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IMPROVEMENT AND PERFORMANCE EVALUATION OF STATIONARY COMBINE THRESHER

Mohammed Ahmed AbdElmowla[*]

Mohamed Hassan Dahab[**]

Fatah ElRahman Ahmed EL Mahie[***]

Farid Eltoum, A.E**

Abstract:

This study was conducted at the Faculty of Agriculture, Nile Valley University, Darmali, North of Atbara. The main objective of this study was to develop and improve the stationary threshing machine by adding a diesel engine 49 hp and gearbox to become self operated. The diesel engine and gearbox were installed in the rear side of the thresher. Three iron frames were used to link the diesel engine and gearbox. The power was transmitted from the installed diesel engine through pulleys and belts to the threshing unit. The improved machine was evaluated and compared with the convention one through threshing two crops, faba bean and wheat. The time of linking thresher to the tractor, field efficiency, field capacity, fuel consumption and weight of seed and straw were measurement in all plots with three replications.

The results indicated Low field operation time (0.03 hr) for improved thresher compared to (0.25 hr) for the conventional thresher. Higher field efficiency and capacity were observed for the improved thresher. They were 85% and 1.43 fed/ hr for the improved machine compared to 25% and 1.0 fed/hr for the conventional one respectively. Low fuel consumption of 3.5 liter/hr for the improved threshing machine compared to 7.57 litter/hr forthe conventional one.

Statistical analysis showed highly significant difference (at p >0.01) between the improved thresher and conventional threshing machine for the time taken for linking, field efficiency, field

[*] Dept. of Agricultural Engineering, Faculty of Agriculture, Nile Valley University, Atbara, Sudan.

[**] Dept. of Agricultural Engineering, Faculty of Agriculture, Shambat, P.O. Box 32, Sudan.

[***] Department of Mechanical Engineering Faculty of Engineering, Nile Valley University.

capacity and Fuel consumption. No significant difference was observed between the two threshers for the weight of seed and straw output.

The improved threshing machine is durable, portable, easy to operate and of Low maintain costs, All components of the machine were fabricated from local materials and total cost for the design and improvement of the threshing machine was only SDG (2500).

Keywords: Stationary thresher, power, diesel engine, gearbox,performance

INTRODUCTION

Agricultural engineering is the science and art of engineering, mathematical and physical theories application to solve some agricultural problems and to increase production beside good work environment for farmers (Elsanoberi 1993). Power source in agricultural farms is of great importance in determining the level of agricultural mechanization and development, there are three sources of power for carrying out operations, the human power (about 0.07 – 0.1 kw) l, animal power and mechanical power (Grossly andKilgour1983). Mechanical power through tractors will continue to be an absolute necessity for agricultural production (Hunt 1983). The tractor engine can be used as a prime mover for active (moving) tools or stationary farm machinery through the power take off shaft (PTO) or belt pulley (Rodicher and Rodicheva 1984).

Transmitting of power from its source to the points of use is one of the important variables to the farm equipment designers. Krutz*et. al*. (1984) cited that the selection of proper power transmission systems on mobile agricultural machinery must take into account the customer requirements, cost constraints, field usage, operator safety and reliability. The primary function of the transmission member is to affect the change in speed between the two shafts as well as in linking them. It is generally required that the transmission system should have adequate reliability, service life, simple in construction, little resistance to motion, produce little noise, offers substantial resistance to vibration and easy to control. There are many power transmission systems used, but the most extensively used in agricultural machinery applications are V-belts (Kepner*et. al*., 1982, Krutz*et. al* (1984). Shigley and Mitchell (1983) stated that, the efficiency of V-belts ranges from 70 – 95 %. Gears and chains are also widely used for power transmission as linear or rotary motion (Hunt and Garver 1973, Spotts 1978, Crouse 1980, Liljedahl*et. al*. 1984).

Other power transmission systems included bearings, shafts and universal joints. Rotating shafts are of various lengths, diameters and types and they may be subjected to bending, tension, compression or torsion loads, acting singly or in combination with one another (Shigley and Mitchell.1983,). Therefore it is important to locate the PTO shaft of the tractor with respect to the draw bar because of the telescoping action of the drive member.

