Modification and evaluation of sorghum thresher

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Abstract

In Amhara Region, sorghum is among the leading cereals by area coverage. In the region, sorghum is threshed in a traditional way by trampling of animals, which is cumbersome and in efficient. This method of threshing requires more labour and results in less recovery percentage of the crop. Taking these factors into consideration, modification of the Bako made maize sheller was done so as to make appropriate for threshing sorghum. Performance evaluation of the modified thresher was done extensively in the field. The test results revealed that threshing capacity, threshing efficiency, cleaning efficiency, recovery percentage and labour productivity increased significantly. Finally in this study even though, promising results are recorded regarding the threshing performance of the modified thresher, extensive tests need to be undertaken under farmer’s field condition using different variety to verify the output of this paper under different condition. In addition economic advantage of the technology should be studied.

Key words: Maize sheller, sieve overflow, sorghum thresher, threshing capacity, threshing efficiency.

Introduction

The traditional threshing floor for sorghum like the other crops is usually made by smearing the ground with cow dung or irrigating with water and leaving to dry for some time. During threshing the crop to be threshed is laid on the floor and several animals tread on it. The animals go around the threshing floor over the crop for some time and are taken out intermittently to turn the unthreshed crop from bottom up for efficient treading. Threshing sorghum is tedious work. It takes 5:25 ox hr q^{-1} and 3:50 man hr q^{-1} for trampling and 6 man hr q^{-1} for cleaning. Despite the long time spent on threshing and cleaning, some times more than 30-40% of unthreshed crop is observed in the kernels. During the operation care is taken not to under thresh or over thresh in order to prevent cracking and damaging of the kernels. The threshing season normally lasts 2- 3 months after harvesting, which is possibly extended with high yielding varieties. Threshing may not be completed in this time due to lack of treading animals. The delay in the completion of the threshing operation within the safe time limit will expose the product to unfavorable weather resulting in high level of quality loss and insect and rodent attack.

The traditional method of threshing sorghum requires large labor and results in low recovery percentage and quality of the crop. This implies that sorghum productivity is greatly affected by the threshing method practiced. Therefore, this study was conducted with the objective of modifying the Bako made maize sheller so as to thresh sorghum and evaluate the threshing performance.

Materials and methods

Modification of parts

A two stage improvement was done in modifying the Bako made maize sheller to suit for threshing sorghum. After the first modification, preliminary test was conducted to gather required information for further modification. Clearance between concave sieve and beater, perforated concave sieve opening hole diameter and perforated shaking sieve opening hole of the Bako made maize sheller were modified to suit the sheller for threshing sorghum (Table 1).

Table1. Modifications in the Bako made maize sheller to thresh sorghum.

Parameters modified	Bako	1st modified	2nd modified
Clearance between concave sieve and beater (mm)	60	45	40
Perforated concave sieve opening hole diameter (mm)	16	10	8
Perforated shaking sieve opening hole (mm)	14	8	7

In addition, during the second modification the following changes were made:

Peg (bended round bar) was welded on the beater at the inlet side to improve feeding rate and then to increase threshing capacity (Figure 1).

The size and shape of feeding hopper was re-designed by incorporating feeding table with the opening gate cover made from canvas in order to have enough space for the material to be threshed and reduce loss of grain due to hopper overflow (Figure 1). Since the concave sieve has to be changeable for sorghum threshing and maize shelling activity, to make assembling and disassembling activity easy the side plate that was previously welded to the concave sieve and blower housing been designed to be attached with bolt and nut in both sides rather than being welded.

The hopper and feeding table shape and size was changed for better threshing capacity and to decrease loss and table overflow (Figure 2).

Figure 1. Beaters of maize sheller and modified sorghum thresher.

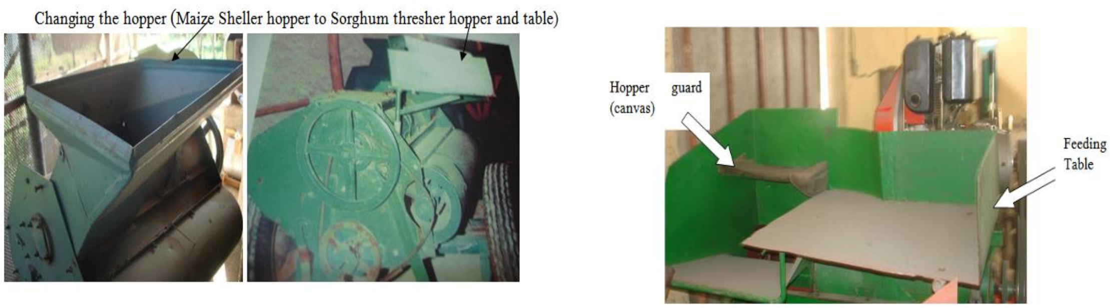

Figure 2. Modified hopper parts of the sorghum maize thresher.

