DEVELOPMENT OF FEEDING DEVICE IN A TURKISH THRESHING MACHINE

Mahmoud M. A. Ali * **Moheb M. A. El-Sharabasy** * **Mahmoud Kh. A. Khattab** **

ABSTRACT

A feeding device in a Turkish threshing machine was constructed to increase machine efficiency and avoid many traumatic injuries during threshing process. Five different material feeding rates of 900, 1000, 1100, 1200 and 1300 kg/h; five rotating drum speeds of 23, 25, 27, 29 and 31 m/s and three grain moisture contents of 17, 19 and 21 % were deduced and compared to determine the un-threshed grains, mechanical grain damage and total grin losses; threshing and cleaning efficiencies; energy consumed and total cost requirements for threshing wheat crop.

The data obtained show that using threshing machine with the constructed feeding device decreased un-threshed grain losses by 26.99 %, mechanical grain damage by 40.37% and total grain losses by 34.85%. In addition, threshing efficiency increased by 0.62 %, cleaning efficiency increased by 3.00 %, energy requirements increased by 3.49 % and finally threshing cost decreased by 14.27 % at material feed rate of 1100 kg/h, drum speed of 27 m/s and grain moisture content of 19 %.

INTRODUCTION

Wheat crop is considered the most economical crop participating in the international income added to the local consumption in feeding and different aspects. Therefore, increasing the yield by means of up to date technology through the different agricultural processes, decreasing grain losses during harvesting and threshing operations are important questions to be answered.

Wheat crop is too sensitive to threshing operations due to the high percentage of grain losses affecting on the total yield. There are many factors affecting the performance of threshing machines such as cylinder peripheral speed, feeding rate and moisture content. The mentioned factors affected directly on the crop losses, energy requirements, and

* Lecturer of Agric. Eng. Dept., Fac. of Agric., Zagazig Univ., Egypt.
** Assist. Prof. of Agric. Eng. Dept., Fac. of Agric., Zagazig Univ.,

efficiency, which in return, influenced the total operational cost. Threshers are used extensively on Egyptian farms for threshing grains, but they are involved in a significant proportion of limb crush injuries.

International safety standards are somewhat difficult to enforce because manufacturing of machines was done at widely dispersed local workshops. In Egypt, many small workshops and manufactures produce threshing machines without any scientific guidance.

Beside that, no feeding device was attached with the threshing machine, which makes feeding operation difficult and danger.

For these reasons, a feeding device was constructed and attached with the Turkish threshing machine to increase its efficiency and decrease total grain losses, energy, and total cost requirements.

Singh and Sinha (1980) reported that 30 thresher injuries out of 50 in a survey from India, but the study did not give any details of type of injury or mechanism of injury. **Majumdar (1985)** designed a multi-crop thresher by incorporating an axial flow arrangement on a traditional spike tooth thresher for threshing major crops. The machine was operated by a 5 hp electric motor and the output capacities at maximum feed rate were 348, 276, 200, 540, 1635 and 392 kg/h for gram, wheat, soybeans, sorghum, maize and paddy, respectively. The threshing efficiency was approx. 99 % in most cases. Cleaning efficiency was 99, 97 and 99 % for wheat, sorghum and maize and slightly lower for the other crops. Total grain losses were 2 % for wheat, gram, sorghum and paddy and 2.2 and 4% for maize and soybeans, respectively. **Helmy (1988)** compared two threshing machines, American (A) and Egyptian (E). Three cylinder speeds (11, 20, 52 and 36.65 m/s), five feed rates (0.06, 0.13, 0.19, 0.25 and 0.31 kg/s) over ranges of 13.6 to 18.8 % and 9.7 to 13.5 % (d.b) grain and straw moisture contents of wheat were used. He strongly recommended using the local threshing machine for good performance. The threshing efficiency, unit energy, total grain damage, un-threshed grain and cut straw 99.10 %, 1.0 kW.h/ton, 6.5 %, 0.86 % and 22.5 %, respectively at 20.52 m/s cylinder speed and 0.25 kg/s feed rate for 18.8% and 13.5% grain and straw moisture contents are considered optimum conditions of the local threshing machines. **Rawal (1988)** reported that the human factors were associated with thresher injuries in 73 % of the cases. These included inattentiveness, wearing of loose garments, overwork and physical incapability, etc. However, these observations were not based on any detailed investigations. No study has evaluated improvements in design or any safety mechanisms. **Mufti *et al.* (1989)** reported that belt entanglement, electric shock and feeding crop without safety were main reasons attributed to thresher injuries they added also that the mechanical failures responsible for injuries were 17 %. **Mohan and Patel (1992)** stated that the mechanization of agricultural practices has resulted in increased agricultural productivity in India but at the same time the incidence of traumatic injuries among agricultural workers seems to have increased also. It is estimated that every year in three states of northern India alone there may be 5000 to 10000 deaths, 15000 to 20000 amputations and 150000 to 200000 serious injuries due to agricultural related activities. Among these, threshing machines are responsible for a significant number of serious injuries. **Morad (1997)** investigated threshing machine performance in terms of grain losses, energy requirements, and threshing cost as a function of change in feed rate, cylinder speed, and grain moisture-content during wheat threshing. From the obtained data he concluded that threshing losses as well as threshing cost can be minimized when the feed rate of 1 ton/h drum speed of 25 m/s, and moisture content of 20 % are considered for the used machine. **Abdelghany and El-Sahar (1999)** selected three cultivars of bread wheat cv. (Giza-163 and Sids-10) and durum wheat cv. (Sohag-1) and dried to moisture contents of about 9, 8 and 7 % were threshed in a flail threshing machine at drum speeds of 11, 20 and 36.7 m/s and feeding rates of 0.013, 0.125 or 0.050 kg/s. The broken grain percentage was higher in Sohag-1 than the other cultivars, at 8 and 9 % moisture content than 7 %, and increased with increasing drum speed, but decreased with increasing machine feeding rate. **Kumar *et al.* (2000)** stated that threshing machine recorded 2 % of total agricultural injuries though they are used only for a few days in the whole year, thresher injuries have not been reported by any high- income countries after 1969.

Gill *et al.* (2002) studied the effects of various operational factors like feed rate and cylinder speed on wheat grain loss, sieve loss, cleaning efficiency, threshing efficiency on a spike tooth cylinder type plot thresher having dimensions of (925×700×925 mm). The feeding rates taken were 150, 252 and 348 kg/h at each feed rate; the observations were taken at cylinder speed of 775, 900 and 1050 rpm. The optimum combination of feed rate and cylinder speed was found at 252 kg/h and 900 rpm, respectively. At this combination the threshing efficiency, cleaning efficiency and total grain losses were 99.14, 99.97 and 1.3 %, respectively.

