The Performance Evaluating of Thresher Machine Attached to the Tractor

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Abstract— *This research carried out for the purpose of field performance study of the wheat crop threshing machine locally manufactured. The experiments were carried out in Diq village of directors Jhran province of Dhamar governorate. Under different crop feed rate (10 kg, 15 kg and 20 kg) and different thresher drum speed (1400 rpm and 1600 rpm). The Fiat 640 (64hp, 47.7 kW) Tractor was used to run the thresher machine and evaluate the field performance of the thresher. The results showed that the field capacity of the machine (the crop yield that can be threshed by the machine) was 600 kg / h and 1028.6 kg / h of wheat crop yield at 1400 rpm and 1600 rpm respectively. The results showed that highest threshing and cleaning efficiencies of 95 % at feed rate 10 kg with dram speed 1600 rpm .The highest grain loss and grain damage percentage of 0.21 and 0.13 % at drum speed 1600 rpm. The highest grain output 300 kg/h at 20 kg feed rate with 1400 rpm drum speed. The results showed that lowest threshing and cleaning efficiencies of 87 an 84 % respectively at feed rate 20 kg with dram speed 1400 rpm .The lowest grain loss and grain damage percentage of 0.03 and 0.05 % respectively at drum speed 1400 rpm. The highest grain output 300 kg/h at 20 kg feed rate with 1400 rpm drum speed. The lowest grain output 144 kg/h at 10 kg feed rate with 1600 rpm drum speed. The wheat thresher is therefore, a suitable machine with high efficiency and low grain damage and loss percentage for small-scale post-harvest operation.*
Keywords: *Wheat, thresher machine, feeding rate, Diq village, evaluation.*

I. INTRODUCTION

Wheat crop is most important strategical crop and staple for majority of the world populations. Wheat is too sensitive to grain losses affecting on the total grain yield. The thresher process is one of the important processes, which takes place after harvest. It's performed manually or mechanically. The problem for manual thresher it is expensive and needs a great time to complete. In addition the losses in manual threshing are too large. Threshing is a major aspect that is usually carried out after harvesting of grain crops (Olugboji, 2004). Mechanized threshing, particularly into labor deficit area is very important in mining losses as well as for timely threshing of wheat crop (Arnaout et al., 1998). The imported thresher machines often be expensive and is not suitable for local conditions. Therefore, the provision of homemade threshing machine can significantly contribute to reduce the burden on farms and thus revive the rain-fed agriculture.

The progress and development in agriculture and increase agricultural production and reduces the cost attributed to several factors, most notably the introduction of agricultural machinery for implementation of various agricultural factors and transition from manual labour to mechanical work.

1.1 Traditional method of threshing

Joshi, et al. (1998) indicated that, traditional methods are safer for seed purpose point of view, they are consuming the time and labour intensive. The delayed and consuming time operation will also expose the crop to the natural hazards like rains. Bakhwar et al. (2007) studied the loss of harvests and threshing of some grain crops in the Northern Highlands region of Al-Mahweet Governorate in two locations, Taweelah and Al-Mahweet villages, to estimate the losses during harvest and traditional threshing**.** They found that, the wheat crop losses ranged between 7.7% and 11.1% during the harvesting and threshing of the two sites, respectively. The researchers also recommended that mechanization of all agricultural operations and the need to use a multi-purpose thresher machine of different crops for losses reducing.

1.2 Mechanical Method of threshing

Many threshing machines were design and developed that mechanically operated either by hand or attached to the tractor or those self-operated motor-fuel or electric motor.

Muharram et al. (2005) studied the efficiency of the three threshers of the maize crop machines, Italian hand-made machine type OMMA, a small Japanese machine self-powered Kubota machine and self-operated thresher by diesel motor , Research 2003, they used the traditional method and tractor threshing as whiteness. The results showed superiority thresher research 2003 in terms of time spent in the threshing process. The manual thresher OMMA was the best in terms of losses ratio. The study also recommended using the Research 2003 thresher machine in more than one crop, including wheat.

