MODIFICATION AND PERFORMANCE OF MULTI CROP THRESHER

By:

Omran Musa Abbass[1], **Omer Mohamed Eltom Elshami**[2] **and Hassan Ibrahim Mohamed** [3]

1-Sudanese Agricultural Council. 2-Department of Agriculture Engineering, College of Agriculture Studies. Sudan University of Since and Technology. 3- Department of Agriculture Engineering, Faculty of Agriculture, University of Khartoum.

KEYWORDS: Multi crops thresher, Clearance, Adjustment and Simulation models.

ABSTRACT

Stationary crops thresher was modified and a proto- type simple machine was constructed to simulate a commercial stationary thresher to harvest sorghum, groundnut, and wheat. The machine modifications to harvest each crop were made simple and includes threshing cylinder concave, shaker, pulleys and a set of pegs and sieves. For purpose of improving harvest efficiency of different size of pods the cylinder - concave clearance was made adjustable at two points.

The thresher model was tested for groundnut variety (MP_3) at three levels of concave clearance (30, 25, 15 mm), two levels of crop moisture (dry, wet) and two speeds (87, 98 rpm) using three replications in a complete randomized design. Results obtained showed a high threshing efficiency at clearances (25–30 mm) in dry moisture condition at a speed of 87 rpm.

الملخص:

تم تعديل دَّراسة حبوب مع تصنيع نموذج تمثيلي مبسط مشابه لدراسات محاصـيل الـ ذرة، الفول السوداني, القمح وهو يتكون من أسطوانة الدرس, الصدر، الهزاز وبكرات ومجموعة غرابيـل. لرفع كفاءة الدَّرس لمختلف محاصيل الحبوب حيث تم التحكم في الخلوص بين الأسطوانة والـصدر عبر نقطتين.

تم اختبار نموذج الدراسة على محصول الفول السوداني (MH_3) باستخدام ثلاث مستويات للخلوص بين الأسطوانة والصدر (30, 25, 12 ملم) وعند مستويين للرطوبة (جاف، رطب) وسرعتين (87،98 لفة/ دقيقة). تم تكرار التجربة ثلاث مرات وتم تحليلها باستخدام طريقة المربع العشوائي الكامل. أظهرت نتائج تحليل التجربة إن أعلى كفاءة درس كانت عند خلوص (25–30 ملم) وعندما يكون المحصول جاف وسرعة اسطوانة الدرس 87 لفة/دقيقة.

INTRODUCTION

Agricultural production in the Sudan is categorized into rainfed and irrigated sectors. The rainfed sector is subdivided into traditional rainfed and mechanized rainfed. The total area of rainfed sector is 6.4 million hectars, while the total area of the irrigated sector is 1.2 million hectares (AOAD, 1993).

The main crops in the mechanized area are sorghum, which occupies 85% of the total land, sesame, which occupies 10% of the land, sunflower that occupies 2% of the land, and millet and maize, occupies a small percentage of the land (1% of the total land).

Wheat is the only completely mechanized crop in the irrigated sector. The cultivated area of wheat is expanded into the central plains of the country where plenty of land and water are available for purpose of food security.

Groundnut is an important economic oil crop in the Sudan. Its average contribution to the total export value is 1-18%. The total area cultivated is about 365.000hectares. This area is fluctuating annually due to the variation in rainfall intensity and price of the produce. Average pod yield is low (about 600kg./ha in the rainfed area and 1440 kg/ha in the irrigated area). However, the potential yield under irrigated experimental conditions can be as high as 6.7ton/ha.

Agricultural labour alone cannot suffice these lands. Hence, it is necessary to employ mechanical power for agricultural production, especially for those operations that require high labour inputs (land preparation, fertilization, sowing, weeding, and harvesting).

The harvesting of wheat and groundnut primary consists of hand pulling and transportation to the thresher. Machine threshing losses are estimated to up to 25% while manual threshing of groundnut is highly labour intensive. Groundnuts mobile thresherare is an expensive machine and crop losses in these mobile machines are excessive. (Abdel Moneim, 1985).

Mobile thresher distributes the fodder along the field. In recent years, prices of fodder have risen dramatically, so this compelled farmers to use stationary thresher rather than the mobile ones. Statistical data of combine import into the Sudan indicates that the total available machine number is less than the required number to harvest the crops at their optimum time. (Bank of Sudan, 1999).

Shortage in number of harvesters is attributed to economic constraint, lack of proper maintenance facilitates, and non-optimum machine replacement polices.

This can be felt by the large heaps of scrape tractors and implements in the junkyards and workshops of the mechanized rainfed areas and irrigated projects. The reason of the increase in the number of the written off machinery can be attributed to administration and policy formulation. The case can be evidenced by the variety of makes and type of combine harvesters, important to the Sudan. Moreover, it can be visualized by the timing of the viscous cycle of new death state of large number of harvesters, and the renewal of the number of the harvesters by importation.