MATERIAL AND METHODS

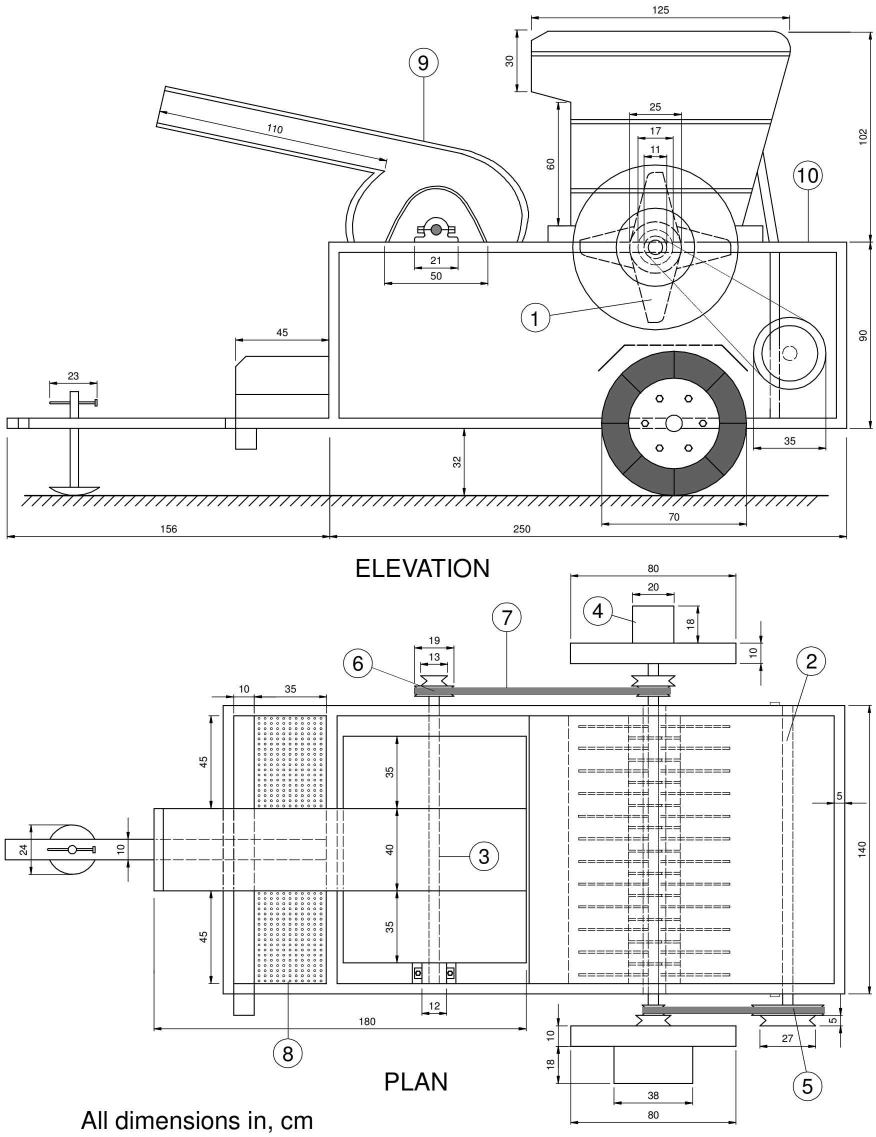
Field experiments were carried out for threshing wheat crop (Sakha-93 variety) in a private farm in Sharkia governorate during the agricultural summer season of 2006. All experiments were conducted using a threshing Turkish type machine before and after development. The elevation and plan of Turkish thresher machine before and after development are shown in figs (1 and 2), respectively.

(A) MATERIALS:

- Threshing machine:

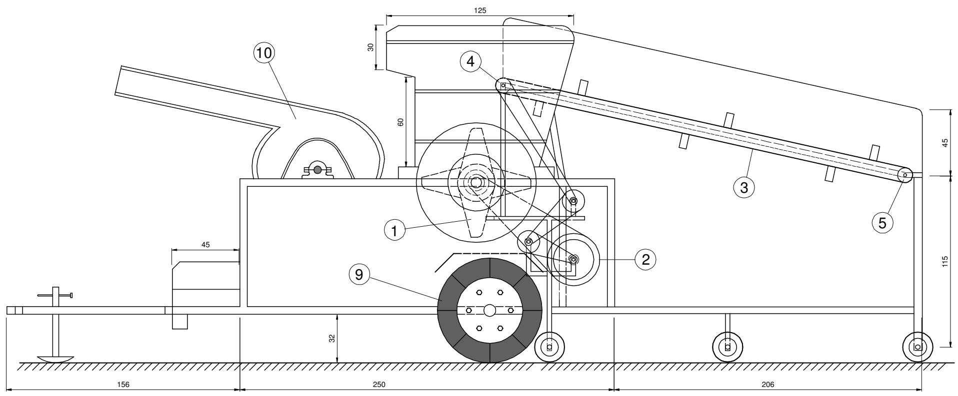
Made	Turkish
Type of drum	Beater fingers
Drum diameter (cm)	73
Drum length (cm)	120
Concave clearance (cm)	3
Concave holes (No./100 cm^2)	18
Concave hole diameter (cm)	1.8
Screen holes (No./100 cm^2)	40
Screen holes diameter (cm)	1.4

The threshing machine was powered with M34/T tractor with a four cylinder diesel engine – 60 hp (44.10 kW).

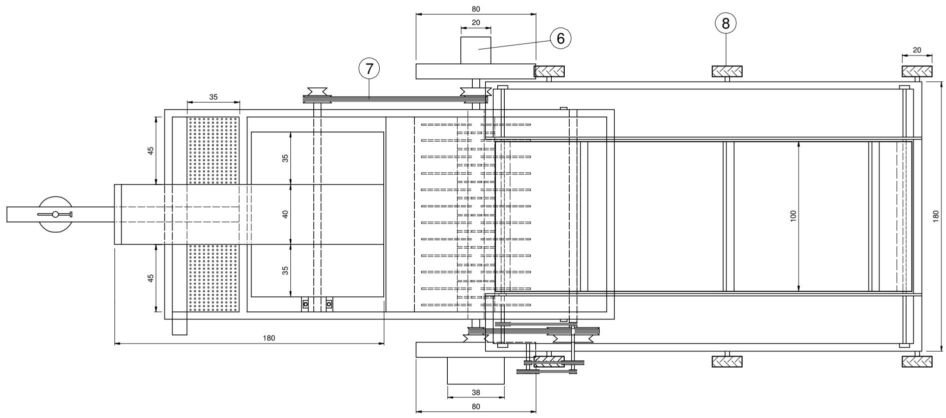


No.	Part name	No. off	No.	Part name	No. off
1	Threshing drum	1	6	Fan pulley	1
2	Sieve shaft	1	7	V-Belt	2
3	Fan shaft	1	8	Sieve	1
4	Guide pulley	1	9	Blower	1
5	Sieve pulley	1	10	Frame	1

Fig. (1): Elevation and plan of a Turkish thresher machine before development.



ELEVATION



PLAN

All dimensios in, cm

No.	Part name	No.off	No.	Part name	No.off
1	Threshing drum	1	6	Guide pulley	1
2	Sieve pulley	1	7	V-Belt	5
3	Flat belt	1	8	Device wheel	6
4	Edler pulley	1	9	Thresher wheel	2
5	Edle pulley	1	10	Blower	1

Fig. (2): Elevation and plan of a Turkish threshing machine after development.

