

Research Article

Adaptation and Performance Evaluation of 'MAQTRON' Multi Crop Threshing Machine for Threshing Maize, Soya Bean and Wheat

Merga Workesa^{*} , Matiwos Balina

Oromia Agricultural Research Institute, Bako Agricultural Engineering Research Center, Oromia, Ethiopia

Abstract

Threshing is a key part of agriculture that involves removing the seeds or grain from plants from the plant stalk. In most threshing operations the next steps are separation and cleaning seeds from material other than grains. The operation of separation refers to separating threshed grains from bulk plant material such as straw. Most of the topography of the western Oromia farm lands is not affordable for hiring combine harvesters. Nowadays, Different research centers including regional and federal have been manufacturing different models of stationary multi crop threshers. Even though, an effort made to develop and manufacture multi crop thresher is so encouraging most of can't thresh efficiently more than two crop types. The performance of the multi crop thresher was tested at three different drum speeds of (DS1= 750, DS2 = 800 and DS3= 850 rpm and DS1= 480, DS2 = 530 and DS3= 580 rpm), three different feed rates of the crop (FR1 = 1250, FR2 = 2500 and FR3 = 3745 kg/hr. and FR1 = 915, FR2 = 1830 and FR3 = 2745 kg/hr) for wheat and maize crop respectively. Threshing capacity, threshing efficiency, cleaning efficiency and grain loss for wheat crop and shelling capacity, shelling efficiency, cleaning efficiency and mechanical damage for maize crop of the prototype machine were monitored at different drum speeds and feed rates. The maximum threshing capacity of 2066.01 kg/hr was observed at drum speed of 800 rpm and feeding rate of 3750 kg/hr. The maximum shelling capacity of 1817.4 kg/hr was observed at drum speed of 530 rpm and feeding rate of 2745 kg/hr followed by 1803.4 kg/hr at 480 rpm with the same feeding rate.

Keywords

Drum Speed, Performance, Multi Crop, Shelling, Thresher

1. Introduction

Ethiopia is the second largest producer of wheat in Africa (next to Egypt) and produces 5.5 Mt wheat, which is equivalent to 21.7% of wheat produced and 18.3% wheat area harvested in Africa [3]. In terms of acreage wheat ranks fourth next to tef (*Eragrostis tef* Zucc.), maize (*Zea mays* L.), and sorghum (*Sorghum bicolor* L. Moench), respectively [16].

According to Ethiopian Statistics Services wheat accounts for about 12.2% harvested area (1.9 million ha), 20.2% total production and employment for 4.9 million subsistence smallholder farmers. Regionally, the largest volume of wheat originates from Oromia (ca. 53% wheat area and 57-58% of the national production), Amhara (34% wheat area and 28-32%

^{*}Corresponding author: mergaw180@gmail.com (Merga Workesa)

Received: 2 September 2025; **Accepted:** 13 September 2025; **Published:** 10 October 2025



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of the production), SNNP (8% wheat area and 8% of the production) and Tigray (5% wheat area and 3-6% of the production). Threshing is a key part of agriculture that involves removing the seeds or grain from plants from the plant stalk. This may be accomplished by impact between the heads and a fast-moving element, rubbing, squeezing or a combination of these methods [12]. Threshing is breaking grain free from other plant material by applying mechanical force that creates a combination of impact, shear, and/or compression [11].

In most threshing operations the next steps are separation and cleaning seeds from material other than grains. The operation of separation refers to separating threshed grains from bulk plant material such as straw. The cleaning operation uses air to separate fine crop material such as chaff from grain [10]. The three operations can perform in separately /like animal trampling or stationary threshers using forks and winnowing equipment/ or in one machine like combine harvester. In Ethiopia most threshing is done by animal trampling this method is very time consuming and labours activity not only for threshing it is difficult to separate and cleaning.