Mishra and Desta (2010) studied the performance of a white corn threshing machine through three weights and three speeds of the thresher drum. The results indicated that by increasing the speed of the thresher drum, the efficiency of the thresher ratio increased for all three feeding weights of the crop. The efficiencies were between 98.3% and 99.9%.

Olaoye (2002) noted that the influencing of both threshes ability and grain damage translates to measurable grain losses if not properly managed. The results which were find by Mishra and Desta (1990) from sorghum thresher evaluation showed that threshing efficiency increased with an increase in cylinder speed. The threshing efficiency was found in the range of 98.3 to 99.9 % and the maximum output of the thresher was 162.7 kg/h.

Saeed et al. (1995) tested field performance and economic evaluation of the rice crop threshing machine. The results showed that the percentage of grain broken increases by increasing the speed of the threshing drum for the different ratios of the crop feeding and the efficiency of the threshing increases by increasing the weight of the crop feeding. Comparing the mechanical threshing with the manual threshing for the loss of threshing (grain) indicated that the losses were 2.64% and 7.95% for both mechanical and manual threshing, respectively.

Gbabo et al. (2013) designed, manufactured and tested a Millet Mill. They found that the efficiency of the machine and the cleaning of grain (grain purity) were 63.2% and 62.7%, respectively, at the drum speed 800 rpm and 700 rpm. They concluded that, the appropriate threshing speed is 800 rpm.

Chimchana et al. (2008) developed a rice crop thresher machine. They found that, the appropriates threshing drum speed 600 rpm and favourite speed to grain separate is 720 rpm. With a feed rate of 0.6-1.8 kg / s, the loss of separation was between 0.7 - 1.3% at a speed range of 27.4 - 33.5 m / s and when the speed increased to higher than 33.5 m / s (800 rpm), the breakage ratio increased.

Osueke (2011) mentioned that many researchers studied and tested the effect of feed rate, cylinder speed and the grain damage (Desta and Mishra, 1990, Seyed, et al., 2006). They found that the threshing efficiency and the percentage of grain damage increased with an increased in cylinder speed for all feed rates.

Younis, et al. (1998) found that, the average of thresher grain loss due to the cleaning fan and shaker were 1.06 % at 906 rpm drum speed.

Tajudeen et al. (2011) developed and tested a Prosopis Africana Pod thresher. The results of the performance evaluation showed that threshing efficiency, cleaning efficiency and seed loss increased with increase in cylinder speed. Saiedirad and Javadi (2011) studied the effect of thresher variables including cylinder speed and feed rate weight percentage of separated seeds and damaged seed. They found increasing cylinder speed from 12.8 to 16.5 m/s, increased the percentage of separated seeds and damaged seed.

Muhammed-Bashir et al. (2018) studied fabrication and performance evaluation of Cowpea thresher. They found that as the speed decreased the threshing efficiency, the throughput capacity and grain loss also decreased while damaged grains are negligible.

Morad, (1997) found that, the breakage of grains was increase with increasing the drum speed and with increasing the feed crop rare the percentage of broken grains was decreased. In addition, he was found that, the unthreshed grains increased with increasing the crop feed rate and decreased with increase in drum speed of thresher.

Syed et al. (2013) found that increased in feed rate (2650, 2720 and 2880 kg/hr) decrease the grain damage, the threshing efficiency and cleaning efficiency.

Zakaria (2006) studied the modification of the threshing machine drum of a stationary thresher to suit separating flax crop. He concluded that the increase of seed output was increased when the feed rate and drum speed were increased. Decreasing in the drum speed tend to decrease the seed losses, seed damage and threshing efficiency.

Adekanyem et al. (2016) found that the threshing efficiency, the blown seeds and throughput capacity increases as the drum speed increased. The cleaning efficiencies increase as the cylinder speed decreased. High cylinder speed tends to increase the percentage of damage seed, blown seed and seed loss. While low cylinder speed tends to reduce the percentage damage speed, blown seed and seed loss respectively.