Grain harvesters used in Sudan are popular due to their high productivity and ability to cut and thresh the crop at the same time; these combines were not designed for beans or groundnut. They need service system to collect the fodder. In contract, stationary threshers are recognized by their lower capital cost and capability of heaping fodder in one place. However, stationary threshers are described by their low productivity and the need for crop feeding and handling before starting threshing process. Hence, the avenue to compromise between grain mobile combine harvester and groundnut stationary thresher is to develop a cheap multi-purpose thresher especially for fodder production. The objective of this study is to develop stationary prototype thresher for harvesting multi-crops for small farmers in developing countries. In addition:

1- To modify stationery thresher drum in order to separate groundnut crop vine and sorghum or wheat heads.
2- To develop manually adjustable cylinder–concave clearance for harvesting multi crops.
3- To evaluate the performance of the locally made prototype machine using Groundnut crops.

(Singh and Verma 1972) tested groundnut thresher (model K.E.M) manufactured by Kincaid Equipment Manufacturing Chicago USA, at the National Agricultural Research of Islamabad. Results were not encouraging as the output was too low (63.3kg/h) with poor clearing efficiency of only 24%. The low output was mainly due to non-continuous feeding system of the machine. (Madian, 1958) developed an axial flow threshing system for groundnut. He made a comparison between existing groundnut (spike tooth type) threshing system and the axial flow system. He found that the total pod loss through a specific power consumption and steamer saw load were less for the axial flow system, in addition to better straw quality. (Dosa, 1984) studied the threshing cylinder and concave adjustments. He described two basic adjustments provided for the threshing cylinder and concave. These are cylinder or rotor speed and concave spacing. Cylinder or rotor speed is usually controlled from the operator's platform. Concave spacing on most combines is controlled by moving the concave up or down as desired to get the proper spacing or by moving cylinder up and down. (Khan 1990) developed a dual model axial flow thresher for multi – crop in Egypt. He reported the work of (Majumdar 1985) and (Harrison 1991) to show the advantages of using axial flow thresher. (Singh and verma 1972) developed and evaluated an experimental groundnut thresher. He found that pod damage decrease with decrease of moisture content and the optimum cylinder speed is 5.7 m/s. However, (Zafar 1997) reported that drying the crop for two days (20 % moisture level) resulted in minimum pod harvesting losses.

MATERIALS AND METHODS

The workshop used for the modification lies in Khartoum Central Military Workshops. While the needed materials were collected from Rahad Agricultural Scheme Workshop. The principles followed in the design are:

Threshing system for multi-corps. Simple compact and low cost machine. Easy to manufacture with local available technology level. Continuous feeding. Tractor (PTO) driven with the option for engine motor driver, proper handling of fodder.

To achieve these design principles the following specific modifications are made:

- The concave is made to face the different flows of materials, which goes through it, hence, a semi-circular mesh type concave was made of MS. bar (800mm dia) and has been provided with two points of adjustment. Hence, the concave can go up and down through slotted track to suit various types of crops.
- The threshing drum is a hollow cylindrical drum. It is made of MS. Bar sheet and its length is 800mm. Tow circulars MS. Plates of the same thickness are bolted on each end of the drum. MS. Bar is welded between the two circular plates located at both ends.

There are 24 spiral begs made of MS. bar (20 mm length at the outer surface of the drum). The begs are fixed by screws and can be changed to suit the different types of grain or pod crops.

The blower is made to rotate at a speed that is three times higher than the speed of the threshing drum, and it can be adjusted to suit the different type of crops. The blower is equipped with slide to adjusted airflow. The slide is made of MS. Angle with bushes in the center. The blower shaft passes through the bushes and is supported on the main frame.

The shaker unit is made of MS. Sheet and welded on a rectangular angle frame at one side, while the other side is used for adjustment. The adjustment can be mad to obtain the required inclination. The shaker at the rear end can be lowered to spill out the dirt, pops and the straw particles.

Based on the current market prices the cost of each item needed to modify the commercial thresher is given in (Table 1). The cost of modification amounts to 6% of the price of a new thresher.

Table (1): The Cost of Modification the New Thresher

Unit	Cost (Dinars)
Pass shaft	20.000
Square pipe	9.000
Circular pipe	4.500
Pedestal bearing	21.100
Belts	100.000
Pulleys	75.000
Total	**720.000**

The model machine (plat 1) and (Fig. 1) is powered by an electrical motor (950–1400 r.p.m). The motor transmits the power to the drum unit by belt and pulley system. The shaft of the drum and pulley transmits. The power to chaff blower, which in turn transmits the power to the shaker.

The model of the thresher was tested to the standard methods given by Tandon (1982). The thresher performance was measured in terms of weight of grain output, broken grain percentage, separation losses, threshing efficiency and percentage of the grain with stem.

Groundnut material (9000kg variety MH3) was manually collected by hand pulling from the farm of the Rahad Research (latitude 13.08 and 14.08 north, and longitude 3306 and 34.00 east). The soil of the farm is classified as vertisol with high clay content. Rainfall ranges between 300-600 and average evaporation is 6-9 mm/day (Abdullah, 1990).

Half of groundnut material (4500 kg) was collected after two days from hand pulling (at 36.5% moisture condition on weight basis) to represent wet harvesting condition. While the other half (4500 kg) was collected after six days from hand pulling (at 10.1% moisture condition on weight basis) to represent dry harvesting condition. (Abdul Moneim, 1985).