-The developed feeding device:

The developed feeding device in the Turkish thresher machine consists of four main parts as shown in fig. (3).

1- Frame:

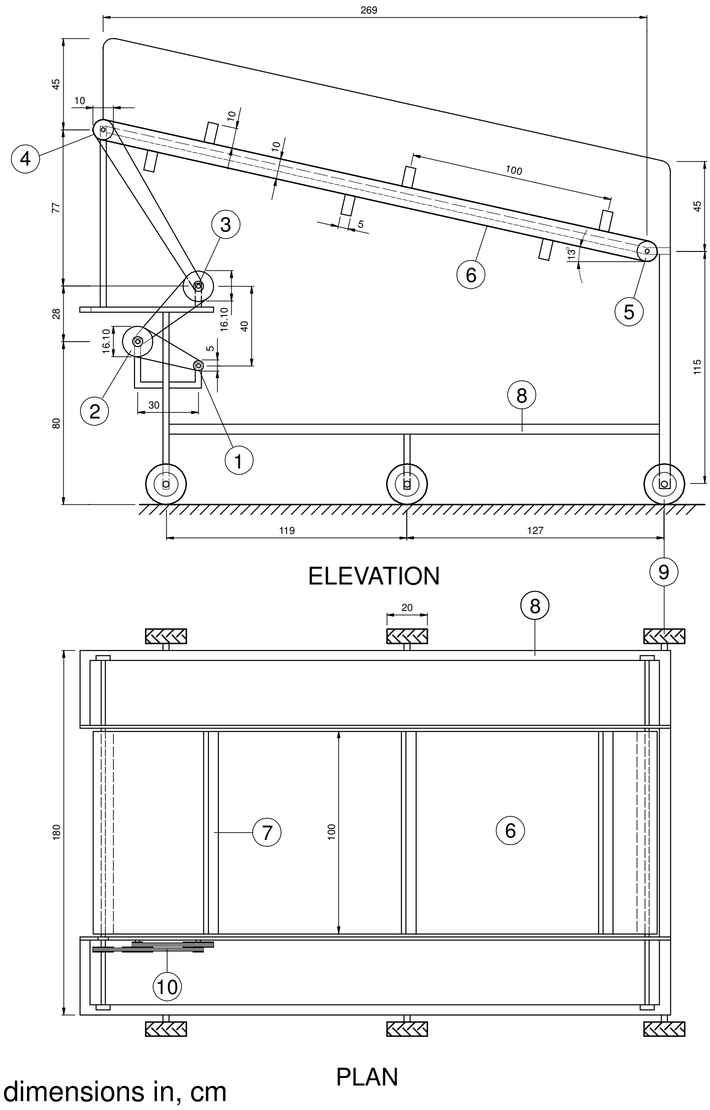
The frame consists of two trapezoidal shape sides with a lateral space between them of 180 cm. Its height is 185 cm from the front side, which the idler driven drum is fixed; and its height is 125 cm from the backside, which the idle driven drum is fixed. The longitudinal distance between the front and the backsides is 275 cm. This frame shape makes the conveyor belt is 300 cm in length and the oblique angle with horizontal was about 12° to transport the crop materials to the threshing drum more easily.

2- Transmission system:

The motion is transmitted from the sieve shaft (main drive shaft), which provided with a fixed pulley of 5 cm in diameter to transmit the motion to the speed reduction shaft, to the feeding shaft, to the driven shaft, which carried the belt for feeding the crop materials.

The speed reduction shaft is provided with five pulleys, which can be replaced. They have diameters of 14.90, 15.50, 16.10, 16.70, and 17.30 cm to control the reduction speed. The pulley of 16.10 cm was selected as optimum pulley speed through the experimental procedures, which represents 27.00 m/s. This shaft is ended with a fixed pulley of 5 cm in diameter to transmit the motion from it to the feeding shaft, as shown in fig. (3).

The feeding shaft is also provided with different five pulleys, which can be replaced. They have diameters of 13.80, 14.90, 16.10, 180, and 19.80 cm to give different material feeding rates of 1300, 1200, 1100, 1000, and 900 kg/h. This shaft is ended with a fixed pulley of 5 cm in diameter to transmit the motion to the driven shaft which carry the conveyor belt and crop materials and provided with a fixed pulley of 10 cm in diameter.



All dimensions in, cm

.	Part name	No. off	No.	Part name	No. off
	Feeding shaft	1	6	Flat belt	1
	Transmission shaft (1)	2	7	Bar	6
	Transmission shaft (2)	2	8	Frame	1
	Edler shaft	1	9	Wheel	6
	Edle shaft	1	10	V-Belt	3

Fig. (3): Elevation and plan of the developed feed device in a Tur kish threshing machine.

3- Idler drive and idle driven drums:

Two drums with diameter of 10 cm and length of 120 cm powered the conveyor belt. The idler drum pulley of 10 cm in diameter takes its motion from the feeding shaft.

4- Rubber conveyor belt:

A flat belt with dimensions of 300 cm in length, 100 cm in width and 0.2 cm in thickness was constructed on idler drive and idle driven drums. Eight aluminum bars 10 cm in height and 100 cm in width were fixed on the flat belt to control uniformity of the crop materials during the feeding process.

(B) METHODS:

All experiments were conducted using three variables: five material feed rates of 900, 1000, 1100, 1200 and 1300 kg/h; five drum speeds of 23, 25, 27, 29 and 31 m/s and three moisture contents of 17, 19 and 21 %. The grain moisture content was determined on dry basis using the oven method at 105^{o}C for 24 hours in the laboratory of faculty of agriculture, Zagazig University.

1- Threshing losses:

The total threshing losses percentage (TGL) including both un-threshed grain losses (UGL) and damage grain losses (DGL) was calculated before and after developing the thresher using the following equation, (Mishram and Desta 1990):-

$$TGL\,,(\%) = \frac{D_G + Un_G}{T_G} \times 100 ....(1)$$

Where:

D_G = Weight of damaged grains collected at all outlets per unit time, kg.

Un_G = Weight of un-threshed grains per unit time, kg.

T_G = Weight of total grains input per unit time, kg.

Un-threshed grain losses percentage was calculated as follows:-

$$UGL, (\%) = \frac{Un_G}{T_G} \times 100 ....(2)$$

Damaged grain losses percentage was calculated as follows:-

$$DGL,(\%) = \frac{D_G}{T_G} \times 100 ....(3)$$

2-Threshing and cleaning efficiency:

The threshing efficiency was calculated according to the following formula:-

$$Threshing\ efficiency,(\%) = \frac{T_G - Un_G}{T_G} \times 100 .....(4)$$

$$Cleaning\ efficiency,(\%) = \frac{W}{W_O} \times 100 ....(5)$$

Where:-

W = Weight of grains from the main output opening after cleaning, kg.

W_O = Weight of grains and small chaff from the main output opening, kg.

