving in operational cost over traditional method, Rs. ha ⁻¹	1454.00

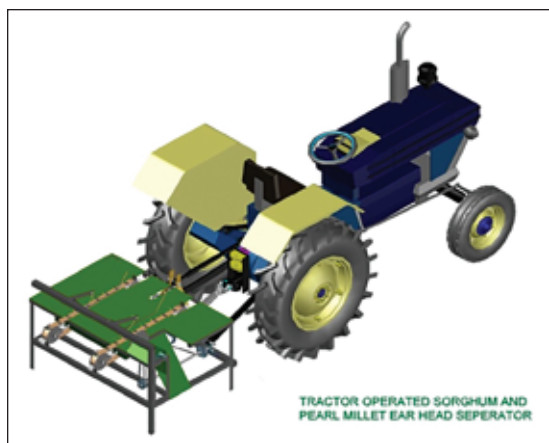


Fig. 1. Tractor Operated Sorghum and Pearl Millet Ear Head Separator



Fig. 2. Tractor Operated Sorghum and Pearl Millet Ear Head Separator

reduced the time, cost and labour required for sorghum and pearl millet ear head cutting operation as well as it reduced the drudgery and arduousness of the ear head cutting by manual method. Prototype of tractor operated sorghum and pearl millet ear head separator has been developed at AICRP on FIM, MPKV, Rahuri and

its laboratory and functional field trials were undertaken during the year 2016. The preliminary test data is presented in the Table 1

Conclusions

Newly developed tractor operated Sorghum and Pearl Millet ear head separator was developed and its laboratory and functional field trials were undertaken. Based on the results, following conclusions are drawn *viz.*

1. New prototype was adaptable to sorghum, pearl millet crop with height ranging from 1450 to 2100 mm
2. Conveyor linear speed of 0.48 m s^{-1} was adequate to feed the material to its fullest cutting capacity
3. Output capacity of the machine is 1.00. ha per hour
4. Ear head cutting efficiency was found to be 95%
5. The machine reduced the time, cost and labour required for sorghum and pearl millet ear head cutting operation as well as it reduced the drudgery and arduousness of the ear head cutting by manual method.

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