Each half of the collected material was divided into 18 groups (250kg each) and each group was fed to the locally made machine. The study operating parameters include:

Two levels of cylinder speed S_1= 87 rpm and S_2 = 98 rpm,

Three levels of concave - cylinder clearance:

(C_1) = 30 cm , (C_2) =25 cm and (C_3) = 15 cm,

Two levels of moisture Contents: Dry condition M_1 = 6.5% moisture content and Wet condition M_2 = 10 % moisture content.

Complete randomized design was used with six treatments replicated three times. Fore each replication in each treatment the following measurements was made:

Threshed pods by weight (kg), unthreshed pods by weight ((kg), pods blown out with chaft by weight (kg), total clean pods (kg), broken pods from total clean pods (kg), pods with stem from total clean pods (Kg).

RESULTS AND DISCUSSION

The components of the developed model are shown in (fig. 1). (Table 2) shows the performance of the developed machine operating at two speeds (87 and 98 rpm.), tow moisture levels (dry, wet) and three clearance (30.25, 15 mm) measured by weight of groundnut material. The table reveals that:

- Speed and moisture have a highly significant effect on threshed pods while clearance has no significant effect (Fig. 4).
- Effect of various levels of speed, clearance, and moisture shows a significant effect on weight of unthreshed pods (fig. 5).
- As for broken pods operating speeds and moisture status has no significant effect but clearance levels have highly significant effect (fig. 6).

- Weight of pods blown with chaff was not significantly effect by variations in moisture content or clearance as shown in (Fig. 7).
- The three Clearance levels resulted in no significant effect on weight of produced stem. In contrast, moisture status and levels of speed shows highly significant effect (Fig 8).
- Total pod weight is found to be significantly affected by variations of all operating parameters (fig. 9).
- Evaluation of machine efficiency is depicted in (Fig. 10). Highest efficiency was obtained at dry condition and slow speed (87rpm), while minimum efficiency was obtained at clearance 25mm. Under wet crop condition.
- For separation losses highest values occurred with slow speed (87 rpm) and maximum separation losses occurred at 25mm clearance and 87 rpm speed (Fig. 11).

From these results, the optimum operating parameters for the model machine to thresh groundnut crop are to work at speed 87 rpm, clearance 25-30mm and 6.5% moisture content. These results are in agreement with (Singh 1972), (Khan 1990).

Table (2): Statistical Analysis of Operating Parameters

Source	Threshed Pods	Un-threshed Pods	Pods with chaff	Total Pods	Broken Pods	Pods with stem
Drum speed	**	ns	**	*	ns	**
Concave clearance	ns	ns	ns	*	**	ns
Drum speed x concave clearance moisture	*	ns	ns	*	*	*
Moisture	*	**	ns	*	ns	**
Drum speed x moisture content	*	ns	**	Ns	ns	*
Concave clearance x moisture	*	ns	ns	**	*	ns
Speed x clearance x moisture	ns	ns	ns	**	*	ns