3-Energy requirements:

To estimate the engine power during threshing process, the decrease in fuel level is accurately measured immediately after each treatment. The following formula was used to estimate the corresponding used engine power (*EP*) according to Hunt (1983).

$$EP = \left[f.c.(1/3600) PE \times L.C.V. \times 427 \times \eta_{thb} \times \eta_m \times 1/75 \times 1/1.36 \right], kW ....(6)$$

Where:-

f.c. = The fuel consumption, (*l*/h).

PE = The density of fuel, (kg/*l*), (for Gas oil = 0.85).

L.C.V. = The lower calorific value of fuel, (11.000 k.cal/kg).

η_{thb} = Thermal efficiency of the engine (35 % for Diesel).

427 = Thermo-mechanical equivalent, (Kg.m/k.cal).

η_m = Mechanical efficiency of the engine (80 % for Diesel).

Hence, the energy requirements can be calculated as follows:-

$$Energy\ requirements = \frac{EP,(kW)}{Feed\ rate,(ton/h)},\ kW.h/ton ....(7)$$

4- Threshing cost:

The total cost of threshing operation was estimated using the following equation, (Awady *et al.* 1982):-

Threshing cost, (L.E/ton) = Operating cost + Grain losses cost….(8)

Operating cost was determined using the following equation:-

$$Operating\ \cos t = \frac{Machine\ \cos t\ (L.E/h)}{Feed\ rate\ (ton/h)}, (L.E/ton) \ldots\ldots\ldots\ldots\ldots\ldots(9)$$

Machine cost could be determined using the following equation (Awady 1978):-

$$C = \frac{P}{h}\left(\frac{1}{a} + \frac{i}{2} + t + r\right) + \left(0.9 W.S.F\right) + \frac{m}{144} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(10)$$

Where:-

C = Hourly cost, L.E/h.
P = Price of machine, L.E.
h = Yearly working hours, h/year.
a = Life expectancy of the machine, h.
i = Interest rate/year.
F = Fuel price, L.E/*l*.
t = Taxes, over heads ratio.
r = Repairs and maintenance ratio.
m = Monthly average wage, L.E
0.9 = Factor accounting for lubrications.
W = Engine power, hp.
S = Specific fuel consumption, *l*/hp.h.
144 = Reasonable estimation of monthly working hours.

RESULTS AND DISCUSSION

There are many parameters affecting the performance of the threshing machine such as: material feed rate, drum speed and grain moisture content.

1- Un-threshed and damaged grain losses:

The un-threshed grains as well as damaged grains are affected by many parameters such as material feed rate, threshing drum speed, grain moisture content, ..…etc.

a- Effect of material feed rate on un-threshed and damaged grains:

Concerning the effect of material feed rate on the percentage of un-threshed grains, results obtained in fig. (4) show that increasing feed rate increased the percentage of un-threshed grains and decreased the percentage of damage grains under all experimental conditions.

Increasing feed rate from 900 to 1300 kg/h under constant drum speed of 27 m/s and various grain moisture contents of 17, 19 and 21 % increased the percentage of un-threshed grains by 76.36, 66.59, and 64.02 %, respectively using the threshing machine before development and by 90.79, 87.72, and 78.41 %, using the developed machine under the same previous conditions.

While the vice-versa noticed with the damaged grain losses. Increasing material feed rate from 900 to 1300 kg/h under constant drum speed of 23 m/s and various grain moisture contents of 17, 19 and 21 %, decreased the percentage of damaged grains by 15.90, 34.86, and 24.69 %, respectively using the threshing machine before development and by 40.21, 60.18, and 61.44 %, using the developed machine under the same previous conditions.

The increase in the percentage of un-threshed grains and the decrease in percentage of damaged grains by increasing material feed rate are attributed to the excessive wheat plants in the threshing chamber. Consequently, wheat plants leave the device without complete threshing that tends to increase un-threshed grains and decrease damaged grains.

Results also show that the developed machine decreased the percentage of un-threshed grains and damaged grains comparing with the machine before development due to the uniform distribution of wheat plants along the developed feeding device, which enable plants to enter the threshing chamber from the panicles direction, thus uniform impact is expected resulting in low percentage of un-threshed and damaged grains.

b- Effect of drum speed on un-threshed and damaged grains:

Relating to the effect of drum speed on the percentage of un-threshed grains, results in fig. (4) show that increasing drum speed decreased the un-threshed grains and increased the damage grains under all experimental conditions. Increasing drum speed from 23 to 31 m/s under constant material feed rate of 1100 kg/h and various grain moisture contents of 17, 19 and 21 % decreased the percentage of un-threshed grains by 70.60, 55.73, and 58.82 %, respectively using the threshing machine before development and by 77.98, 72.56, and 54.16 %, using the developed machine under the same previous conditions.