Testing and Evaluation

Testing and evaluation of the 1st modified thresher

After the prototype has been developed, preliminary test was conducted at the Kobo sub center trial site of Sirinka Agricultural Research Center using three types of improved sorghum verities namely Gobiye, Teshale, and 76–T_1#23 following the FAO standard test procedure (Smith *et al*., 1994). Among the drawbacks observed during the first test that were found to be critical and had to be solved were:

Clogging of concave sieve opening hole by stalk and spent panicle.

Assembling and disassembling of concave and shaking sieve was found challenging to the farmers and even workshop technicians.

The threshing capacity of the machine was not found good enough as compared to the rated speed (horse power) of the driving units.

Less cleaning efficiency.

By considering these problems the second modification was intended in order to improve the overall working conditions.

Testing and evaluation of the 2nd modified thresher

During testing the first modified thresher merits and demerits of the thresher were observed and recorded and then design parameters were determined. Using these parameters, the second prototype was developed. Preliminary performance test was conducted for six hour using different sorghum varieties to observe its technical fitness for testing. Then, three tests were conducted at Sirinka Agricultural Research Center using the sorghum variety Gobiye. Each test was replicated three times. The tests were done according to the FAO standard test procedure (Smith *et al*., 1994).

Results and discussion

Results of the 1st modified sorghum thresher

As result of modification from the original one, threshing capacity and threshing efficiency of the thresher increased by 26.9% and 2.47%, respectively and cleaning efficiency decreased by 8.64% (Table 2). Hopper overflow of the modified sheller has been recorded to be 1.75%. Further, the sheller required 7-10 man days to run the machine efficiently.

Table 2. Test result of the first modified sorghum thresher.

Parameter	Value
Actual threshing capacity	0.723 t hr^{-1}
Theoretical threshing capacity	1.035 t hr^{-1}
Cleaning efficiency	93.3%
Threshing efficiency	100%
Feed rate	not recorded

Results of the 2nd modified sorghum thresher

The result of the test from the second modified engine driven sorghum thresher is tabulated as in Table 3.

Table 3. Test result of the second modified sorghum thresher.

No.	Description	Test Number			Average
		1	2	3	
2	Moisture content average (%)	6.78			
3	Grain:spent panicle ratio	3.96:1			
4	Threshing drum speed (rpm)	930	880	730	845
5	Feed rate (t hr^{-1})	2.117	2.374	2.612	2.368
6	Threshing capacity (t hr^{-1})	1.44	1.67	1.87	1.66
7	Threshing efficiency (%)	100	100	100	100
8	Cleaning efficiency (%)	90.98	91.65	89.46	90.69
9	Unthreshed grain (%)	-	-	-	-
10	Blown grain (%)	0.0160	0.0265	0.0178	0.0201
11	Sieve overflow (%)	2.285	0.9375	0.2075	1.143
12	Hopper (table) overflow (%)	0.640	0.3219	0.6197	0.5271
13	Total loss (%)	2.9416	1.2859	0.8447	1.515
14	Labor requirement (lb-hr q^{-1})	0.422	0.361	0.320	0.367
15	Fuel consumption (lt hr^{-1})	1	1	1	1
16	Panicle weight (g)	70.26	61.96	54.56	62.26
17	Length of panicle (mm)	271	264	276.66	270.55
18	Diameter of panicle (mm)	32.15	32.86	30.35	31.78
19	1000 grains weight (g)	29.3	28	28	28.43
20	Ave. grain length (mm)	4.28	4.19	4.37	4.28
21	Ave. grain width (mm)	4.07	4.00	4.08	4.05
22	Ave. grain thickness (mm)	2.54	2.50	2.53	2.52
23	Ave. stalk diameter (mm)	9.63	8.96	8.57	9.05

The test result showed that, threshing capacity has increased by 60.4% and cleaning efficiency has decreased by 2.8% when compared with the first modified diesel engine driven sorghum thresher (Table 4). This may be due to clogging of sieve by well threshed impurities. Increasing the threshing cylinder speed resulted in more imparts on the sorghum head introduced to the concave. This result is in line with the results of Simonyan *et al.*

(2006). They stated that with an increase in drum speed the materials other than grain are also chopped into fine particles, which results in more materials load being delivered to the sieve for separation. Also, the increased cylinder speed results in an increased range of particle sizes and formation of minute particles, which aerodynamically resembles sorghum grain, thereby creating challenges in cleaning operation.

