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Performance Evaluation Of Jima Drum Replaceable Multi-Crop Thresher For Wheat And Barley Threshing

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ABSTRACT

The Jima drum replaceable multi-crop thresher which was produced at Jima agricultural engineering research center was evaluated in Fedis agricultural research center for threshing performance of the crops wheat and barley. During evaluation the basic variables that given-attention were feed rates (kg/min), machine speeds (rpm) and crop types. The performance evaluation was done for wheat and barley crops at their average temperature 210C, average moisture content 12.25 % and at constant inlet 20mm, central-beneath 50mm and out-let 20mm drum-concave clearance of the machine. The results obtained were threshing efficiency varied in the range of 99.03% to 99.82% for wheat crop and 97.10% to 100% for barley. Its output capacity was 2.25 to 2.5qt/h and 2.2 to 2.86 qt/h for wheat and barley respectively.

KEYWORDS

Thresher, performance evaluation, variables, threshing efficiency, output capacity.

INTRODUCTION

The term threshing can be defined as the process of detaching grains from the heads or from the plants. Threshing separates grains from panicles, cops and pods. Threshing or detaching the kernels from the ears or pods is accomplished by combination of impact and rubbing action. While the conventional tangential threshing unit threshes mostly by impact other threshing devices like rotary threshing units act more by rubbing (Bill et al., 1999).

A threshing is on the principle that when; some input or pounding is given on crops the grains

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is separate from panicles, cops and pods. The crop mass passes through a gap between drum and concave wearing or rubbing action takes place this separates grain form panicles. Thus rupture of the bond between the grain ears is due to the factor, like: impact of beaters or spikes over grain and wearing or rubbing action; the strength of bond between the grain and panicles depends up on type, variety, ripening phase and moisture content of crop (Dr Jagdish, 2010).

In Ethiopia as well as in the Oromia region most of threshing operation was done manually (by hand). Few threshing operations are done by using combine harvesters and some engine driven threshers. For threshing of wheat and barley crop Asela wheat and barley thresher is utilized in limited areas. In East Harerghe Zone utilization of wheat and barley thresher is almost nothing. Due to that farmers are lost their time, money and energy for traditional threshing.

So, the objective of this study was to do the performance evaluation of this machine and if there was drawback plus inconveniences for threshing wheat and barley crops, to made improvement work on the machine, consequently by preparing the appropriate thresher, solving threshing problems of wheat and barley producer farmers of our mandate area.

MATERIALS AND METHODS

Experimental materials

The basic experimental materials were used:- Jima drum replaceable multi-crop thresher (figure.1), 12hp Akmi engine, un-threshed wheat and barley harvests, tachometer, DRAMINSKI moister meter, digital balance weight, a stopwatch and caliper.

Experimental Site

The performance evaluation test was done in east Hararghe zone, at Garamuleta (Grawa) district at the place known as Rasa jeneta, which is found near to in the iterance direction of Grawa town. The site is the major wheat and barley growing area in the Zone. The experiment was done using the farmer's harvest.

Figure1. Drum replaceable Jima multi- crop thresher

Experimental Design

Grain throughput capacity, T_C (kg/h)

This is the capacity of the thresher in terms of the total quantity of threshed materials in sample per unit time.

$$T_c = \frac{Q_s}{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: Q_s = Quantity of threshed grain will be collected after a threshing operation (kg)

T = Time for a complete threshing operation (h)

Threshing efficiency, T_e (%)

This parameter will be used to determine the threshing ability of the threshers.

$$T_e = 100 - \frac{Q_u}{Q_t} * 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where: Q_u = quantity of un-threshed grains in sample (kg)

Q_t = Total quantity of grain in sample (kg)

Mechanical grain damage, M_d (%)

This parameter will be used to determine the quantity of grains damaged during threshing.

$$M_d = \frac{Q_b}{Q_t} * 100\% \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where: Q_b = quantity of broken grains in sample (kg)

Moisture Content of the grain, M_c %

The moisture content of the grain will be determine using oven drying in which the sample will dried at 130°C for 18 hours and moisture content on wet basis will being obtained from the equation below (ASAE, 1972). In our case the moisture content of samples were determined using DRAMINSKI moister meter

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$$M_c = \frac{W_i - W_d}{W_i} * 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

M_c= moisture contain (%)

W_i = initial weight of sample (kg)

W_d = dried weight of sample (kg)

Diameter of the grain, D_e(mm)

The diameter of grain was calculated tri-axially (along its three axis) and geometric mean diameter (Mohsenin, 1980).

$$D_e = (\text{abc})^{1/3} \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (5)$$

Where, a, b, c = diameters along three axes.