The goal of good crops harvesting is to ensure maximum grain yield through minimizing grain loss and the prevention of quality deterioration. A wide variety of tools is used in harvesting, such as knives, sickles, animals, stationary threshing machines, tractor-mounted harvesters, and self-propelled combine harvesters.Stationary threshers which are drawn and operated by tractors PTO are now of great important in the Sudan for threshing many crops. Since stationary threshers are tractor engine operated, it was important to improve the operational performance of threshers to make the harvesting operation more efficient and economical. Therefore, the objectives of this present study are:

1- to install a diesel engine and conveyor belt on a stationary thresher as a technical and economic improvement.

2- to evaluation e the field performance of the improved threshing machine and to compare with the conventional thresher.

MATERIALS AND METHODS

The study was carried out in Darmally village, 13 km north of Atbara city and 325 km north of Khartoum city.

Diesel engine (49,26hp), with technical specifications given in (Table1),and gearboxand Massey Fergeson (290) tractor of 74.8 hp (maximum PTO),were used as source of power for a stationary combiner thresher (Elshams) improvement. The technical specifications of the thresher are shown in (Table2). Other materials and tools used to carry out the installation included, iron sheets, iron angles, iron flanges, fixing bolts, nuts, shims, pulleys and other workshop equipment.

1. The Frame

A metal engine and gearbox frame was fixed in the rear part of the thresher (Fig 1). All design criteria were considered when fixing the frame strongly with fixing bolts. The frame is composed of three components: The main frame (A) made of mild steel U -sections angles 15 x7 x 0.5 in. The main frame supports are frame (B) and frame (C). Farm (B) stands made of mild steel angle

2.5 x 2 x 0.3 in and frame (C) 2.5 x 2.5x 0.3 inof mild steel.They are used tomount the engine and bolts and nuts were used to fix the U-section in grooves at both ends of the frame(Fig2).

2. Transmission of power

The power to operate thresher unit was transmitted from gearbox shaft to flywheel thresher through a coupling, belts and pulley.

3. The coupling

Couplings are used to connect a driver gearbox (power source) shaft to the shaft of the driven unit (combiner thresher shaft) such a connection allows torque to be torsion lead to the driven unit. The details of couplings are shown in Table 3.

Table 1: Technology specification of Engine

Technology specification	Engine
Displacement	1.8L (1839 cc)
Cylinder bore	83 mm
Piston stroke	85 mm
Valve train	SOHC
Fuel type	diesel
Power	49,26 Kw

Table2: Technological specification Combiner thresher (ElSHAMS)

Technology specification	ElSHAMS
Length (mm)	4020
Width (mm)	2200
Height (mm)	24000
Drum type:	Mobile finger
Drum length (mm)	1200
Drum diameter (mm)	75/120
Rows pegs	4
Numbers of pegs	44
Out put (kg)	2300
Tire size	16x600
Flywheel diameter(mm)	732
Flywheel weight (kg)	130

Main bearing inner diameter (mm)	70
Cardanshaft	Standard
Belt tension	Standard
Bag filling possibility (seed diameter)	All sizes