Table 4. Performance of the two modified sorghum threshers.

Parameters	1st modified thresher	2nd modified thresher
Threshing capacity (t hr^{-1})	0.72	1.67
Threshing efficiency (%)	100	100
Cleaning efficiency (%)	93.3	91.63

From the three selected rpms of the drum the maximum cleaning efficiency of 91.7% was recorded at 880 Rpm (Figure 3). As Rpm increased cleaning efficiency did not increased correspondingly. This could be because as rpm of the beater increased the spent panicles and stalks might have been over threshed and impurities were not removed easily.

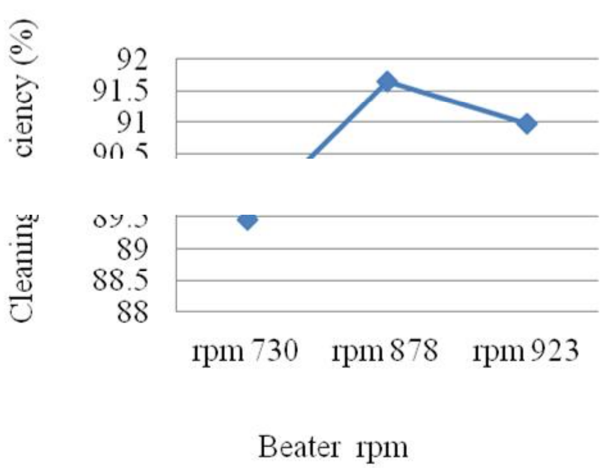

Figure 3 . Relation between Rpm and cleaning efficiency in a sorghum thresher.

The maximum threshing capacity of 1.87 t hr^{-1} was recorded at 730 Rpm (Figure 4). It was observed that threshing capacity decreased as the Rpm of threshing drum increased. This is due to the fact that as rpm of the beater increased, the pegs did not get sufficient time to draw in the material to be threshed. As result, they bring repelling effect and also the inlet hole of the concave is at the center of the drum, hence the panicles can pushed back by the tangential force created on the pegs, poor feeding rate and then decrease the threshing capacity.

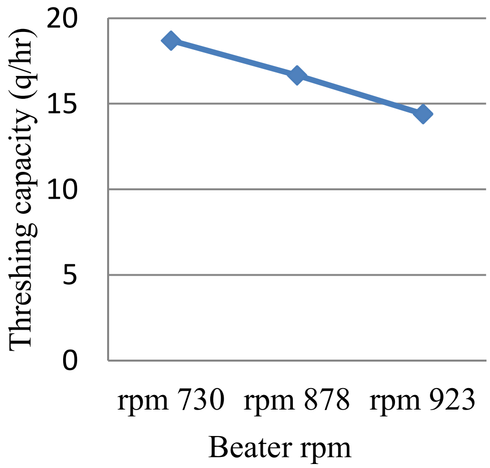

Figure 4. Relation between rpm and threshing capacity in a sorghum thresher.

The highest sieve overflow of 2.29% was recorded at 925 Rpm (Figure 5). It was observed that as Rpm increased sieve overflow also increased.

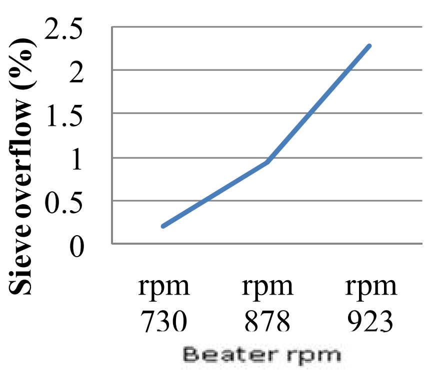

Figure 5. Relation between rpm of the beater and sieve overflow in a sorghum thresher.

Conclusion

The capacity of the improved sorghum thresher is better than the previous thresher (from 0.7 to 1.67 t hr^{-1}) and can solve the threshing problem in sorghum.

For efficient threshing the optimum Rpm of the beater should be between 730 and 880 Rpm.

To use this thresher for efficiently the concave sieve has to be cleaned at the end of each threshing activity.

To use this thresher for maize shelling and sorghum threshing activity interchangeably, the following items should be supplied as an optional accessory that are used for sorghum threshing. These are feeding hopper, feeding table, straw walker, concave sieve without its attachments, shaking sieve, guard that is assembled to the feeding hopper, and pegs with their bolts and nuts.

Promising results were recorded on the performance of the modified thresher. Therefore, extensive tests need to be undertaken under farmers' field condition using different varietyy to verify the results under different condition. In addition economic advantage of the technology should be studied.

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FORESTRY