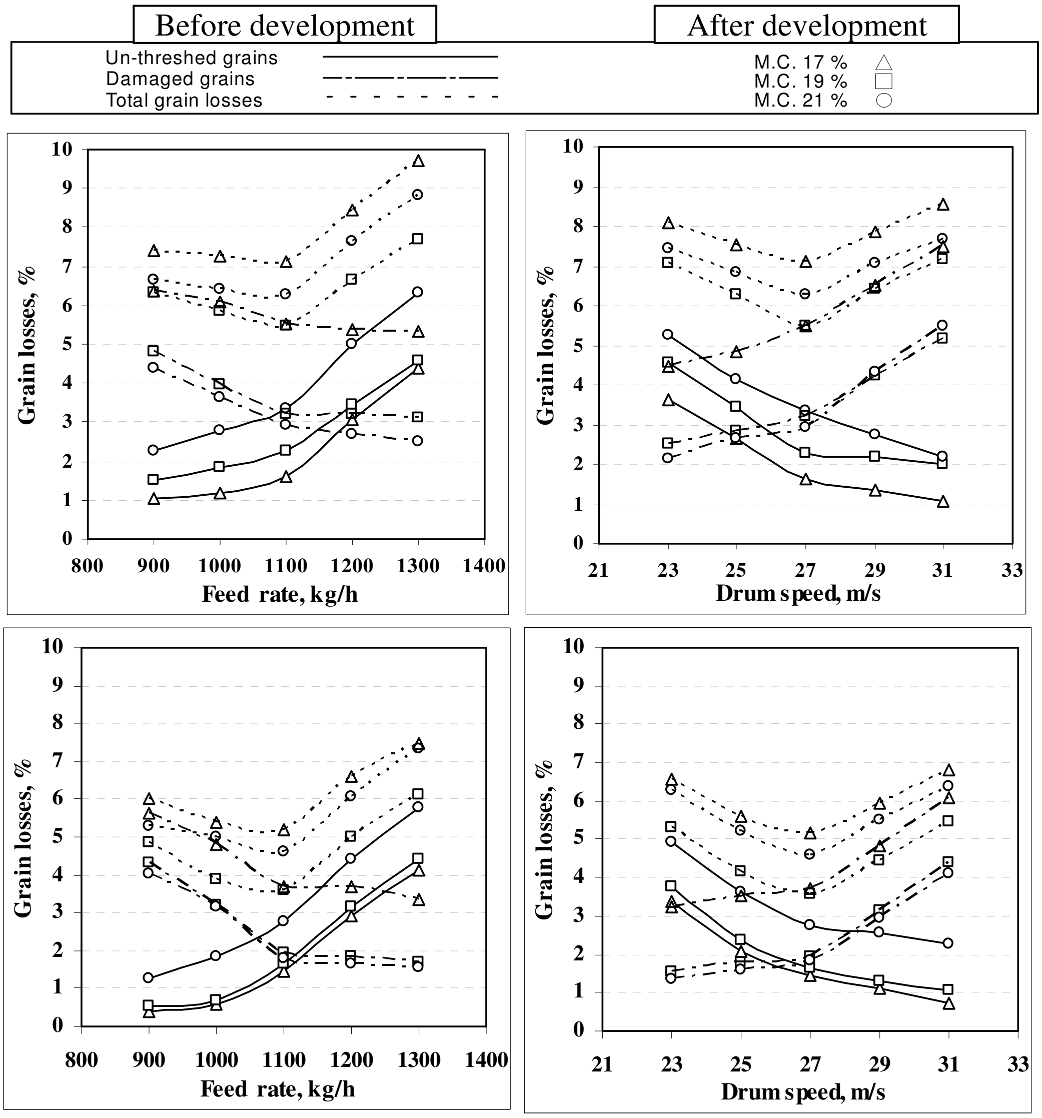


Fig.(4): Effect of material feed rate and drum speed on un-threshed grains, damaged grains and total grain losses at different grain moisture contents.

While the vice-versa noticed with the damaged grain losses. Increasing drum speed from 23 to 31 m/s under constant material feed rate of 1100 kg/h and various grain moisture contents of 17, 19 and 21 % increased the percentage of damaged grains by 40.32, 51.45, and 60.66 %, respectively using the threshing machine before development and by 46.95, 65.38, and 67.55 %, using the developed machine under the same previous conditions.

The decrease in the percentage of un-threshed grains and the increase in percentage of damaged grains by increasing drum speed are attributed to the high stripping and impacting forces applied to the wheat plants, that tends to improve the threshing operation and decrease un-threshed grains and increase damaged grains.

The obtained data also show that the developed machine decreased the percentage of un-threshed grains and damaged grains in comparison with the machine before development because the uniform distribution of wheat plants along the threshing chamber enable the threshing drum to knock the panicles more times that tends to decrease un-threshed grains and increase damaged grains.

c- Effect of grain moisture content on un-threshed and damaged grains:

As to the effect of grain moisture content on the percentage of un-threshed grains and damaged grains, data in fig. (4) show that increasing grain moisture content from 17 to 21 % increased un-threshed grains and decreased damaged grains under all experimental conditions. Increasing grain moisture content from 17 to 21 % under constant material feed rate of 1100 kg/h and various drum speeds of 23, 25, 27, 29 and 31 m/s increased the percentage of un-threshed grains by 30.93, 35.66, 51.79, 50.73, and 50.69 %, respectively using the threshing machine before development and by 31.85, 41.99, 46.93, 57.09, and 67.26 %, using the developed machine under the same previous conditions.

While the vice-versa with the damaged grains, increasing grain moisture content from 17 to 21 % under constant material feed rate of 1100 kg/h and various drum speeds of 23, 25, 27, 29 and 31 m/s decreased the percentage of damaged grains by 51.68, 45.06, 47.09, 33.44, and 26.70 %, respectively using the threshing machine before development and by 58.39, 54.26, 50.94, 38.76, and 31.69 %, using the developed machine under the same previous conditions.

The increase of un-threshed grains and the decrease of damaged grains percentage by increasing grain moisture contents due to the elastic conditions of high moisture content of grains resulting in a little impacting force on the wheat materials.

2- Total grain losses:

The total grain losses affected with many parameters such as material feed rate, threshing drum speed, grain moisture content, ..…etc.

The total grain losses are the sum of un-threshed grains and damaged grains during the threshing operation.

Concerning the effect of material feed rate, drum speed and grain moisture content on total grain losses, results obtained in fig. (4) show that the material feed rate of 1100 kg/h, drum speed of 27 m/s and grain moisture content of 19 % are considered the optimum values during threshing operation in both before and after development, which recorded the minimum total grain losses of 5.48 and 3.57 %, respectively. The developed machine decreased the percentage of total grain losses by 34.85 % in comparison with the machine before development due to the decrease in both un-threshed grains and damaged grains.

Fig. (4) show that, the decrease or increase material feed rate, drum speed and grain moisture content less or more than the optimum values mentioned above, lead to increase total grain losses significantly under all experimental conditions due to increase both un-threshed grains and damaged grains as a result of non uniform conditions during threshing operation.

3- Threshing and cleaning efficiencies:

The threshing efficiency is a function to the un-threshed grain losses. It decreased as increasing both material feed rate and grain moisture content. While the cleaning efficiency expresses the amount of clean grains with minimum straw, stone and foreign materials thorough the threshing operation. It decreased as increasing both material feed rate and grain moisture content.

a- Effect of material feed rate on threshing and cleaning efficiencies:

Concerning the effect of material feed rate on the threshing and cleaning efficiencies, results obtained in fig. (5) show that increasing feed rate decreased both the percentage of threshing and cleaning efficiencies under all experimental conditions. Increasing material feed rate from 900 to 1300 kg/h under constant drum speed of 27 m/s and various grain moisture contents of 17, 19 and 21 % decreased the percentage of threshing and cleaning efficiencies by 3.40, 3.10, and 4.13 %; by 5.10, 5.44, and 5.65 %, using the threshing machine before development and by 3.76, 3.88, and 4.60 %; by 4.22, 4.36, and 4.89 %, using the developed machine under the same previous conditions.

The decrease in the percentage of threshing and cleaning efficiencies by increasing material feed rate are attributed to the excessive wheat plants in the threshing chamber. Consequently, wheat plants leave the device without complete threshing.

Fig. (5) show also that, the developed machine increased the percentage of threshing and cleaning efficiencies comparing with the machine before development due to the uniform distribution of wheat materials along the developed feeding device, which guide wheat materials to the threshing chamber uniformity resulting in low percentage of un-threshed grains and improve threshing operation.

b- Effect of drum speed on threshing and cleaning efficiencies:

Relating to the effect of drum speed on the percentage of threshing and cleaning efficiencies, results in fig. (5) show that increasing drum speed increased the threshing and cleaning efficiencies under all experimental conditions. Increasing drum speed from 23 to 31 m/s under constant material feed rate of 1100 kg/h and various grain moisture contents of 17, 19 and 21 % increased the percentage of threshing and cleaning efficiencies by 2.60, 2.58, and 3.17 %; by 5.01, 4.79, and 4.44 %, respectively using the threshing machine before development and by 2.64, 2.78, and 2.73 %; by 3.39, 3.81, and 4.55 %, respectively using the developed machine under the same previous conditions.

