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RESEARCH ARTICLE

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ADAPTATION AND EVALUATION OF JAPAN MODEL ENGINE OPERATED WINNOWER

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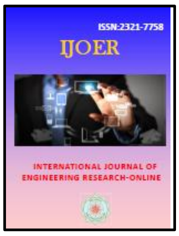

ABSTRACT

Cleaning practice for most agricultural grain is traditional at present. These methods are one of the most time consuming with the associated fatigue and low output. The cleaning operation using local equipment such as darba, afarsa, korbi, gundo, sieve and other accessories. To overcome these problems, a diesel engine operated cleaner had been adopted and evaluated for wheat and maize. The experimental was conducted in a split- plot design having fan speeds in main plots and feeding rates in sub-plots with three replications as block. The machine that was adopted was evaluated for its performance indices in respect of cleaning capacity, cleaning efficiency and cleaning loss at different fan speed and feed rate. According to the results obtained, concerning cleaning capacity (kg/h), cleaning efficiency (%) and cleaning loss (%).The prototype of adopted cleaner appears to be most efficient at fan speed of 410, 475rpm and the feed rate of 22.00, 22.8 kg/min for maize and wheat respectively.

Key words: Cleaning, Winnower and Evaluation

INTRODUCTION

Cereals are grown in almost all regions of Ethiopia with notable variation in the extent of areas planted and the volume of production obtained. This variation is seemingly caused by a shift in choice of crops by the holders and difference in weather conditions. The size of area planted to maize and wheat and volume of production of the same crops harvested in Oromia Region were 906,267.31, 609,912.36 ha and 17,450,664.01, 8,835,745.98qun respectively (CSA, 2002).

Harvesting and post-harvest handling methods introduce contaminants such as stones, sticks, Chaff and dust (Ogunlowo and Adesuyi, 1999) into grains, which needs to be cleaned. Materials from the threshing unit are mixtures of long stalks, chaff, small fragments of Spikes, stalks, leaves and grains. Cleaning practice for most agricultural grain is traditional at present. These methods are one of the most time consuming with the associated fatigue and low output. The cleaning operation using local equipment such as darba, afarsa, korbi, gundo, sieve and other accessories. To overcome these problems, a diesel engine operated cleaner had been adopted and evaluated for wheat and maize.

Objectives of the studies:

- To adopt Japan model engine operated winnower and
- To evaluate its performances

MATERIALS AND METHOD

Experimental Site

The experiment was conducted at Westshao zone Ginchiwereda and West Wellegasibu sire wereda.

Description of the Machine

The major components of the Japan model engine operated winnower are frame, feed table and cleaning unit (fan and sieve).

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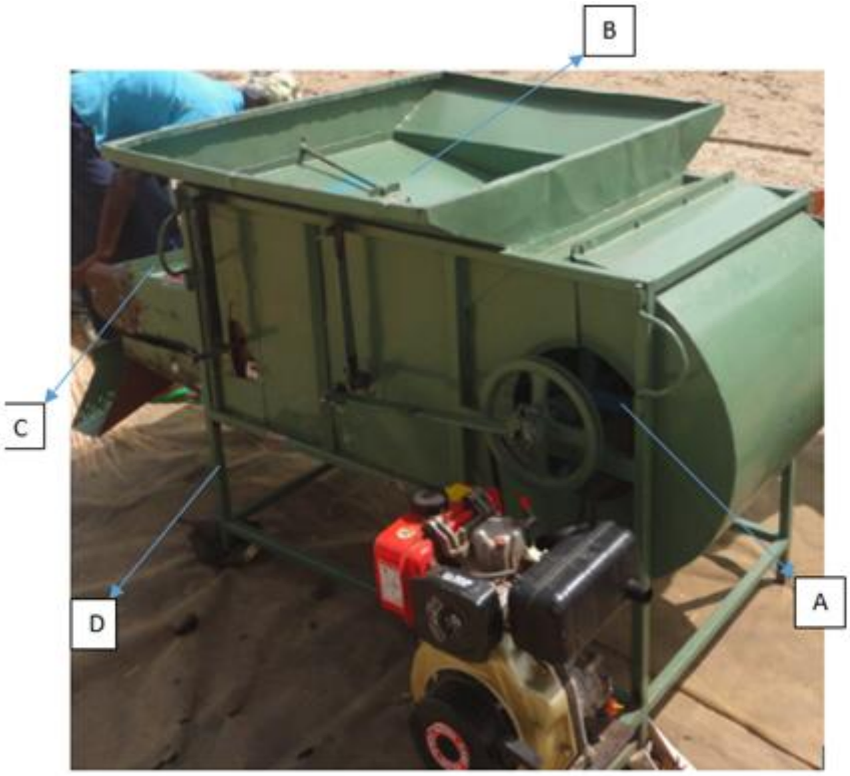