Most of the topography of the western Oromia farm lands is not affordable for hiring combine harvesters. Nowadays, Different research centers including regional and federal have been manufacturing different models of stationary multi crop threshers. The multi-crop threshers which are used to handle number of crops are highly successful for threshing cereal crops and pulses. The advantage of multi crop threshers is that with minor adjustments it can be used to thresh different crops, whereas other threshers can thresh a particular crop only. In efficient threshing not only requires substantial time but also cause considerable threshing losses of grain. An improved mechanical thresher would improve timeliness of operation and also reduce threshing related losses.

Even though, an effort made to develop and manufacture multi crop thresher is so encouraging most of can't thresh efficiently more than two crop types. This problem arises from lack adjustment made to the machine in line with crop properties while manufacturing. According to [9] the on-farm performance evaluation of the AAERC Asella model-III wheat and barley thresher has the threshing capacity of 353 kg/hr for wheat and an average cleaning efficiency of 88%. Besides to the low capacity and the cleaning efficiency of the threshing machine was driven by ACME engine.

MAQTRON multi crop thresher is an imported threshing machine with high capacity. According an importer the threshing machine is capable to thresh different types of crops such as, rice with rind 18 -30, maize 30-50, soya beans 15-25, wheat and barley 14 -23, rye and oat 14-23, birdseed 8-13, sunflower and lentil 14 -23, sorghum 14-23 and green gram 12-15 quintals/hr. currently we are BAERC has adapt this machine and has evaluated for wheat and maize; from this performance test feedback related capacity of was obtained for the two crops and the manufacturability of the machine was investigated and was being copied at the center level.

Hence, this activity was initiated to develop and evaluate on farm performance of the machine for enhancing quality production and increase farmers income through reduction in machine and operation costs, since the topography of western Oromia is not suitable for combine harvester, especially cereal like wheat and soya bean and maize with objectives of to adapt and on farm performance evaluation of the threshing machine for selected commodity crops, to create awareness and participatory performance evaluation the machine and enhancing farmers know how about the threshing machine and to enhance service provider in engaging with the threshing machine and generating their income.

2. Materials and Methods

This study was planned to adapt and evaluate the threshing and shelling parameters of multi crop threshing machine to assess its performance in terms of threshing and cleaning efficiency. The experiments were done at three levels of wheat crop feeding rates (1250, 2500 and 3750 kg) and threshing cylinder speed (750, 800 and 850 rpm). The feeding was done manually by experienced men laborer. The whole process was replicated three times with different samples of wheat crop and drum speed. Maize (915, 1830 and 2745kg) and threshing cylinder speed (480, 530 and 580 rpm). The production process, percentage of breakage, threshing efficiency, grain damage, grain loss, grain output and cleaning efficiency were calculated for each running test. Detailed procedure of entire research work had been described in subsequent paragraphs including instruments used, prototype manufactured and test conducted.

Experiential Site

The threshing machine was manufactured at Bako Agricultural Engineering Research Center (BAERC), which is located in West Shewa zone. It lies between $9^{\circ} 04' 45''$ to $9^{\circ} 07' 15''$ N latitudes and $37^{\circ} 02'$ to $37^{\circ} 07'$ E longitude in sub-humid agro-ecological zone. The performance evaluation of the threshing machine was carried out at Gobu sayo district on farmer's farm land.

Measuring Devices and Instruments

Laboratory and field equipment/instruments used include:

- 1) A stopwatch with accuracy of 0.02 second;
- 2) A tachometer with revolution measuring ranged from 60.00 to 19,999.00 having an accuracy of 1.00;
- 3) A digital balance with capacity of 5.00 kg and accuracy of 1.00 g to estimate the mass of to measure threshed and shelled crops suspended balance to weight grain with biomass.

Materials

To manufacture the prototype the following materials were used:-

Angle iron, square pipe, sheet metal, wood to manufacture cranking mechanism, different aluminum cast pulleys, iron casts, tires, mild steel shafts, round bars and consumable electrodes.