Bulk density, β (kg/m^3)

The bulk density of the grain and straw were determined using the following formula (Mohsenin, 1980).

$$\beta = \frac{m}{v} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where: m = mass of grain, chaff or straw (kg), v = volume of container (m^3)

EXPERIMENTAL METHOD

The thresher was driven with 12hp *Akmi* engine. Two crops; wheat and barley, three levels of cylinder speed 1300, 1400, and 1500 and three levels of wheat and barley feed rates; 5 kg/min, 10 kg/min and 15 kg/min and at constant inlet 20mm, central-beneath 50mm and out-let 20mm drum-concave clearance. Moisture content of the wheat grain was 12.3% and its grain straw ratio 62.1%, for barley crop.

For wheat crop moister content was 12.2 % and grain straw ratio 53.4%.

The selected experimental design for this study was RCBD design with three replications. During the test operations, the selected weight of wheat and barley were fed through the inlet part of the machine by an operator and the threshed outputs were collected from the outlets. Three samples were taken from each test of main and straw out let. From each sample pure, with husk, un-threshed and broken grain were separated, weighed and then, the result was recorded.

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The above procedure was repeated thrice for all combinations of wheat and barley with cylinder-concave clearance, rpm and feed rate. The selected design was used to analyze the obtained data during the experiment. Accordingly, the two types of crops wheat and barley were taken as the main plot treatment factors, three speeds as sub-plot treatment factors, three feed rates as sub-plot-plot and treatment factors with three replications as block. To analyze the treatment factors by split plot design laid down (2x3x3) x3 factorial combinations with three replications, which result 54 numbers of trials.

RESULTS AND DISCUSSIONS

Using GenStat released 16.1 (sixteenth edition) the processed data for wheat crop at constant inlet 20mm, central-beneath 50mm and out-let 20mm drum-concave clearance was analyzed and the following results obtained. Coefficient of variation (CV) was 0.3% for pure grain and 61.6 % for broken grain. Least significant deferent (0.05) values for pure and broken grain were 0.477and 0.515 % respectively. During the test it was observed that the threshing efficiency of the machine was varied in a range of 99.03% to 99.82%. Maximum threshing efficiency of 99.82% was obtained at speed of drum 1400 rpm and feed rate of 10 kg/min. The 99.03 % or minimum threshing efficiency of the machine was observed at feed rate of 10 kg/ min and speed of 1500 rpm. From those results it can be said that threshing efficiency increases with increasing drum speed in a given range then decrease (see table 1).

The highest broken grain of 0.96% was noticed at feed rate of 10 kg/min and 1500 rpm speed of the drum. However, the lowest broken grain percentage was 0.181 % obtained at the feed rate of 10 kg/min and 1400 rpm speed of the drum. From the results obtained it can be said that increasing cylinder speed above the range raises grain breakage.

Table.1. Effect of drum speed and feed rate on threshing efficiency and grain damage for wheat crop.

Parameter		Threshing Efficiency (Mean)	Broken Grain (Mean)
Crop types	wheat		
Drum speed (rpm)	Feed rate		
	5kg/min 10 kg/min 15kg/min		
1300	S1xF1	99.54[a]	0.463[a]
	S1xF2	99.76[a]	0.240[a]
	S1XF3	99.13[a]	0.867[a]

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1400	S2XF1	99.77[a]	0.2366[a]
	S2XF2	99.82[a]	0.1810[a]
	S2x F3	99.81[a]	0.1933[a]
1500	S3XF1	99.13[a]	0.8700[a]
	S3XF2	99.03[a]	0.9600[a]
	S3XF3	99.34[a]	0.6566[a]
Mean		99.48	0.52
LSD (0.05)		0.477	0.515

For barley crop maximum threshing efficiency 100 % was recorded at feed rate of 5 kg/min and 1300 rpm and speed of drum. While, the minimum threshing efficiency 97.10 % was seen at a feed rate of 5 kg/min and 1500 rpm speed of drum (see table 2). Un-threshed grain had been one of the independent variable which was considered in the experiment whereas, at the time of data collection on both wheat and barley crop visible un-threshed grain had not seen.