Figure 1: The Prototype of the winnower (A-Fan, B-Feed table, C-sieve, D-frame)

The frame is constructed from 40 mm by 40 mm square pipe. The feed table has adjustable inlet that feeds the crop to be winnowed to the cleaning unit and constructed from 1.50mm thick sheet metal. The fan house was also constructed from 1.50 mm thick sheet metal and meant to accommodate the fan blade and shaft. The cleaning unit had two sieves (φ8mm and φ12mm sieve holes for wheat and maize respectively), sieve housing at bottom and side and husk and grain outlet. A 5 hpkama diesel engine was used as source of power.

Measuring Devices and Instruments

A digital balance, Japan made, an accuracy of 0.01 g. Cole-Parmer 8204 tachometer, with measuring range of 62 to 19999 rpm and having a resolution of 1rpm (over, 1000 rpm) was used to measure the speeds of cylinder.

Preparation of Samples

The performances of the machine were evaluated with 10, 15 and 20kg of hand-cleaned wheat and maize (debris-free) mixed with 1.4, 2.1 and 2.8 and 1, 1.5 and 2kg of chaff and broken stems or cobs for wheat and maize respectively.

Performance Evaluation

During each experiment, materials leaving through chaff and grain outlet were weighted using digital balance in order to determine the cleaning capacity, cleaning efficiency and cleaning loss.

As per Ismail et al., 1994 cleaning capacity, cleaning efficiency and cleaning loss were calculated using the following formulas.

$$CC(kg/hr) = \frac{M_s}{T}$$

$$CE(\%) = \frac{M_{cw}}{M_{cw} + M_{ck}} X100\%$$

$$CL(\%) = \frac{M_{gl}}{M_{cg}} X100\%$$

Where: Ms = the mass of sample feed to feed table (kg), T = time of winnowing operation (hr), Mcw = quantity of winnowed chaff, kg, Mck = quantity of chaff goes with grains/kernels, kg, Mcw = the mass of grains or kernels loss behind the machine, kg, Mcw = the mass of clean grains or kernels at the collector, kg.

Experimental Design and Treatment

The experimental was conducted in a split-plot design having fan speeds in main plots and feeding rates in sub-plots with three replications as block. The design was laid as 23 factorial combinations in three replicates as block giving 27 total experimental units (3x3x3 = 27).

The details of the treatments were:

Three levels of fan speeds V1 = 335rpm, V2= 375rpm and V3 = 410rpm for maize and V1 = 335rpm, V2= 410rpm and V3 = 475rpm for wheat. Three levels of feeding rates F1 = 11.00kg/min, F2 =16.50kg/min and F3 = 22.00 kg/min for maize and F1 = 11.40kg/min, F2 =17.10kg/min and F3 = 22.80 kg/min for wheat.

Statistical Analysis

Data were subjected to analysis of variance using statically producer as described by Gomez and Gomez (1984). Analysis was made using Gen Stat 15th edition statistical software. When the treatments effects were found significant, LSD test was performed to assess the difference among the treatments at 5% level of significance.

RESULT AND DISCUSSION

Performance of the Prototype Machine for Maize

Cleaning Capacity

ANOVA, clearly indicated that the cleaning capacity of the prototype winnower was highly significantly ($P < 0.01$) affected by fan speed and feed rate. The combined effect of fan speed and feed rate was also significant at the 5% significance level. The maximum cleaning capacity of 913.87 kg/hr was recorded when the fan speed was 410 rpm and the feed rate was 22 kg/min.