* = Significant, ** = highly significant, ns = not significant

Plat (1): View of the Model Machine

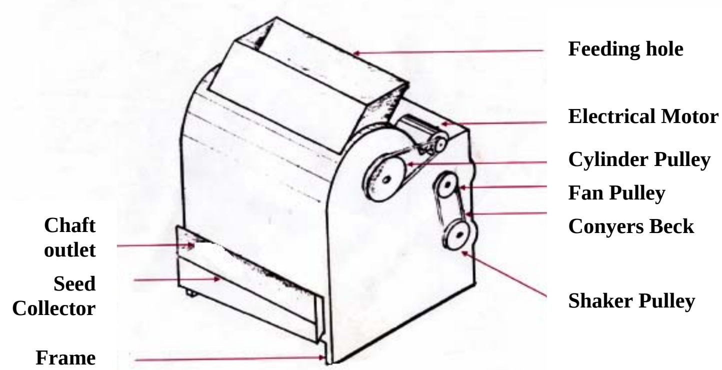


Fig. (1): Components of the Machine Model

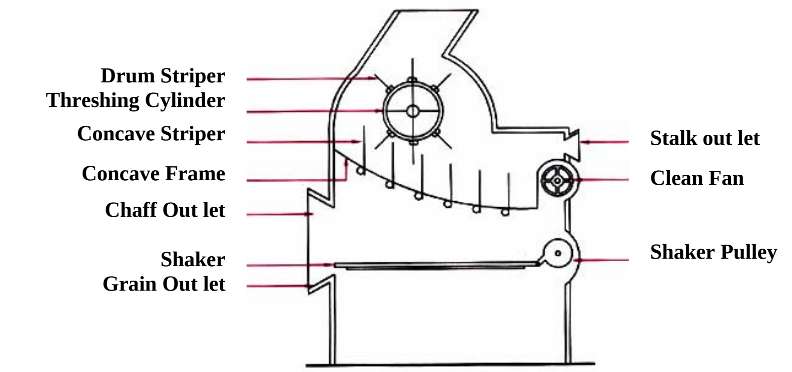
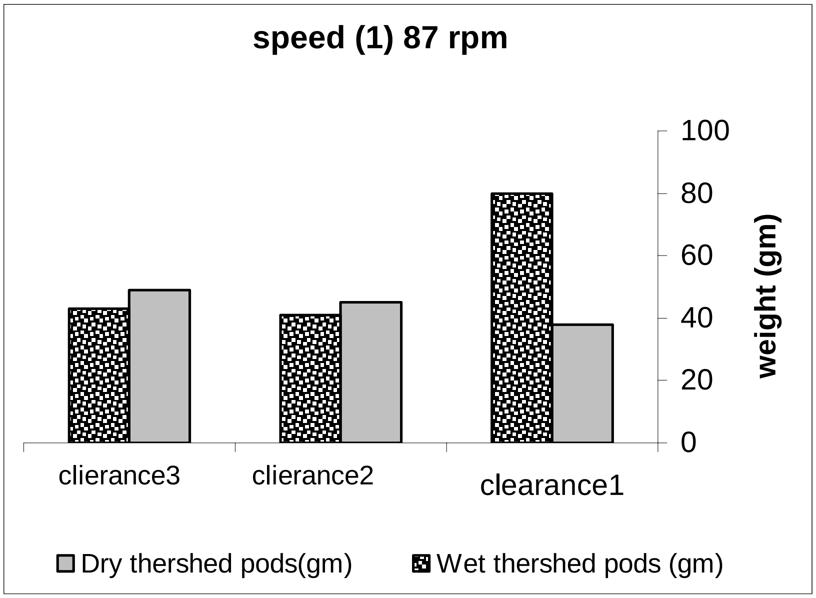


Fig. (2) Components of the Model Machine



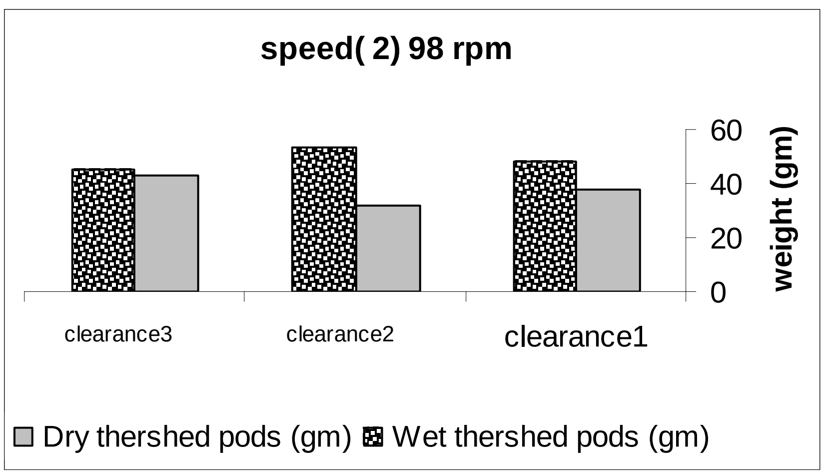
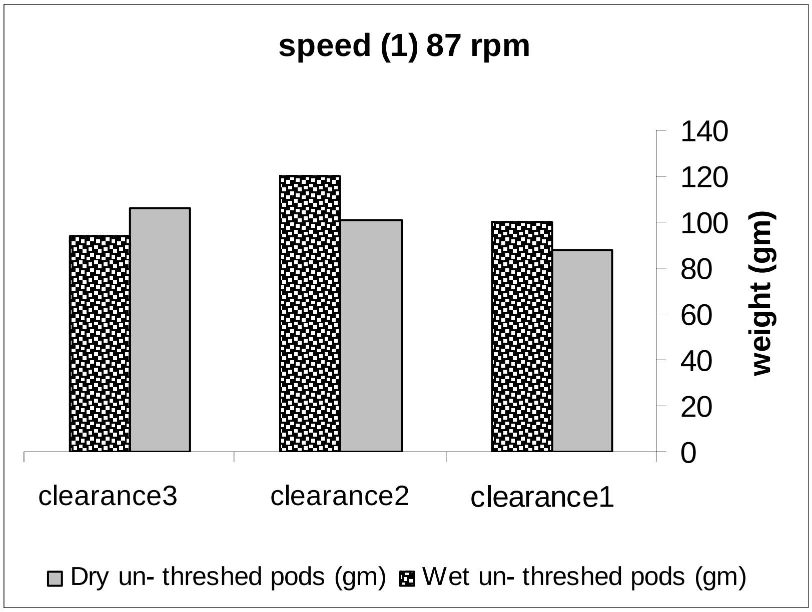