The aim of this research was to evaluate the agricultural threshing machine attached to the tractor and locally manufactured for wheat crop threshing. The following parameters were considered to evaluate the thresher performance. They are: material input/unit time, effect of drum speed, effect of feeding rate, percentage of grain damage, percentage of blow grain, percentage of grain loss, threshing efficiency, cleaning efficiency and output capacity.

II. MATERIAL AND METHODS

This study was carried out in the Daiq village of directors Jhran province of Dhamar Governorate. The Local threshing machine, spike tooth type drum 24tooth called (thresher machine 2010) was attached to P.T.O. of Fiat 640 tractor with diesel engine power of 64 hp (47.7kW) for running it figure 1. The experiments were done at three levels of wheat crop feeding rates (10, 15 and 20 kg) and tow revolution number of threshing cylinder speed (1400 and 1600 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. The threshing grain losses action of the winnowing brower and shaker, were collected by frame and plastic screen. The frame was hitched to the thresher tail to collect the straw and grain comes of the thresher at different drum speed and feeding rate. The production process, percentage of breakage, threshing efficiency, grain damage, grain loss, grain output and cleaning efficiency were calculated for each running test.

Fig. 1: The thresher machine.

2.1 Machine productivity

The threshing machine productivity can be calculated from the equation (1) that investigated by Alsharifi (2018):

$$q = \frac{w*60}{T*1000} \quad (1)$$

Where, q is machine productivity (t/h); w is output mass (g) and T is time (min)

2.2 Grain breakage

The percentage of grain damage and breakage during threshing process can be calculated by Alsharifi (2018) as the following:

$$P_{Br} = \frac{w_{br}}{w_s} * 100 \quad (2)$$

Where, P_{Br} is the percentage of breakage (%); W_{br} is the mass of breakage grain (g), and W_s is the mass of wheat sample used (g).

2,3 Cleaning efficiency

The randomized of 1000 g grains were used to calculate the grain cleanliness, Equation (3) was used Alsharifi, 2018 and Ghonimy and Rostom, 2004):

$$G_c = \frac{w_s - w_I}{w_s} * 100 \quad (3)$$

Where, G_c is the percentage of grain cleanliness (%); w_s is mass of sample (g) and w_I is mass of impurities (g).

2.4 Grain loss evaluation

Grain loss was found in the term of fraction of damage grain (%) and fraction of unthreshed head (%) using the following equation (Olaoye,et al. 2010)

$$F_{dg} = Q_b/Q_T*100 \quad (4)$$

$$F_{ug} = U_T/Q_T*100 \quad (5)$$

Where: Fdg = fraction of damaged grain, F_{ug} =fraction of unthreshed grain, Q_b = quantity of broken grain in sample (g), Q_T = Total grain in sample (g), U_T = Total unthreshed head in sample (g)

2.5 Threshing efficiency

The following equation was used for calculation of threshing efficiency (Olaoye et al. 2010):

$$N_T = 100 – Q_u/Q_T *100 \quad (6)$$

Where N_T = Threshing efficiency, Q_u Quantity of unthreshed grain in sample.

III. RESULTS AND DISCUSSION

3.1 Effect of threshing cylinder speed and feeding rate on the time of threshing

Table 1 shows the effect of threshing cylinder speeds and feeding rates on the time of the threshing. The results showed that by increasing the speed of the threshing cylinder, the threshing time decreased for all feeding rates, while increasing the feeding rate leads to increase in threshing time at the same threshing cylinder speed.

Table 1: Effect of threshing cylinder speed and feeding rare on the time of threshing

Threshing cylinder speed (rpm)	Feeding rate (kg)	Threshing time (s)
1400	10	60
	15	90
	20	120
1600	10	35
	15	53

	20	70

3.2 The effect of drum speed on field capacity

The field capacities of the threshing machine (the crop that can be threshed) were 600 kg / h and 1028.6 kg / h of the crop at the speed of 1400 rpm and 1600 rpm respectively as shown in table 2. Increasing in drum speed from 1400 rpm to 1600 rpm lead to increase in field capacity from 600 kg to 1028.6 kg as shown in Table 2.