Multiple regression analysis was made to obtained relationship

$Y = 179.692 + 0.824*V +16.384*F$

$R^2 = 0.97$

Cleaning capacity was dominantly affected by feed rate than fan speed. Generally, cleaning capacity increased by increasing the fan speed and feed rate (Table 1).

Cleaning Efficiency

Analysis of variance made indicates that the effect of fan speed and feed rate were highly significant ($p<0.01$) on cleaning efficiency. The combined effect of fan speed and feed rate has no significant effect on cleaning efficiency at 1 and 5% significance level. The maximum cleaning efficiency of 92.50% was recorded when the fan speed was 410 rpm and the feed rate was 11 kg/min. Generally, cleaning efficiency increased by increasing the fan speed and decreased as feed rate increasing (Table 1).

Multiple regression analysis was made to obtained relationship

$Y = 69.311 +0.048* V -0.079*F$ $R^2 = 0.72$

Table 1. Mean table of cleaning capacity and efficiency of the prototype on maize

Parameter	Source of variation							
CC (kg/hr)	Interaction (VXF)				Fan speed		Feed rate	
	Speed levels	Feed rate			levels	Mean	levels	Mean
		F_1	F_2	F_3				
	V_1	638.82	758.49	822.28	V_1	739.86	F_1	690.80
	V_2	691.02	810.23	876.92	V_2	792.72	F_2	809.90
	V_3	742.56	860.99	913.87	V_3	839.14	F_3	871.02
	LSD (5%)	6.44			LSD (5%)	3.72	3.72	
	SE (M)	1.98			SE (M)	1.14	1.14	
CE (%)	Interaction (VXF)				Fan speed		Feed rate	
	Speed levels	Feed rate			levels	Mean	levels	Mean
		F_1	F_2	F_3				
	V_1	87.45	81.72	79.67	V_1	82.95	F_1	90.46
	V_2	91.43	85.97	83.00	V_2	86.80	F_2	85.12
	V_3	92.50	87.67	86.00	V_3	88.72	F_3	82.89
	LSD (5%)	2.70			LSD (5%)	1.56	1.56	
	SE (M)	0.83			SE (M)	0.48	0.48	

Performance of the Prototype Machine for Wheat Cleaning Capacity

ANOVA, clearly indicated that the cleaning capacity of the prototype winnower was highly significantly ($P < 0.01$) affected by fan speed and feed rate. The combined effect of fan speed and feed rate has no significant effect on cleaning capacity at the 1 and 5% significance level. The maximum cleaning capacity of 584.09 kg/hr was recorded when the fan speed was 475 rpm and the feed rate was 22.8 kg/min. Generally, cleaning capacity increased by increasing the fan speed and feed rate (Table 2.).

Multiple regression analysis was made to obtained relationship

$Y= -4.365 +1.049*V +4.027*F \quad R^2 = 0.994$

Cleaning capacity was dominantly affected by feed rate than fan speed and both of them have direct relationship with it.

Cleaning Efficiency

Analysis of variance made indicates that the effect of fan speed and feed rate were highly significant ($p<0.01$) on cleaning efficiency. The maximum cleaning efficiency of 92.86% was recorded when the fan speed was 475.00 rpm and the feed rate was 11.40 kg/min. Generally, cleaning efficiency increased by increasing the fan speed and decreased as feed rate increasing (Table 2.).

Multiple regression analysis was made to obtained relationship

$Y = 72.774 +0.053*V -0.463*F \quad R^2 = 0.967$

Cleaning efficiency has direct relationship with fan speed but inverse relationship with feed rate

Cleaning Loss

Analysis of variance made indicates that the effect of feed rate and fan speed were highly significant ($p<0.01$) on cleaning loss. The combined effect of fan speed and feed rate has no significant effect on cleaning loss at the 1 and 5% significance level. The maximum cleaning loss of 1.57% was recorded when the fan speed was 475.00 rpm and the feed rate was 22.80 kg/min. Generally, cleaning loss increased by increasing the fan speed and feed rate.