Fig. (3): Effect of Different Speeds and Clearance Sizes on Threshed Pods



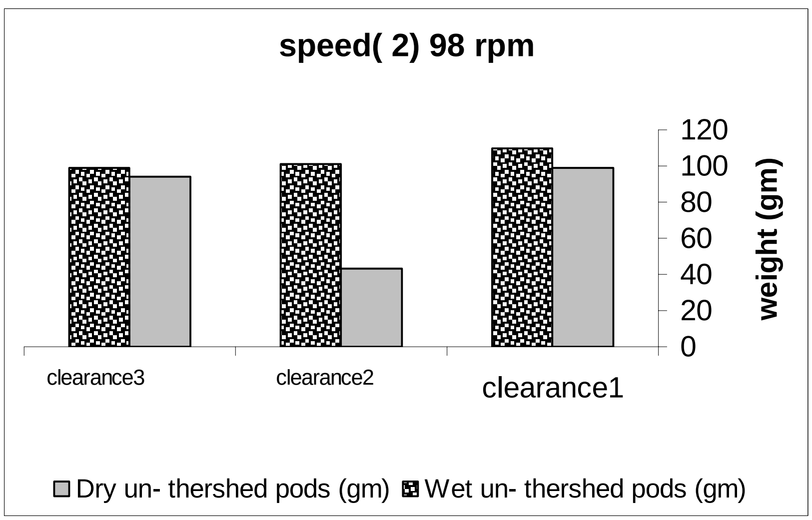
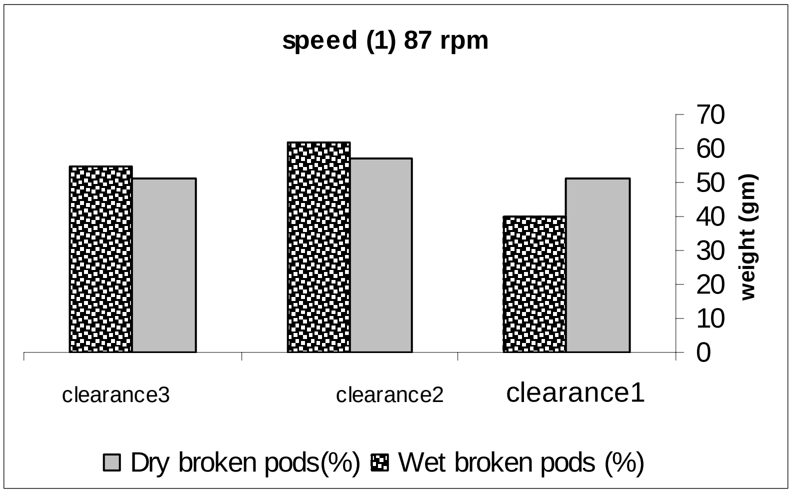


Fig. (4): Effect of Different Speeds and Clearance Sizes on un- Threshed Pods



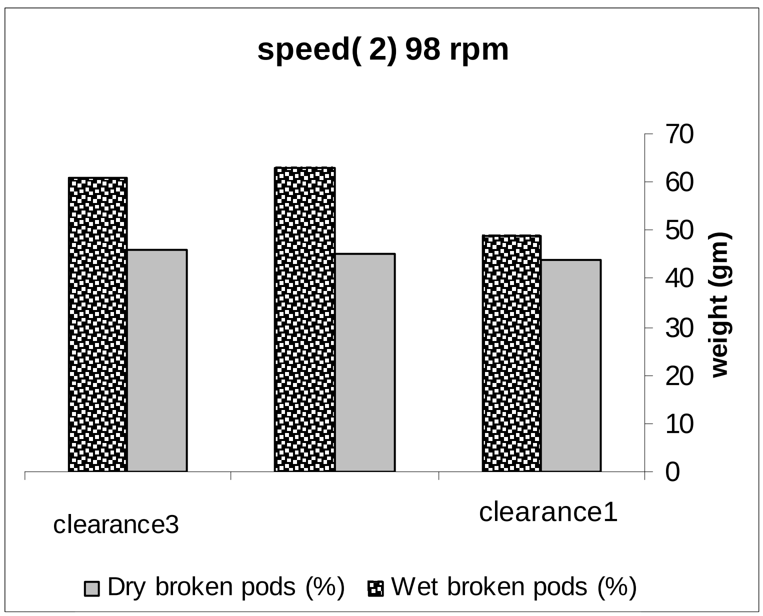
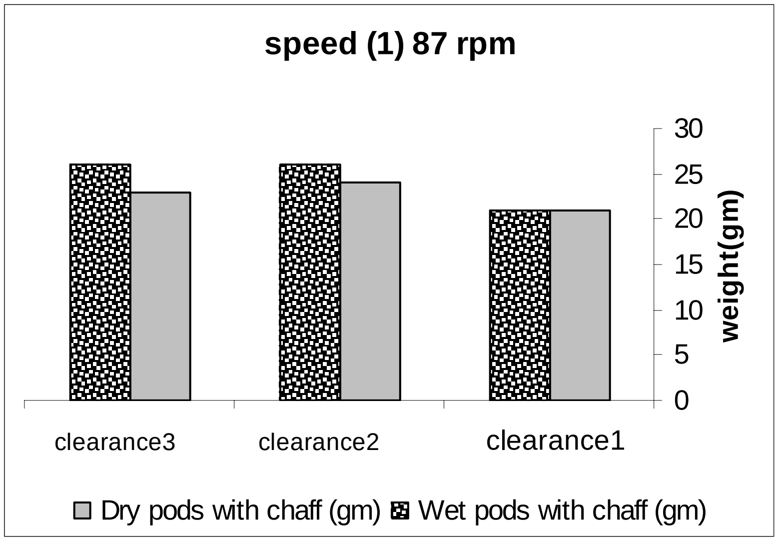