The increase in the percentage of threshing and cleaning efficiencies by increasing drum speed are attributed to the high stripping and impacting forces applied to the wheat materials, that tends to improve the threshing operation and increase threshing and cleaning efficiencies. The obtained data also show that the developed machine increased the percentage of threshing and cleaning efficiencies comparing with the machine before development because of the uniform distribution of wheat materials along the threshing chamber which enable the threshing drum to knock wheat materials more times that tends to improve threshing process and increase threshing and cleaning efficiencies.

c- Effect of grain moisture content on threshing and cleaning efficiencies:

As to the effect of grain moisture content on the percentage of threshing and cleaning efficiencies, results in fig.(5) show that increasing grain moisture content from 17 to 21 % decreased the threshing and cleaning efficiencies under all experimental conditions. Increasing grain moisture content from 17 to 21 % under constant material feed rate of 1100 kg/h and various drum speeds of 23, 25, 27, 29 and 31 m/s, increased the percentage of threshing and cleaning efficiencies by 1.69, 1.52, 1.77, 1.41, and 1.11 %; 1.90, 1.95, 2.14, 2.27, and 2.49 %, respectively using the threshing machine before development and by 1.62, 1.55, 1.32, 1.47, and 1.53 %; 3.44, 3.13, 2.89, 2.68, and 2.27 %, respectively using the developed machine under the same previous conditions.

The results show that the developed machine increased the percentage of threshing and cleaning efficiencies compared with the machine before development because of the uniform distribution of wheat materials along the threshing chamber that tends to decrease both un-threshed and damaged grains.

4- Energy requirements:

The energy requirements are a measure for all parameters affecting the threshing operation. It increased as increasing the material feed rate, threshing drum speed and grain moisture content.

a- Effect of material feed rate on energy requirements:

Results obtained in fig. (6) show that increasing material feed rate increased the percentage of energy requirements under all experimental conditions. Increasing material feed rate from 900 to 1300 kg/h under constant drum speed of 27 m/s and various grain moisture contents of 17, 19 and 21 % increased the percentage of energy requirements by 19.31, 17.78, and 18.25 %, respectively using the threshing machine before development and by 16.72, 16.62, and 18.51%, respectively using the developed machine under the same previous conditions.

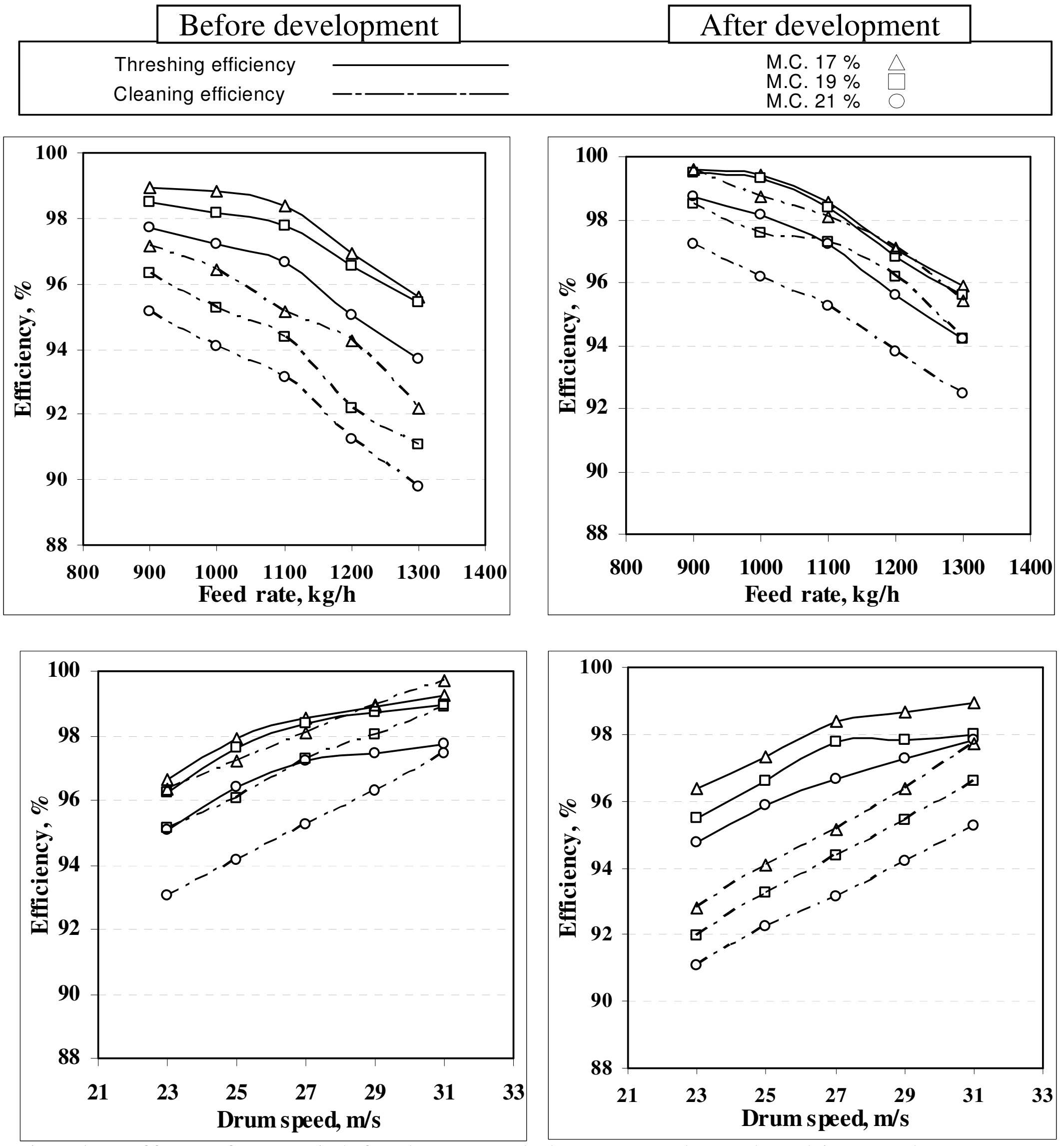


Fig.(5): Effect of material feed rate and drum speed on threshing and cleaning efficiencies at different grain moisture contents.

The increase in the percentage of energy requirements by increasing material feed rate is attributed to the excessive wheat materials in the threshing chamber, that increase the load on the threshing drum caused more fuel consumed.