Determination of physical properties of the crops

Thresher was assessed on its ability to separate grains from straw without damage. In addition to specifying the type and variety, moisture content, size and density of the original material, the average ratio of grain/straw was established for wheat and maize [4]. The physical properties of wheat and maize crops such as moisture content and grain straw ratio were determined by using grain moisture tester instrument.

Determination of crop moisture content

The crop moisture content on wet basis (in the range 10 - 16%) will be determined by oven-dry method, accordingly the moisture of the maize and wheat was determined using moisture tester and found to be 13% and 16% respectively [2].

Grain-Straw Ratio

Grain-straw ratio was determined using the following

procedures. From the material to be threshed, 3 samples were randomly taken of approximately 1 kg for each sample. The samples were placed in containers where the grains and straw will be separated by hand. The straw and grains from each sample will be kept paired and computed using the following as given by [1].

$$Gsr = \frac{\text{weight of the grain from the sample(kg)}}{\text{weight of the straw from the sample(kg)}} \times 100 \quad (1)$$

Description of machine

The multi crop threshing machine consists of the following major component parts; these are feed unit, threshing unit, fan blower unit, straw walker, separation unit and grain out let.

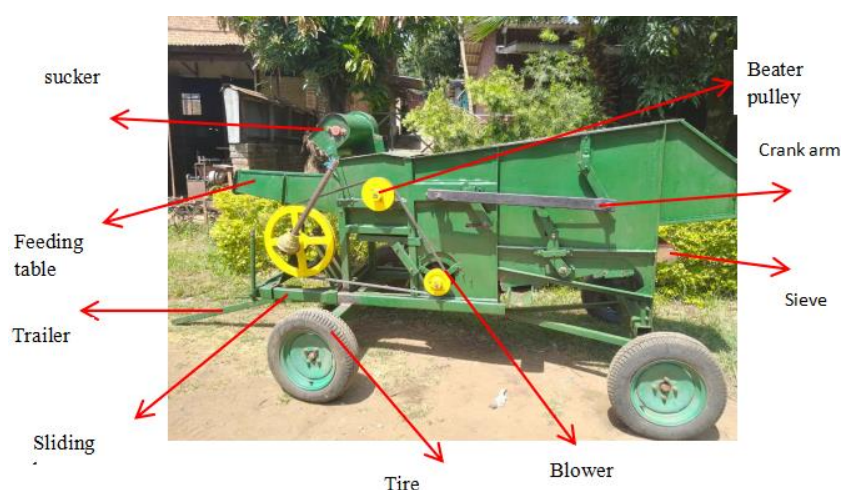


Figure 1. Multi crop Thresher component parts.

Table 1. Specification of Multi crop Threshing machine.

No	Item	Specification
1	Thresher type	Multi crop thresher
2	Threshing drum type	Peg type
3	Drum length (cm)	42
4	Type of pegs	Flat
5	Numbers of pegs	45
6	Numbers of pegs row	9
7	Peg height (cm)	5.5
8	Concave type	Removable
9	Concave length (cm)	42
10	Overall length (cm)	330
11	Width (cm)	170

No	Item	Specification
12	Height (cm)	167

Test and performance evaluation

The thresher was connected to the tractor via a PTO shaft and set up on level ground for testing. For optimal power transmission, the PTO shafts and pulley were axially aligned. Before actually threshing the sample, the thresher was operated without load for a short while to check and clean the threshing drum and sieves. A hand tachometer was used to measure the drum speed while it was in operation. Wheat and maize were the two crops that were weighted sampled for feeding rate, with three treatment levels.