Fig. (5): Effect of Different Speeds and Clearance Sizes on broken Pods



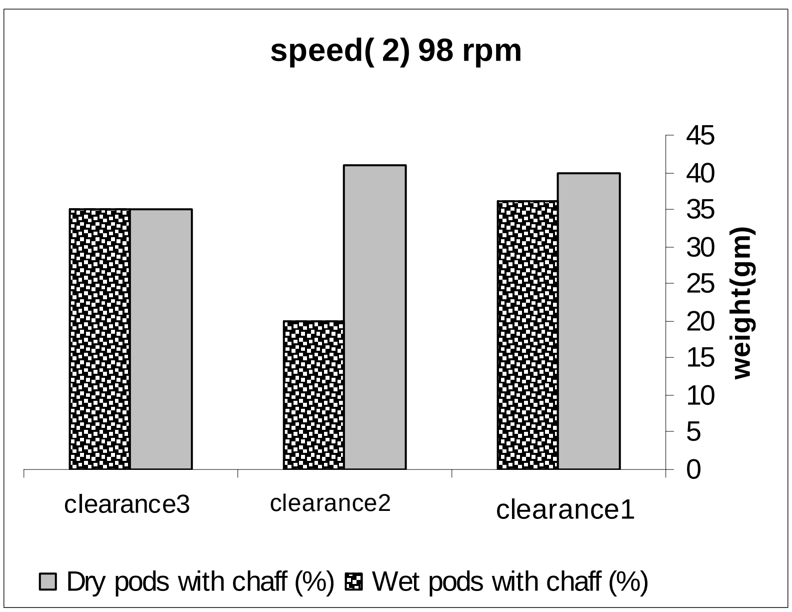


Fig. (6): Effect of Different Speeds and Clearance Sizes on Pods with Chaff

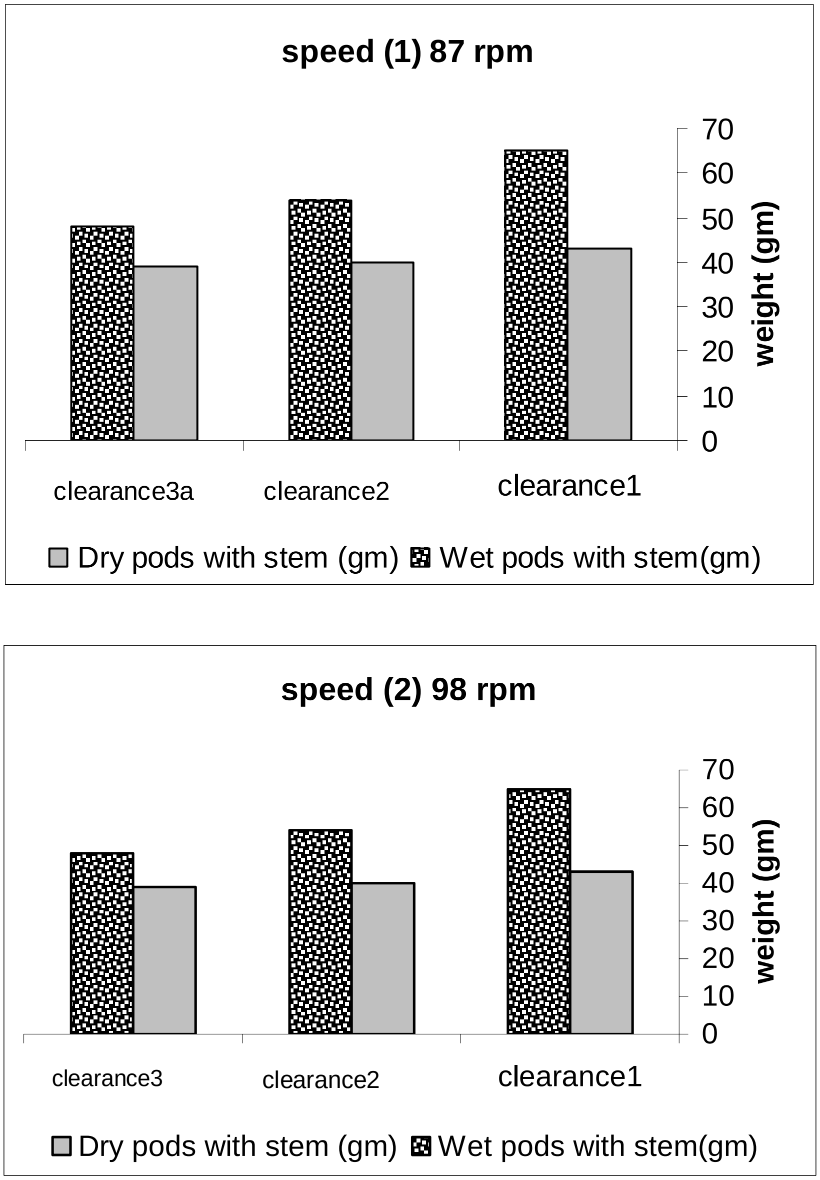
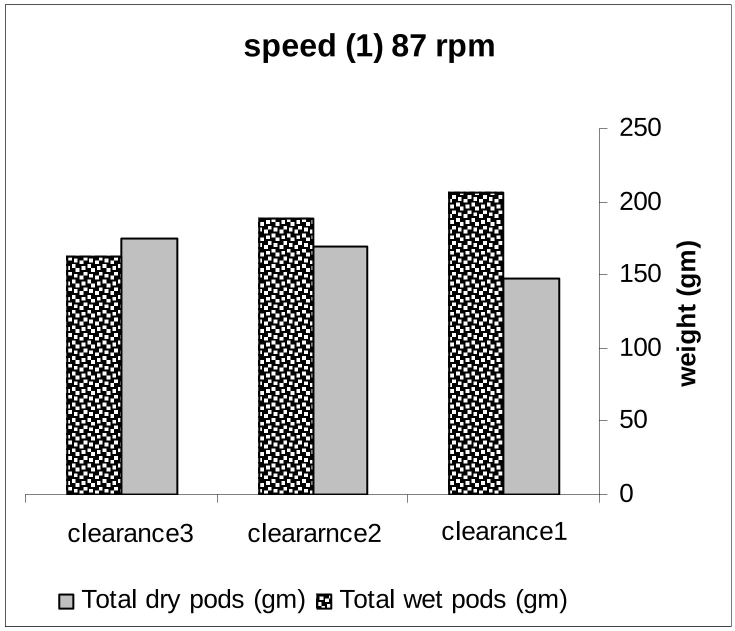