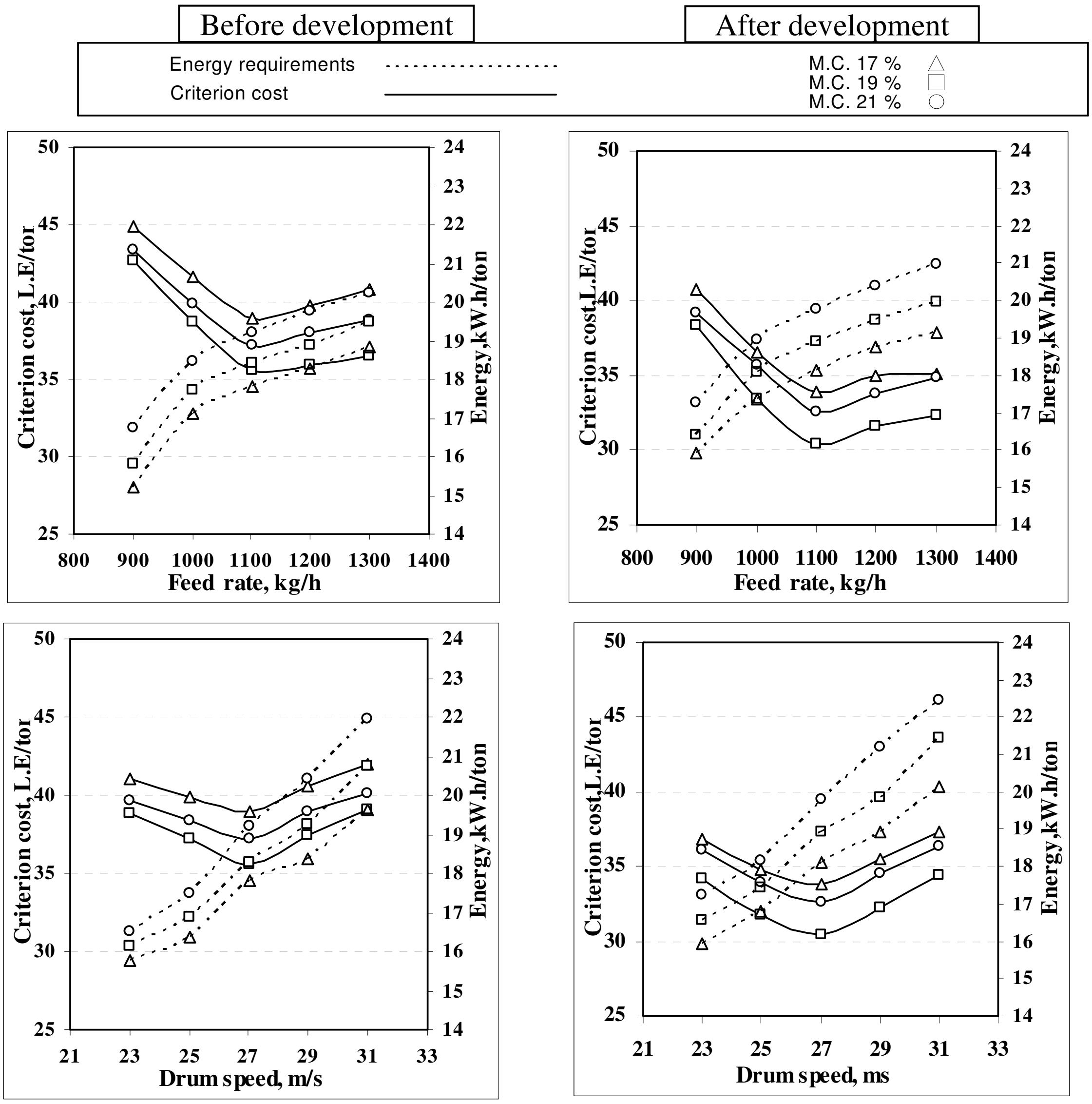


Fig.(6): Effect of material feed rate and drum speed on energy requirements and threshing cost at different grain moisture contents.

b- Effect of drum speed on energy requirements:

Relating to the effect of drum speed on the percentage of energy requirements, results in fig. (6) show that increasing drum speed increased the energy requirements under all experimental conditions. Increasing drum speed from 23 to 31 m/s under constant material feed rate of 1100 kg/h and various grain moisture contents of 17, 19 and 21 % increased the percentage of energy requirements by 19.76, 22.30, and 24.74 %, respectively using the threshing machine before development and by 20.89, 22.64, and 23.32 %, respectively using the developed machine under the same previous conditions.

The increase in the percentage of energy requirements by increasing drum speed is attributed to the high stripping and impacting forces applied during threshing operation, that tend to consume more fuel and increase energy requirements.

c- Effect of grain moisture content on energy requirements:

Data in fig.(6) show that increasing grain moisture content from 17 to 21 % increased the percentage of the energy requirements under all experimental conditions. Increasing grain moisture content from 17 to 21 % under constant material feed rate of 1100 kg/h and various drum speeds of 23, 25, 27, 29 and 31 m/s increased the percentage of energy requirements by 4.60, 6.24, 7.24, 10.13, and 10.52 %, respectively using the threshing machine before development and by 7.49, 7.43, 8.44, 10.62, and 10.32 %, respectively using the developed machine under the same previous conditions.

Results also show that the developed machine increased the percentage of energy requirements comparing with the machine before development due to the attachment of feed device with the threshing machine which required more force to power the constructed shafts, pulleys, and conveyor belt with its drums.

5- Threshing cost:

The threshing cost is affected by many parameters such as material feed rate, threshing drum speed, grain moisture content, operating cost and losses cost.

Concerning to the effect of material feed rate, drum speed and grain moisture content on threshing cost, results obtained in fig. (6) show that the feed rate of 1100 kg/h, drum speed of 27 m/s and grain moisture content of 19 % are considered the optimum values during threshing operation in both before and after development, which recorded the minimum threshing cost of 35.53 and 30.46 L.E/ton, respectively. In addition, the developed machine decreased the percentage of threshing cost by 14.27 % comparing with the machine before development due to increase threshing efficiency and decrease both total grain losses and machine labors.

Fig. (6) also show that, the decrease or increase in material feed rate, drum speed and grain moisture content less or more than the optimum values mentioned above lead to increase threshing cost significantly under all experimental conditions due to increase the total grain losses as a result of no uniformity conditions during threshing operation.

So, the materials feed rate of 1100 kg/h, drum speed of 27 m/s and grain moisture content of 19 % recorded the least values of threshing cost using the developed threshing machine comparing with the machine before development. It can be recommended that the threshing machine after development is more economical to use for the lowest cost during threshing operation of wheat crop.

CONCLUSION

A feed device of a Turkish threshing machine was constructed to increase machine efficiency and avoid many traumatic injuries during threshing process.

Data from this study led to the following conclusions:-

- Minimum total grain losses of 5.48 and 3.57 % before and after development were obtained at material feed rate of 1100 kg/h, drum speed of 27 m/s and grain moisture content of 19 %. While both threshing and cleaning efficiencies of 97.74, 94.34 % and 98.35, 97.25 % were obtained before and after development at the same previous conditions.
- The energy requirements of 18.26 and 18.92 kW.h/ton before and after development was obtained at material feed rate of 1100 kg/h, drum speed of 27 m/s and grain moisture content of 19 %.
- The minimum value of threshing cost of 35.53 and 30.46 L.E./ton before and after development was obtained at material feed rate of

1100 kg/h, drum speed of 27 m/s and grain moisture content of 19 %.

REFERANCES

Abdelghany, A. M. and E. S. El-Sahar (1999): Effect of mechanical damage on wheat grain quality. I- Parameters affecting the performance of local wheat threshing machine. Annals of agricultural Science Cairo.1999, 44 (1): 247-270; 16 ref.