Fig 1. The rear part of the thresher

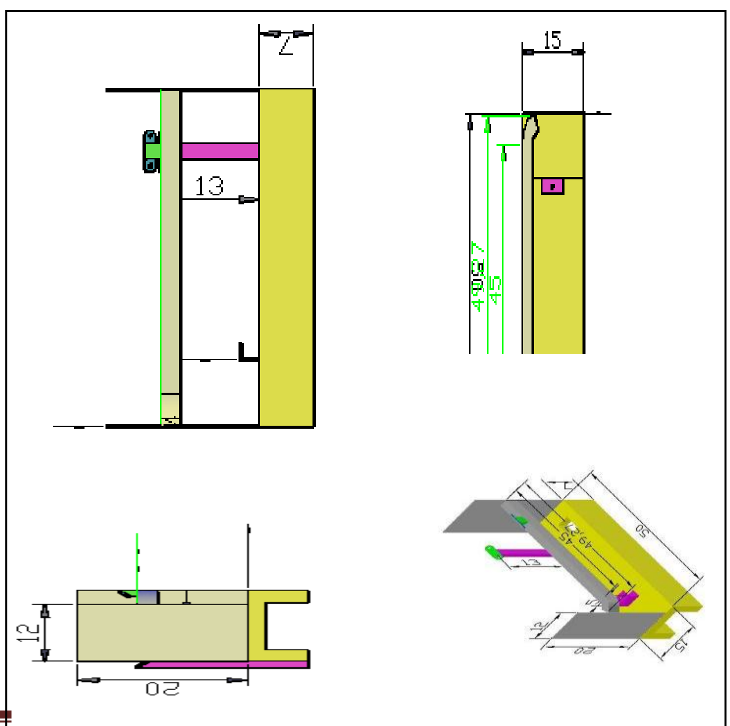
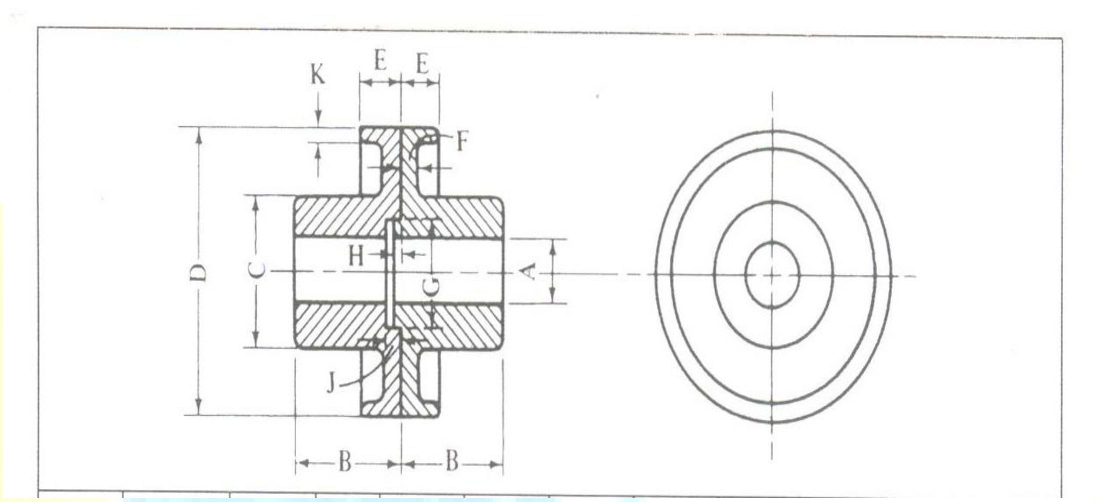


Fig2. Side view of the main frames used

Table 3: Groove Dimensions and Tolerances for the Coupling



A	B	C	D	E	F	G	H	J	K	Blots NO	Blots Dia
1	1.72	2.25	4	0.60	0.31	1.5	0.25	0.20	0.25	5	0.38
1.25	2.1	2.75	5	0.81	0.37	1,87	0.25	0.20	0.25	5	0.43

Source: Machinery's Handbook (2000)

4.Power calculation:

The following formula mentioned by (Shigley and Mischke 1983) was used to calculate the design power for the diesel engine:

Design power = Service Factor × Transmitted power

The service factor was used by assuming the overload75% ((Shigley and Mischke 1983).

Design power = 1.3 ×35 = 45.5 hp(the selected diesel engine of 1c and 49 hp).

a) **Pulley selection:**

The drive and driven pulleys may be selected as follows (Krutz*et. at*., 1984):

$$\frac{PDr}{PDn} = \frac{(rpm)r}{(rpm)n}$$

Where:

PDr = pitch diameter for the driver pulley (inch).

PDn = pitch diameter for the driven pulley (inch), proposed 8 inch.

(rpm)r = driver pulley speed (1000rpm).

(rpm)n = driven pulley speed (1000rpm).

Then:

$$PDr = \frac{1000 \times 8}{1000} = 8 \text{ inch (Table5)}$$

b) **V-Belts selection:**

For V-belts design and selection the computations made follows the methodology mentioned by Shigley and Mischke (1983). The center distance between drive and driven pulleys was 29 inch and this was found to fulfill the following equation:

$$C < 3\,(d + D)$$

Where:

C = center distance.

D = large pulley diameter.

d = small pulley diameter

Therefore from Table (4), a V- belt section A- was selected.

The pitch length of the belt calculated as follows:

$$Lp = 2C + 1.57(D + d) + \frac{(D - d)^2}{4C}$$

Where:

C = center distance.

D = pitch diameter large pulley.

d = pitch diameter small pulley.

Lp = pitch length of belt.

= 2 × (29) +25.12 = 83.12 in

Table 4: standard V-belts sections

Belt section	Width a (in)	Thickness b (in)	Hp range one or more belts	Minimum Sheave diameter- in
A	½	11/32	¼ - 10	3.0
B	21/32	7/16	1 –25	5.4
C	7/8	17/32	15 –100	9.0
D	11/4	¾	50 –250	13.0
E	11/12	1	100 and up	21.6

Source:Shigley and Mitchell (1983)

The shaft threshing and driver pulley is designed as one body to contain only four belts.So that four belts transmitting power rang of 1-25 hpwas selected (Fig.3 and Table 5).