Fig. (7): Effect of Different Speeds and Clearance Sizes Pods with Stem



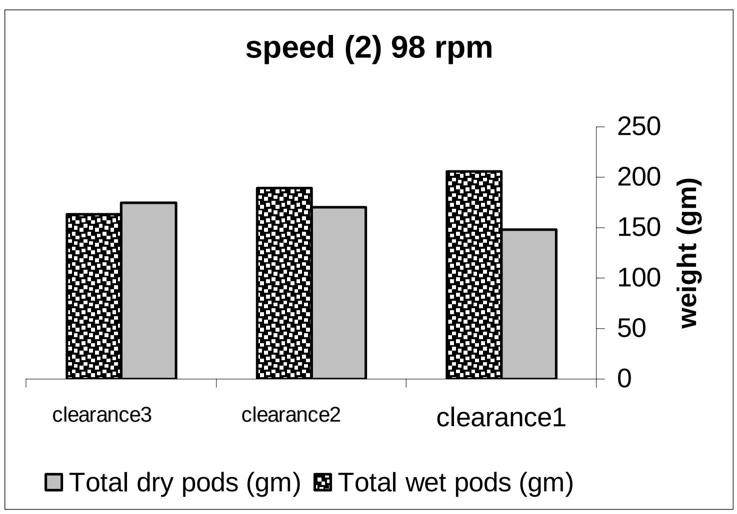
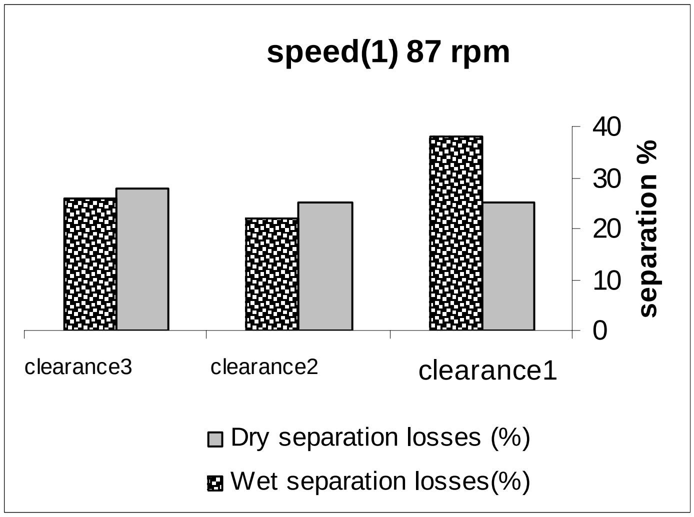