Performance parameters determination

Threshing capacity

Threshing capacity is the weight of grains (whole and damaged) threshed and received per hour at the main grain outlet. At the end of each test, total threshed grain was col-

lected from the main grain outlet. The capacity was calculated using Equation as suggested by [8].

$$TC = \frac{\text{Weight of total grain output main outlet}}{\text{Time recorded (mn)}} \times 60 \quad (2)$$

Threshing efficiency

It is the ratio of threshed grain received from all outlets with respect to total grain input expressed as percentage by weight. For determination of threshing efficiency samples from the straw outlet chaff outlet, main grain outlet and sieve under-flow were collected at equal intervals for each experiment at the outlets. Hence the threshing efficiency was determined using the following equation as suggested by [7].

$$\text{Threshing efficiency} = (1 - \frac{H}{A}) \times 100 \quad (3)$$

Where, H = weight of un-threshed grain, A = Total grain input A = B + C + H = Total grain input B = weight of threshed grain/unit time at main outlet C = Weight of threshed grain /unit time collected at other outlets H= Weight, of un-threshed grain,

Blown out grain percentage

It is calculated by dividing the amount of grain blown out by the weight of all the grain input. Partially broken straw exiting the thresher at the chaff outlet was gathered, and the threshed grain was manually separated using a hand-operated winnower and weighed in order to determine the percentage of blown-out grain [5].

Grain damage percentage

From each of the threshed crop sample were randomly selected. All physically damaged/broken grains were visually observed, manually sorted and weighed using digital balance. Damage due to mechanical threshing was determined as the ratio of weight of the actual damaged kernels to the weight of a sample taken as given by Eqn. below.

$$GD = \frac{\text{weight of broken grain}(g)}{\text{weight of sample taken}(g)} \times 100 \quad (4)$$

Cleaning efficiency

It is defined as the ratio of the weight of clean grain and the grain containing straw expressed in the percentage. For the determination of cleaning efficiency, a representative sample will be taken from the main grain outlets and grains will be separated from the sample and weighed. Cleaning efficiency was calculated according to Equation below.

$$CE = \frac{W}{W_a} \times 100 \quad (5)$$

Where; W = Weight of whole seed at main seed outlet per unit time (kg), W_a = Weight of whole seed at all seed outlet per unit time (kg).

3. Result and Discussion

A prototype of multi crop threshing machine was adapted, manufactured, tested and the performance of the same was evaluated at Bako Agricultural Engineering Research Center. The performance of the threshing machine was assessed in terms of threshing capacity, threshing /shelling efficiencies, shelling capacity and cleaning efficiencies against feed rate, drum speed. The data collected at each test run at different combinations of feed rate and drum speed were subject to ANOVA to determine the level and extent of the effect of the variables on the machine performance.

Determination of grain straw ratio

As noted from Table 2 below four samples from each crops were obtained to investigate the grain straw ratio and grain cob ratio. From the table one can noted that an average grain straw ratio for wheat and maize crop were determined to be 0.56 and 0.74 respectively.

Table 2. Grain straw ration and grain cob ratio for wheat and maize crop.

crop type	samples		Grain straw /cob ratio
	Grain with straw/ cob (gr)	Grain (gr)	
Wheat	282	162	0.57
	282	155	0.55
	282	158	0.56
	282	160	0.57
Average	282	158.75	0.56
	359	268	0.75
Maize	191	140	0.73
	280	208	0.74
	385	290	0.75

crop type	samples		Grain straw /cob ratio
	Grain with straw/ cob (gr)	Grain (gr)	
Average	303.75	226.5	0.74

Performance of the threshing Machine

The effect of drum speeds, and feeding rates on the performance of the threshing machine such as threshing capacity (TC) kg/hr, threshing/shelling efficiency (TE/SE)%, Grain loss (GL%) and mechanical damage (MD%) were assessed as presented below.

Thresher performance parameters

The main effect of the drum speed and feeding rate on the performance parameter indicator of the threshing machine were analyzed and presented in Table 3 below. The statistical analysis, ANOVA, clearly indicated that the threshing effi-

ciency of the machine was significantly ($P < 0.05$) affected by feeding rate while threshing wheat crop. The effects of drum speed and the cross effect of the two factors on the other performance parameters were not significant at $p < 0.05$. As shown in the Table 2 below there is no significant difference between the means of cleaning efficiency, percentage of loss, threshing efficiency as the drum speed increases. The machine maximum threshing capacity of 1056 kg/hr and 1939.7 kg/hr were observed at drum speed of 800 rpm and at feeding rate of 3750 kg/hr respectively. The result agrees with the findings reported by [6].