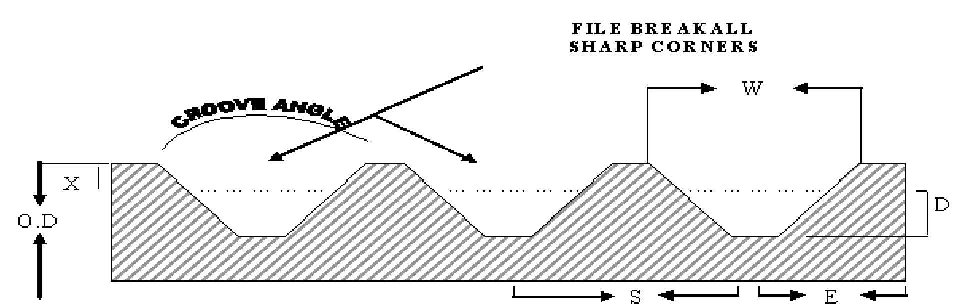


Table 5: Groove Dimensions and Tolerances for Multiple V- belt Sheaves

Belt	Pitch Diameter Minimwn	Recommended Range	Groove Angle	Standard Groove Dimensions W	D	X	S'	E	Deep Groove Dimensions W	D	X	S'	E
B	3.0	2.6 to 5.4	±1/2°	(2)	±.031	…	±.031	(3)	(2)	±.031	…	±.031	(3)
			34°	.494	.490	.125	5/8	3/8	.589	.645	.280	3/4	7/16
		over 5.4	38°	.504					.611				

Source: Machinery's Handbook (2000

RESULTS AND DISCUSSION

A diesel engine was installed to the conventional thresher to improve its operational performance. The power transmitted from the gearbox shaft of the diesel engine to operatethe combiner thresher (35hp) through belts and pulleys as shown in Fig.3.

Table (6) shows the field performance evaluation parameters measured for improved thresher compared to the conventional thresher using two crops. All measured parameters were improved when using the improved thresher.

Fig 3. The Improved thresher

The results showed that the time taken to carry out the threshing time was decreased by the improved thresher by 0.22hr for faba bean and wheat crops. This may be due to the higher waste of time by stopping during the operation and in turning at the ends of the field.

Table 6:The average operation time, field efficiency and capacityand fuel consumption

Machine	Time of operation (hr)	Field efficiency %	Field capacity (fed/hr)	Seed weight (kg)	Straw weight (kg)	Fuel consumption (l/hr)
a- Feabean						
improved	0.03	0.85	1.43	47	60	3.5
conversational	0.25	0.41	1.00	38	69	7.3
b- Wheat						
improved	0.03	0.68	0.33	43	46	3.5
conversational	0.25	0.15	0.42	40	53	9.1

The average field efficiency was increased by the improved thresher by 103% for the faba bean and by 450 % for thewheat compared to the conventional thresher.

Analysis of variance of the data indicated highly significant difference between the two threshers. It was noticed that the machine efficiency is generally low; which may be due to the high waste of time by stopping during field operation and high waste time in turnings at the ends of the.

The improved thresher was also increased the average actual field capacity by 0.43 fed/hr. for the faba bean and by 0.09 fed/hr for wheat crop compared to the conventional thresher. This is mainly due to the time taken in linking and preparing and the higher efficiency of the improved thresher. This finding agreed with that of Dahab*et.al.* (2007).

The averagemeasured fuel consumption (l/h) for the improved thresher during threshing of fababean and wheat was reduced by 3.8 liter/hr and 5.6 liter/hrfor the two crops respectively(Table6). Therefore more fuel was saved and the threshing operation was economical compared to the conventional. This finding is consistent with the findings of El-Awad (2007) and compared well with those reported by Snigh*el.al.* (2007).Statistical analysis showed highly significant difference between the two threshers at 1 % level for all measured parameters. It was observed that the added parts in the improved thresher .didn't change the threshing mechanism of the machine.

CONCLUSION

The following conclusionsmay be drawn from the results obtained:

-The improved threshing machine helped to do the threshing operation without a tractor.

-The Field efficiency and effective field capacity of the improved thresher were increased resulting in time and cost saving of the threshing operation.

-The installed and designed parts of the improved thresher were found of low energy consumption and low production costs.

- Further work is neededto make the thresher more efficient by developing and fixing front cutter and pickup reel.

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