Fig. (8): Effect of Different Speeds and Clearance Sizes on Total Pods



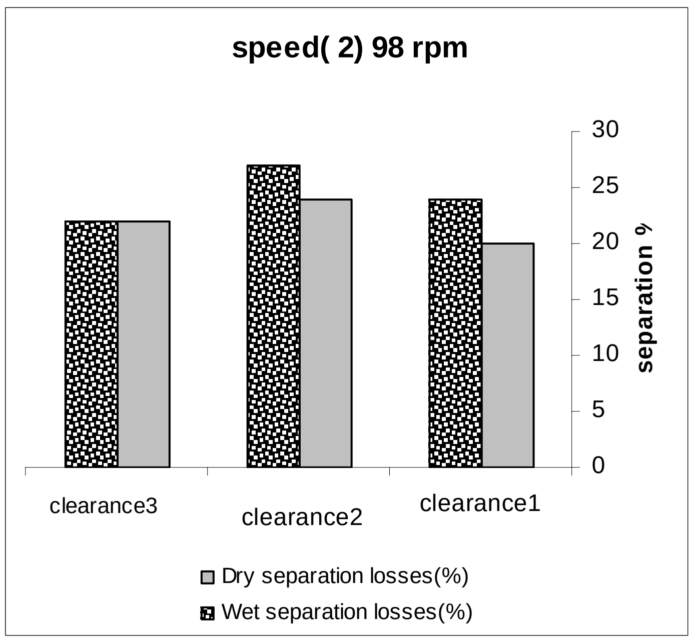
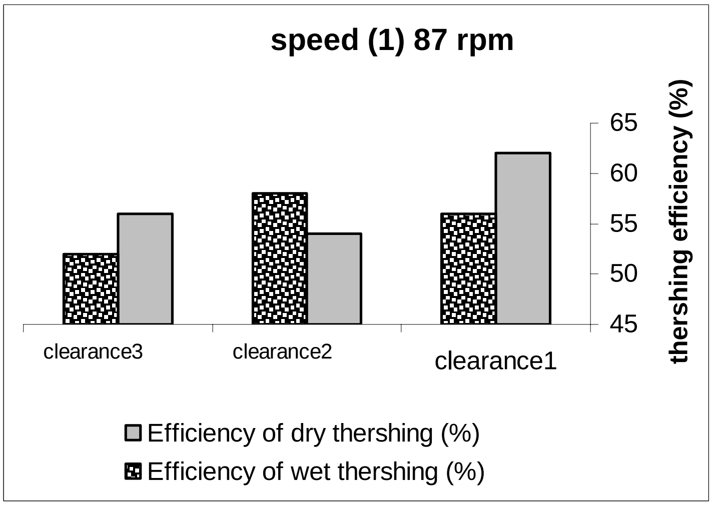


Fig. (9): Effect of Different Speeds and Clearance Sizes on Separation Losses



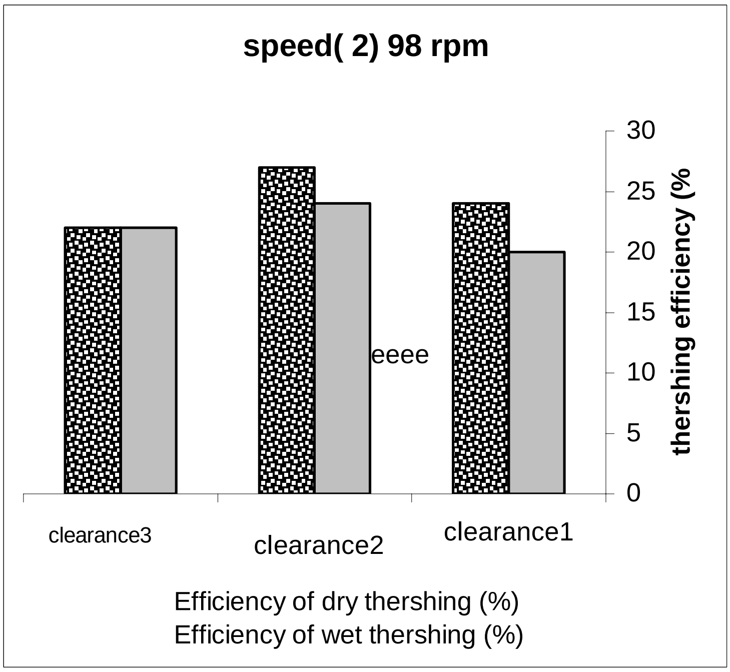


Fig. (10): Effect of Different Speeds and Clearance Sizes on Threshing Efficiency

CONCLUSIONS

The drum and concave of a stationary crop thresher was modified and built in complete machine to simulate the operating parameters commercial threshers. Evaluation of the machine model indicated the possibility to modify the existing commercial thresher so as to thresh multi-crops with low costs of modification. To obtain optimum thresher performance it is recommended to operate the machine with speed of 87 rpm and clearance of 25-30mm under dry crop moisture.

However, the modified machine needs to be test in wet farmer's field by adding a stammers saws system.

REFERENCE

1- **Abdul Moneim, O .A.** (1985). Evaluation of the losses of the groundnut crop. M.Sc. Thesis University of Khartoum.

2- **Abdullah, Y. A.** (1990). Design and evaluation of seed crop planters M. Sc. Thesis University of Khartoum.

3- **AOAD**, (1993). Arab Organization for Agricultural Development, Annual Report.

4- **Bank of Sudan,** (1999). Annual report for import machinery in the Sudan.

5- **Dosa, A.** (1984). Mechanization of peanut harvesting in Malaysia, AMA **15** (2): PP: [44-48].

6- **Khan, A. U.** (1990). Dual–model all crop threshers. AMA **21**(4): PP: [11-14].

7- **Madian, A.K and Sign,** (1985). Studies on an axial threshing system for groundnuts ISAF silver juplee Conversion **Vol. 1**.

8- **Singh and Verma, S. R**. (1972). Development and performance of an experimental groundnut thresher, Journal of Agric. Eng. **1**.

9- **Tandon, S. K.** (1982), Threshing efficiency of different pulses using step- wise regression technique AMA **15**(3): PP: [20-25].