Table 3. The main effect of drum speed on threshing efficiency, threshing capacity, cleaning efficiency and threshing loss for wheat crop.

CE (%)		GL (%)		TC (kg/hr)		TE (%)	
DS (rpm)	Means	DS (rpm)	Means	DS (rpm)	Means	DS (rpm)	Means
750	99.78 ^a	750	0.35 ^a	750	887.9 ^a	750	97.01 ^a
800	99.45 ^a	800	0.39 ^a	800	1056 ^b	800	97.19 ^a
850	99.29 ^a	850	0.36 ^a	850	1008.6 ^{ab}	850	96.57 ^a
LSD	0.72	0.03		106.17		0.96	
CV	0.7	7.8		9.6		1.3	

LSD: Least significant difference; CV: co-efficient of variation; at 5% level of probability, CE: Cleaning efficiency, GL: Grain loss, TC: Threshing capacity, TE: Threshing efficiency

The effect of feed rate on cleaning efficiency, grain loss, threshing capacity and threshing efficiency are presented in Table 4. As it was noted from the Table 4 the grain loss, threshing capacity and threshing efficiency were highly significant. The maximum cleaning efficiency of 99.53% oc-

curred at feed rate of 1250 kg/hr; while the lowest of 99.47% was recorded at feed rate of 2500 kg/hr. The highest threshing capacity of 1939.7 kg/hr was recorded at highest feeding rate level and 470.1 kg/hr threshing capacity was investigated at lowest feeding rate.

Table 4. The main effect of feeding rate on threshing efficiency, threshing capacity, cleaning efficiency and threshing loss for wheat crop.

CE (%)		GL (%)		TC (kg/hr)		TE (%)	
FR (kg/hr)	Means	FR (kg/hr)	Means	FR (kg/hr)	Means	FR (kg/hr)	Means
1250	99.53 ^a	1250	0.09 ^a	1250	470.1 ^a	1250	97.1 ^a
2500	99.47 ^a	2500	0.45 ^b	2500	542.6 ^a	2500	95.45 ^b
3750	99.52 ^a	3750	0.56 ^c	3750	1939.7 ^b	3750	98.21 ^a

CE (%)		GL (%)		TC (kg/hr)		TE (%)	
FR (kg/hr)	Means	FR (kg/hr)	Means	FR (kg/hr)	Means	FR (kg/hr)	Means
LSD	0.72	0.03		106.17		1.43	
CV	0.7	7.8		9.6		1.3	

LSD: Least significant difference; CV: co-efficient of variation; at 5% level of probability, CE: Cleaning efficiency, GL: Grain loss, TC: Threshing capacity, TE: Threshing efficiency

The combination effect of drum speed and feeding rate performance parameters

The combination effect of drum speed and feeding rate on threshing capacity, cleaning efficiency, threshing efficiency and grain loss for wheat crop is presented as shown in the Table 5 below. As shown from the table the threshing capac-

ity of the machine was increased with an increase in both drum speed and feeding rate and the maximum threshing capacity of 2066.01 kg/hr was observed at drum speed of 800 rpm and feeding rate of 3750 kg/hr. The result agreed with the finding of reported by [13] and [14].

Table 5. The combination effect of drum speed and feeding rate on threshing efficiency, threshing capacity, cleaning efficiency and threshing loss for wheat crop.