Awady, M. N. (1978): Tractor and farm machinery. Text book, Faculty of Agriculture, Ain-Shams University, Cairo, Egypt. Pp: 164-167.

Awady, M. N; E. Y. Ghoniem and A. I. Hashish (1982): A critical comparison between wheat combine harvesters under Egyptian conditions. R. S. No. 1920, Ain-Shams Univ. J. 1982.

Gill, R. S; Santokh-Singh and S. Singh (2002): Performance studies on plot thresher for wheat. Journal of Research, Punjab Agricultural University. 2002, 39 (3): 408- 416; 3 ref.

Helmy, M. A. (1988): Threshing parameters affecting the performance of local and foreign wheat threshing machines. Misr. J. Ag. Eng., 5 (4): 329-343.

Hunt, D. (1983): Farm power and machinery management. 8th Ed. Iowa state Univ., Press Ames, USA. Ames, Iowa, USA: 364-368.

Kumar, A; M. Varghese and D. Mohan (2000): Equipment related injuries in agriculture. An international perspective. J. Injury Preview. Control 7 (3): 175-186.

Majumdar, K. L. (1985): Design development and evaluation of CIAE multi-crop thresher. Indian Society of Agricultural Engineers. Proceedings of the silver jubilee convention held in Bhopal, India. 29-31 October 1985. Volume 1. Farm machinery and power. 1985, II-103-II-108; 5 ref.

Mishram, T. N. and K. Desta (1990): Development and performance evaluation of a sorghum thresher. Agric. Mech. In ISIA, 21 (3): 33-37.

Mohan, D. and R. Patel (1992): Design of safer agricultural equipment: application of ergonomics and epidemiology. Int. J. Ind. Ergonom. 10, 301-309.

Morad, M. M. (1997): Cost analysis and energy requirements for threshing wheat. Misr. J. Ag. Eng. 14 (1): 93-105.
Mufti, I; S. I. Ahmad and A. Majid (1989): Farm accidents in Pakistan. Agric. Mech. Asia Africa Latin America 20, 73-75.
Rawal, H. S. (1988): Proper selection and safe use of power wheat thresher. Prog. Farming. 24 (7): 12-14.
Singh, K. P. and I. Sinha (1980): Accidents in agriculture. J. Indian Med. Assoc.75 (1): 4-6.

الملخص العربي

تطوير جهاز تلقيم في آلة الدراس التركية الصنع

د. محمود مصطفى علي علي[*] د. محب محمد أنيس الشرباصي[*] د. محمود خطاب عفيفي خطاب[**]

تعتبر عملية الدراس من أكثر العمليات الزراعية مشقة على الفلاح المصري لأنها ما زالت تعتمد على العمالة اليدوية التي ينتج عنها فواقد كبيرة بالإضافة إلى المخاطر التي يتعرض لها العامل أثناء عملية تلقيم الآلة. وتوجد كثير من الأمثلة للإصابات التي تعرض لها العديد من العاملين في هذا المجال، فمنهم من توفى ومنهم من فقد ذراعيه أو أحدهما أو فقد يده أو بعض أصابعه. ونظراً لخطورة هذه العملية على حياة ومستقبل العمال فقد نبعت فكرة هذا البحث وهي تصنيع جهاز تلقيم يناسب أحد أشهر آلات دراس القمح في مصر وهي آلة الدراس التركية الصنع لتجنب هذه المخاطر.

تم تصنيع جهاز التلقيم من إطار رئيسي مركب على ستة عجلات قطر كل منها 20 سم ليسهل تحريكه، حيث يتم تثبيت مقدمته في مؤخرة آلة الدراس وذلك عن طريق تثبيت عمود التلقيم في جسم الآلة عن طريق زوج من كراسي المحور من الجانبين. يتكون هذا الإطار من جانبين كل منهما على شكل شبه منحرف المسافة بينهما 180 سم وأبعاد كل جانب كالتالي:-
القاعدة العليا 185 سم وهي عند عمود التلقيم والقاعدة السفلى 125 سم وطول الجانب الأفقي بينهما 275 سم أما الضلع الرابع فطوله 300 سم ويميل على الأفقي بزاوية مقدارها 13° تقريباً. مركب على هذا الإطار من البداية والنهاية عمودين قطر كل منهما 5 سم يركب عليهما اسطوانتين بقطر 10 سم يوصل بينهما سير طوله 300 سم، يركب عليه عوارض بارتفاع 10 سم على مسافات متساوية 75 سم لعدم انزلاق محصول القمح أثناء التلقيم. وتنقل الحركة إلى جهاز التلقيم من عمود الغرابيل الخاص بالآلة عن طريق مجموعة من الطارات متدرجة الأقطار والمثبتة في الإطار الرئيسي والتي يمكن عن طريقها تغيير معدلات التلقيم وكذلك سرعة الدرفيل.

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[*] مدرس – قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق – مصر.
[**] أستاذ مساعد – قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق – مصر.

وقد أجريت التجربة في أحد المزارع الخاصة بمركز بلبيس حيث تم تجريب الآلة لدراس محصول القمح قبل وبعد التطوير على خمس معدلات تلقيم هي: 900، 1200,1100,1000 و1300 كجم/س وخمس سرعات لدرفيل الدراس هي: 23، 25، 27، 29 و31 م/ث وثلاث نسب لرطوبة الحبوب هي: 17، 19 و21 %.

وقد أظهرت النتائج المتحصل عليها ما يلي:

- أقل نسبة لفواقد الحبوب الكلية كانت 5.48، 3.57 % قبل وبعد التطوير وذلك عند معدل التلقيم 1100 كجم/س، سرعة درفيل الدراس 27 م/ث ونسبة الرطوبة للحبوب 19% على أساس رطب. وكانت كلاً من كفاءتي الدراس و التنظيف هي 97.74 ، و94.34 % و 98.35، 97.25 % قبل وبعد التطوير على الترتيب، تحت نفس الظروف السابقة.
- أقل طاقة مستهلكة في عملية الدراس كانت 15.21 و 15.94 كيلوات.س/طن قبل وبعد التطوير وذلك عند معدل التلقيم 900 كجم/س، سرعة درفيل الدراس 27 م/ث ونسبة الرطوبة للحبوب 17% على أساس رطب. بينما كانت أعلى طاقة مستهلكة في عملية الدراس 21.95 و 22.47 كيلوات.س/طن قبل وبعد التطوير على الترتيب، وذلك عند سرعة درفيل الدراس 31 م/ث، معدل التلقيم 1100 كجم/س ونسبة الرطوبة للحبوب 21% على أساس رطب.
- أقل قيمة لتكاليف عملية دراس محصول القمح كانت 35.53 و 30.46 جنيه/طن قبل وبعد التطوير على الترتيب، وذلك عند معدل التلقيم 1100 كجم/س، سرعة درفيل الدراس 27 م/ث ونسبة الرطوبة للحبوب 19% على أساس رطب.