Multiple regression analysis was made to obtained relationship

$Y= -0.215 +0.003*V +0.019*F \quad R^2= 0.963$

Cleaning loss was dominantly affected by feed rate than fan speed and it has direct relationship with both fan speed and feed rate. Hollatz and Quick (2003) reported that at higher feed rate, material particles were no longer supported aerodynamically, which forms a mat on sieve, increasing grain losses.

Table 2. Mean table of cleaning capacity and efficiency of the prototype on wheat

Parameter	Source of variation							
	Interaction (VXF)				Fan speed		Feed rate	
	Speed levels	Feed rate			levels	Mean	levels	Mean
		F_1	F_2	F_3				
CC (kg/hr)	V_1	419.64	435.51	461.14	V1	438.76	F1	475.47
	V_2	462.39	492.65	518.89	V2	491.31	F2	497.62
	V_3	544.38	564.69	584.09	V3	564.39	F3	521.37
	LSD (5%)	13.29			LSD (5%)	7.67	7.67	
	SE (M)	4.08			SE (M)	2.35	2.35	
	Interaction (VXF)				Fan speed		Feed rate	
	Speed levels	Feed rate			levels	Mean	levels	Mean
		F_1	F_2	F_3				
CE (%)	V_1	86.82	84.54	80.14	V_1	83.77	F_1	89.29
	V_2	88.38	87.08	82.43	V_2	86.79	F_2	87.43
	V_3	92.86	90.47	87.20	V_3	90.18	F_3	84.01
	LSD (5%)	1.14			LSD (5%)	0.66	0.66	
	SE (M)	0.35			SE (M)	0.20	0.20	
	Interaction (VXF)				Fan speed		Feed rate	
	Speed levels	Feed rate			levels	Men	levels	Mean
		F_1	F_2	F_3				
CL (%)	V_1	0.99	1.08	1.19	V_1	1.08	F_1	1.13
	V_2	1.12	1.19	1.28	V_2	1.20	F_2	1.21
	V_3	1.28	1.38	1.57	V_3	1.41	F_3	1.35
	LSD (5%)	0.11			LSD (5%)	0.06	0.06	
	SE (M)	0.03			SE (M)	0.02	0.02	

CONCLUSIONS AND RECOMMENDATION

Cleaning practice for wheat and maize is traditional at present. These methods are one of the most time consuming with the associated fatigue and low output. To overcome these problems, a diesel engine operated wheat and maize cleaner had been adopted and evaluated.

The machine that was adopted was evaluated for its performance indices in respect of cleaning capacity, cleaning efficiency and cleaning loss at different fan speed and feed rate. According to the results obtained, concerning cleaning capacity (kg/h), cleaning efficiency (%) and cleaning loss (%), it can be concluded that the performance of the prototype machine is very much acceptable with high prospect for extending the technology.

Recommendation

The prototype of adopted cleaner appears to be most efficient at fan speed of 410, 475rpm and the feed rate of 22.00, 22.8 kg/min for maize and wheat respectively. Nonetheless, it is recommended that: The machine be re-evaluated at more fan speeds and feed rates for other crops using appropriate sieves.

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Reference

CSA, 2007. Agricultural sample survey of area and production of crops of 2006/2007 in Ethiopia Government annual report on area and production of crops, Addis Ababa, Ethiopia

Gomez, A.K. and A.A. Gomez, 1984.Statistical Procedures for Agricultural Research. Shirgley.J.E., 1980.Engineering design, 4th edition, McGraw-Hill Coy, NY.

Hollatz, B and G. R. Quick. 2003. Combine tailings returns, part 1: the effects of combine performance and settings on tailings. In e-Proceedings of the International Conference on Crop Harvesting and Processing. Kentucky USA.ASAE Publication Number 701P1103e. St Joseph, Mich. ASAE. 22 Pp .

Ismail Z E, Hanna K F, Kassem M A. Factors affecting grain cleaning efficiency. Misr J Agric Engng, 1994; 11(1): 227—238.

Ogunlowo, A.S. &Adesuyi, A.S. 1999.Alow cost rice cleaning/destining machine Agricultural Mechanization in Asia, Africa and Latin America, 30(1) 20 -24.