Treatment		TC (Kg/hr)	CE (%)	TE (%)	GL (%)
DS (rpm)	FR (Kg/hr)				
750	1250	465.32a	99.56a	97.22a	0.1a
	2500	633.17a	99.56a	95.65a	0.5a
	3750	1834.44b	99.8a	98.16ab	0.61b
800	1250	477.01a	99.43a	97.44a	0.09a
	2500	477.01a	99.13a	95.77a	0.52c
	3750	2066.01c	99.8a	98.35ab	0.56c
850	1250	468.04a	99.6a	96.64a	0.09a
	2500	638.97a	99.3a	94.94a	0.49cd
	3750	1918.73bc	98.95a	98.13ab	0.51c
LSD		183.89	1.24	2.32	0.06
CV		9.6	0.7	1.3	7.8

LSD: Least significant difference; CV: co-efficient of variation; at 5% level of probability, CE: Cleaning efficiency, GL: Grain loss, TC: Threshing capacity, TE: Threshing efficiency

The performance parameters of the machine for maize shelling

The prototype machine was also evaluated for maize crop dehulling by inter changing the removable concave and pulley ratio. Each test run was subjected to the analysis of variance and the main effect of the drum speed and feeding rate of the machine on mechanical damage percent and shelling capacity of the multi crop threshing machine was shown in the following Table 6. The ANOVA table shows the main effect of drum speed on mechanical damage percent

and shelling capacity was not significant at 5% significance level. Unlike to drum speed the main effect of the feeding rate on mechanical damage and shelling capacity were significant. The maximum mechanical damage of 5.67% and 5.84% were recorded at drum speed of 580 rpm and feeding rate 2745 kg/hr and maximum shelling capacity of 1260.8 kg/hr and 1825.1 kg/hr at the same drum speed and feeding rate respectively. The finding obtained is in agreement with the result reported on multi crop thresher by [15].

Table 6. The main effect of drum speed and feeding rate on s shelling capacity and mechanical damage for maize crop.

MD (%)				SC (kg/hr)			
DS (rpm)	Means	FR (Kg/hr)	Means	DS (rpm)	Means	FR (Kg/hr)	Means
480	5.60a	915	5.78a	480	1228.7a	915	666.0a
530	5.56a	1830	5.20b	530	1242.5a	1830	1240.9b
580	5.67a	2745	5.84a	580	1260.8a	2745	1825.1c

DS: Drum speed, FR: Feeding Rate, MD: Mechanical Damage, SC: Shelling Capacity

Table 7 below reveals that the shelling efficiency and cleaning efficiency of the multi crop threshing machine highly efficient. During the performance evaluation of the machine the quality of cob was observed and the cob break-

age was investigated to be high for all drum speed with two double comb, one simple comb and one flat comb removable concave arrangement.

Table 7. The main effect of drum speed and feeding rate on shelling efficiency, cleaning efficiency for maize crop.

SE (%)				CE			
DS (rpm)	Means	FR (Kg/hr)	Means	DS (rpm)	Means	FR (Kg/hr)	Means
480	100	915	100	480	100	915	100
530	100	1830	100	530	100	1830	100
580	100	2745	100	580	100	2745	100

DS: Drum speed, FR: Feeding Rate, SE: Shelling Efficiency ans CE: Cleaning Efficiency

Combination effect of drum speed and feeding rate

The combination effect of drum speed and feeding rate on shelling capacity, cleaning efficiency, shelling efficiency and Mechanical damage for maize crop is presented as shown in the Table 8 below. As noted from the table the shelling capacity of the machine was increased with an increase feeding rate and the

maximum shelling capacity of 1817.4 kg/hr was observed at drum speed of 530 rpm and feeding rate of 2745 kg/hr followed by 1803.4 kg/hr at 480 rpm with the same feeding rate. As it was observed from ANOVA table the cross effect of the drum speed and feeding rate has no significant effect on the shelling capacity and mechanical damage percentage.

Table 8. The combination effect of drum speed and feeding rate on threshing efficiency, threshing capacity, cleaning efficiency and threshing loss for wheat crop.