Table.2. Effect of drum speed and feed rate on threshing efficiency and grain damage for barley crop

Parameter		Threshing Efficiency (Mean)	Broken grain
Crop types	Barely		
Drum speed (rpm)	Feed rate		
	5kg/min 10 kg/min 15kg/min		
1300	S1xF1	100[a]	0[a]
	S1xF2	99.96[a]	0.0333[a]
	S1XF3	99.93[a]	0.0746[a]
1400	S2XF1	99.92[a]	0.0776[a]
	S2XF2	99.916[a]	0.0833[a]
	S2x F3	99.86[a]	0.1363[a]
1500	S3XF1	97.10[c]	2.8995[c]
	S3XF2	97.31[c]	2.6900[c]
	S3XF3	98.23[b]	1.7678[b]
Mean		99.14	0.8625
LSD (0.05)		0.646	0.646

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The output capacity of the machine was evaluated for both wheat and barley crops with long duration test by means of three samples intended for wheat and barley crops harvest 7.5 qt, 11.5qt, 20.5 qt and 1qt, 2.5qt, 5.5q respectively. It was done at recommended feed rate 10 kg/min and drum speed 1400 rpm for wheat crop. Also for barley crop feed rate 5 kg/min and drum speed were 1300 rpm along with considering recommended moister content of the grain. Long duration test result was indicated that the machine output capacity was between 2.25-2.5qt/hr for wheat and 2.2-2.86 qt/h for barley crop. Due to its grain straw ratio value barley was showed greater output capacity of the machine than wheat. The evaluated Jima drum replaceable multi-crop thresher does not incorporate the cleaning system as a result, both the grain, small-size straws and dust particles were un-ceparetely come-out in grain outlet of the machine. The average specific fuel consumption was observed 0.138 lit/qt and 0.113 lit/qt for wheat and barley respectively (see figure 2 and 3).

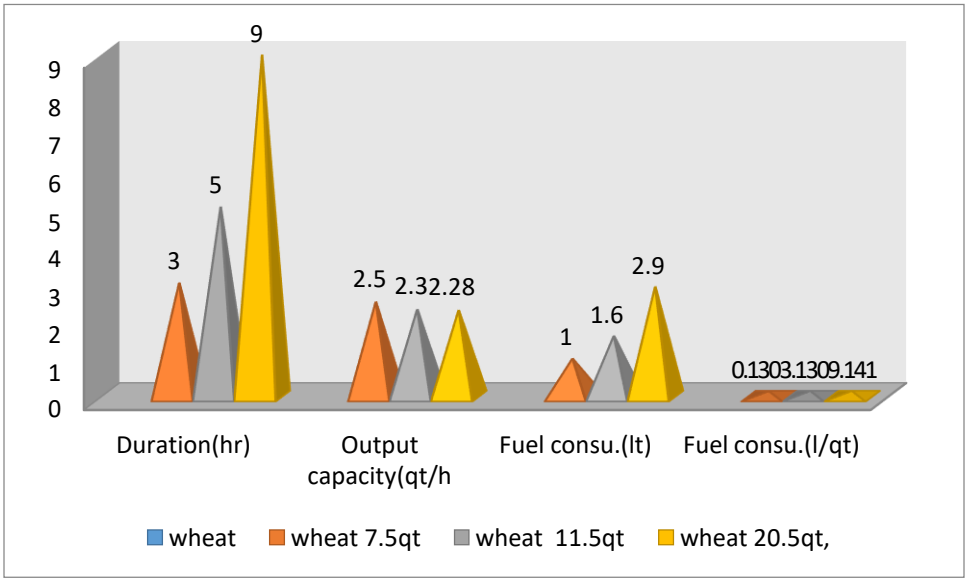

Figure2. Long duration test of drum replaceable Jima multi- crop thresher on wheat crop