Table 2: The effect of drum speed on field capacity

Thresher drum speed (rpm)	Field capacity (kg/h)
1400	600
600	1028.6

3.3 The effect of feeding rate and drum speed on grain output, grain breakage, blown grain and grain losses

Table 3 shows the effect of feeding rate and drum speed on grain output, grain breakage blown and grain losses. The results showed that the total losses found to be 0.14, 0.08, and 0.05 % at feeding rate 10, 15 and 20 kg and drum speed 1400 rpm and 0.21, 0.13 and 0.08 % at the same feeding rates and drum speed 1600 rpm respectively. The grain output was calculated and found to be 150, 222, and 300 kg/h with drum speed 1400 rpm and 144, 216 and 288 kg/h with drum speed 1600 rpm. Increasing in feed rate tend to decrease percentage of grain losses, percentage of grain breakage. Increased in crop feed rate reduces grain breakage because the large amount of crop in the threshold unit protects the grain from the impacting force and thus reduces the breakage rate, which is consistent with Morad (1997) and Syed et al. (2013). The increase of grain output was increased when the feed rate was increased. Percentage of grain breakage and grain loss increased with increase in drum speed. This result is in agreement with the results found by Tajudeen et al. (2011), Muhammed-Bashir et al. (2018), Chimchana et al. (2008), Saeed et al. (1995), and Zakaria (2006). The effect of the variables was observed in percentage of blown grain. Increase in feed rate (10, 15 and 20 kg) resulted to decrease in blown grain. Increase in drum speed (1400 and 1600 rpm) resulted to increase in blown grain. This tend agree with the results founding by *Adekanyem* et al. (2016).

Table3: Effect of feeding rate and drum speed on grain output, grain losses

Drum speed (rpm)	Feeding rate (kg)	Grain output (kg/h)	Grain losses (%)		
			blown	broken	total
1400	10	150	0.04	0.1	0.14
	15	222	0.03	0.05	0.08
	20	300	0.02	0.03	0.05
1600	10	144	0.08	0.13	0.21
	15	216	0.06	0.07	0.13
	20	288	0.04	0.04	0.08

3.4 Effect of feeding rate and drum speed on grain damage

Table 4 shows the effect of feeding rate on grain damage of thresher. The percentage of grain damage was 0.1, 0.05 and 0.03 % and the mean 0.06 % at the drum speed 1400 rpm. The percentage of grain damage at drum speed 1600 rpm were 0.13, 0.07 and 0.04 % and the mean 0.08%. The results showed that the grain damage at lower feeding rate (10 kg) was greater than at other tow feeding rates (15kg and 20kg). The result is in agreement with Syed, et al. (2013). The highest grain damaged was found at 10 kg feeding rate and 1600 rpm threshing speed .The lowest grain damage was found at 20 kg feed rate and 1400 rpm. Increasing in feed rate tend to decrease percentage of grain breakage. Increased in crop feed rate reduces grain breakage because the large amount of crop in the threshold unit protects the grain from the impacting force and thus reduces the breakage rate, which is consistent with Morad (1997) and Syed et al. (2013). Percentage of grain breakage increased with increase in drum speed. This result is in agreement with the results found by (Tajudeen et al. 2011), Muhammed-Bashir et al. (2018), Chimchana et al. (2008), Saeed et al. (1995), and Zakaria (2006).