Treatment		SC (Kg/hr)	CE (%)	SE (%)	MD (%)
DS (rpm)	FR (kg/hr)				
480	915	663.1	100	100	6.00
	1830	1219.5	100	100	4.87
	2745	1803.4	100	100	5.93
530	915	651.6	100	100	5.60
	1830	1258.6	100	100	5.33

Treatment		SC (Kg/hr)	CE (%)	SE (%)	MD (%)
DS (rpm)	FR (kg/hr)				
580	2745	1817.4	100	100	5.73
	915	683.3	100	100	5.73
	1830	1244.5	100	100	5.40
	2745	1244.5	100	100	5.87
LSD		72.43			0.65
CV		3.1			6.20

LSD: Least significant difference; CV: co-efficient of variation; at 5% level of probability, CE: Cleaning efficiency, MD: Mechanical Damage, SC: Shelling capacity, SE: Shelling efficiency

4. Conclusion and Recommendation

4.1. Conclusion

As a follow up of efforts made earlier, this study was conducted at Bako Agricultural Engineering Research Center to adapt and evaluate the performance of a multi crop threshing machine for wheat and maize crop. The machine has threshing unit, straw walker, power transmission units, cleaning unit and grain delivery as major components.

Field testing plans were prepared as per statistical protocols; data were collected and analyzed using computer software. The investigation included evaluation of the effect of drum speed and feed rate on threshing capacity, threshing efficiency, shelling capacity, shelling efficiency, grain loss percentage and mechanical damage percentage analysis of the machine was part of the study. During testing and performance evaluation of the prototype threshing machine, three drum speeds ($V_1 = 750$, $V_2 = 800$ and $V_3 = 850$ rpm) and three feed rates ($Fr_1 = 1250$, $Fr_2 = 2500$ and $Fr_3 = 3750$ kg/hr) and three drum speeds ($V_1 = 480$, $V_2 = 530$ and $V_3 = 580$ rpm) and three feed rates ($Fr_1 = 915$, $Fr_2 = 1830$ and $Fr_3 = 2745$ kg/hr) were considered as independent variables for wheat and maize respectively.

Threshing capacity, threshing efficiency, cleaning efficiency and grain loss for wheat crop and shelling capacity, shelling efficiency, cleaning efficiency and mechanical damage for maize crop of the prototype machine were monitored at different drum speeds and feed rates. Accordingly the following conclusion were drawn:

- 1) The maximum threshing capacity of 2066.01 kg/hr was observed at drum speed of 800 rpm and feeding rate of 3750 kg/hr.
- 2) The maximum cleaning efficiency of 99.53% occurred at feed rate of 1250 kg/hr; while the lowest of 99.47% was recorded at feed rate of 2500 kg/hr.
- 3) The maximum shelling capacity of 1817.4 kg/hr was

observed at drum speed of 530 rpm and feeding rate of 2745 kg/hr followed by 1803.4 kg/hr at 480 rpm with the same feeding rate.

- 4) The maximum mechanical damage of 5.67% and 5.84% were recorded at drum speed of 580 rpm and feeding rate 2745 kg/hr.

4.2. Recommendation

The traditional method of threshing and shelling crops is full of drudgery and consuming much time, needs to be modernized through the introduction of appropriate threshing machines. Consequently, there is a significant demand for multi-crop machines. However, the prototype of the machine seems to be quite intricate to produce, despite its satisfactory performance.

Thus, the following recommendations were made:

- 1) Due to seasonality of the crop the prototype was not evaluated for soya bean, it must be evaluated for this crop.
- 2) The machine was highly recommended to the end users with the current status.
- 3) The capacity of the prototype appears to be low since the machine was evaluated for irrigated wheat and low yield maize; in general this calls for further testing and re-evaluation of the prototype machine over location.
- 4) Drum speed greater than 580 rpm is no required to de-husk and shell maize crop using this machine.

Abbreviations

AAERC	Asella Agricultural Engineering Research Center
BAERC	Bako Agricultural Engineering Research Center
DS	Drum Speed
FR	Feed Rate
RPM	Revolution Per Minute

Conflicts of Interest

The authors declare no conflicts of interest.

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