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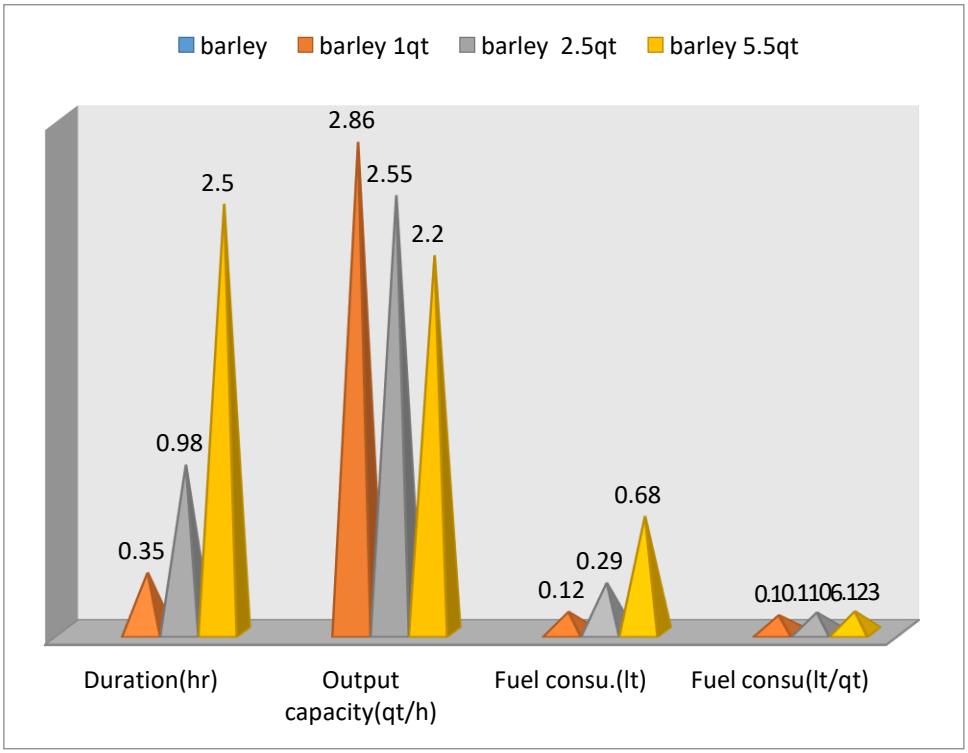

Figure3. Long duration test of drum replaceable Jima multi- crop thresher on barley crop

CONCLUSION AND RECOMMENDATION

The evaluated thresher was found to be best in threshing efficiency for both crops, 99.03% - 99.82%, for wheat and 97.1 - 100% meant for barley. It is above the recommended value. The optimum conditions for thresher evaluation were set for threshing efficiency being 95% (Singhal and Thierstein, 1987). The obtained threshing capacity was between 2.25-2.5qt/hr for wheat and 2.2-2.86 qt/h for barley. The machine doesn't have cleaning system the evaluation regarding cleaning system wasn't done so, the machine needs improvement work by incorporate cleaning system for attaining full system of the machine. Broken grain for wheat crop was between 0.19 – 0.87 % which is below the standard of 2% maximum (Sharma *et al*., 1984). However for barley crop it is in the range of 0 - 2.9 which is above the permissible percentage.

To get maximum efficiency, output capacity and minimum breakage (for wheat =0.46% and for barley=0%) users should adjust the drum speed on 1400 rpm, and feed rate at 10 kg/min for wheat and for barley adjust drum speed on 1300 rpm and feed rate at 5 kg/min, and considering recommended moister content of the grain is important. At the time of feeding the machine, the drum was pushed back grains, straw and dust particles which were

blown on operator face and into the ground so that, an improvement work should be done on feeding table. An improvement work also should be done on engine set for weight reduction. Finally, the obtained machine performance was found to be in the acceptable ranges and taken as good results, therefore it is suggested that, the machine should be multiplied and promoted (disseminated) for farmers, to reduce the drudgery of wheat and barley threshing and grain losses.

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