Table4: Effect of feeding rate and drum speed on grain damage

Feeding rate (kg)	Grain damage (%)		Mean
	1400	1600	
10	0.1	0.13	0.12
15	0.05	0.07	0.06
20	0.03	0.04	0.04
Mean	0.06	0.08	0.07

3.5 Effect of feeding rate and drum speed on threshing efficiency

The effect of feeding rate and drum speed on threshing efficiency showed in Table 5. Drum speed 1400 rpm had 93%, 90 and 87% and drum speed 1600 rpm had 95%, 92% and 88.5% threshing efficiency at feeding rate 10kg, 15kg and 20kg respectively. The mean of threshing efficiency were 90% and 92%. Threshing wheat at 10 kg with a drum speed of 1600 rpm produced the highest efficiency of 95% and threshing wheat at 20 kg with drum speed of 1400 rpm produced the lowest threshing efficiency of 87%. The results showed that the increase in feeding rate decreased the threshing efficiency at tow drum speeds (1400 rpm and 1600 pm) and also the mean of threshing efficiency was decreased, these results agree with Muhammed-Bashir et al. (2018). Increase in drum speed increased the efficiency. This result is in consistent with Gbabo et al. (2013), Muhammed –Bashir et al. (2013), Mishra and Dista (1990) and Syed et al, (2013).

Table5: Effect of feeding rate and drum speed on threshing efficiency

Feeding rate (kg)	Threshing efficiency (%)		Mean
	1400	1600	
10	93	95	94
15	90	92	91
20	87	90	88.5

Mean	90	92	91

3.6 Effect of feeding rate and drum speed on cleaning efficiency

Table 6 shows the effect of feeding rate and drum speed on cleaning efficiency. The cleaning efficiency was found to be 92, 88 and 84 % with drum speed 1400 rpm and 95' 90 and 85 % with drum speed 1600 rpm, at feeding rate 10kg, 15kg and 20kg respectively. The mean of cleaning efficiency were 88% and 90%. The highest cleaning efficiency was found to be 95% with feed rate 10 kg, and the lowest cleaning efficiency was 84% with feed rate 20kg. The results showed that the increase in feeding rate decreased the cleaning efficiency at tow drum speeds (1400 rpm and 1600 pm) and also the mean of cleaning efficiency was decreased. Increase in drum speed from 1400 rpm to 1600 rpm increased the mean cleaning efficiency from 88% to 90%, this agree with the findings of Gbabo et al. (2013), Muhammed-Bashir et al. (2018), Mishra and Dista (1990) and Syed et al, (2013).

Table6: Effect of feeding rate and drum speed on cleaning efficiency

Feeding rate (kg)	Cleaning efficiency (%)		Mean
	1400	1600	
10	92	95	93.5
15	88	90	89
20	84	85	84.5
Mean	88	90	89

It was noted that an increase of speed increase the proportion of the grain cleaning, it's due to the strength of fan cleaning, which increases with the speed of drum thresher increase.

IV. CONCLUSIONS

The thresher machine gave the maximum grain output 300 kg/h at 1400 rpm and 20 kg feeding rate. The maximum threshing efficiency of 95% was found at a threshing speed of 1600 rpm and 10 kg feeding rate. The maximum cleaning efficiency of the thresher was 95% at threshing speed of 1600 rpm and 10 kg feeding rate. The best feeding rate from point of view damaged grain was 20 kg at thresher speed 1400 rpm. This revealed that as the feeding rate increased the total losses decreased, and as threshing speed increased the total losses increased too. The maximum damaged grain was found at 10 kg feeding rate and 1600 rpm threshing speed. That means by increasing feeding rate the damaged grain decreased and by increasing threshing speed the damaged grain increased too. As the feeding rate increased the grain losses, the damaged grain, the threshing efficiency and the cleaning efficiency decreased. As the threshing speed increased, the grain losses, the damaged grain, the threshing efficiency and the cleaning efficiency also increased.

It is recommended using a weight of 20 kg crop to feed the threshing machine with a drum speed 1400 rpm and fabricate small threshers suitable for small areas and use small diesel engine to run them without tractor, moreover can use solar photovoltaic (PV) panels as a prime mover.

ACKNOWLEDGMENT

The authors would like to thank all people who were support directly or indirectly to conducting this research.

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