DEVELOPMENT OF A SELF-PROPELLED REAPER FOR WHEAT CROP

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ABSTRACT

Harvesting of wheat crop is one of the important agricultural operations which demands considerable amount of labour in the case of the use manual harvest. Wheat prevalent harvesting methods in Egypt are manual cutting traditional and by reaper. The present study was carried out to manufacture and evaluate a self propelled vertical conveyor reaper with cutting width of 1.5 m. The reaper was operated by using 12 hp diesel engine and four wheels ground to harvest wheat crop .The reaper consists of two main parts: reaping–conveying part (reaping head) and driving, mobile part (motive power). In order to maintain the wheat stalks complete without wasting. Used by the farmer in order to feed the animals after threshing by threshing machines to overcome the problems resulting from the use of combine harvest. As well as to overcome the high cost of manual harvesting. This Innovative Mechanical machine ensures 100% recovery of straw with negligible grain losses at a surprisingly low cost of operation and will save time. This machine can be used in wheat, rice, barley and other grain crops. With this machine, we hope to provide farmers nationwide with a way to harvest grains on small plots of land in cities and along the periphery of urban areas. The variables of this study were : four forward harvesting speeds of, 2.1, 3.0, 4.2 and 5.1 km/h, four grain moisture content of, 23.5, 21.3, 19.1 and 16.3 %, w.b. and four levels of cut of, 5, 8, 12 and 15 cm. The above mentioned variable were tests to examine their effects on total grain losses,%, harvesting efficiency %, effective field capacity fed/h, energy consumption, kW.h/fed, operating cost, L.E./fed, and criterion cost, L.E./fed. The experimental results reveal that the maximum total grain losses of 2.6, %was recorded at forward speed of 5.1 km/h, levels cut of 5 cm and grain moisture content of 16.3 %. The minimum effective field capacity of 0.61 fed/h at forward speed of 2.1 km/h, levels cut of 5 cm and grain moisture content of 23.5 %.

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The minimum energy consumed of 5.0 kW.h/fed at forward speed of 5.1 km/h, levels cut of 15 cm and grain moisture content of 16.3 %. The maximum operating cost of 30.49 L.E./fed was recorded at forward speed of 2.1 km/h, levels cut of 5 cm and grain moisture content of 23.5 %.

INTRODUCTION

Wheat crop is considered one of the most important foods and export crops in Egypt. The cultivated area of wheat in Egypt is about 3.5 million fed. yearly producing about 10.5 million ton with an average yield of 3.0 tons/ fed. according to **Ministry of Agriculture statistics (2010). El-Nakib et al. (2003)** found that header, threshing, separating and shoe losses increased with the increase of the forward speed and the decrease of grain moisture content. The optimum operating parameters for harvesting wheat crop were, combine forward speed of 4.5 km/h and grain moisture content of 16.5 %. **Badr (2005),** compared the performance of three different combines in terms of harvesting time, grain losses, fuel consumption, energy required and total cost. He found that the highest field capacity of 3.02 fed/h and the lowest field efficiency of 70.5 % were obtained at forward speed about 4.0 km/h and grain moisture content of 22 %. Also, the highest fuel consumption of 18.25 *l*/fed and the highest energy required of 50.55 kW.h/fed were obtained at forward speed about 1.0 km/h and grain moisture content of 22 %. Also, a self propelled cutting machine was constructed and manufactured to cut the main crops in Egypt (rice and wheat), and also accumulated the cutting materials at the side of the machine by a flat conveyor belt. This machine was evaluated to find out the proper working parameters under rice and wheat crops. **El- Sharabasy (2006)** reported that increasing machine forward speed from 1.5 to 3.0 km/h increases effective field capacity from 0.277 to 0.452, 0.251 to 0.382, 0.208 to 0.349 and 0.181 to 0.296 fed/h at different grain moisture contents of 21.45, 22.20, 23.12 and 24.60%, respectively. **Moheb (2006)** illustrated that the decrease of grain moisture content less than 22.20 % and 20.10 % leads to increase the total grain losses due to more grain shattering by cutter bar action during cutting operation. Also, the increase of grain moisture content more than 20.10 % leads to increase the total grain losses due to increase un-cutting plants and more lodging of plants in the field. **Abdelmotaleb et al.(2009)** showed that the increase of combine forward speed from 0.8 to 2.5 km/h leads to decrease the field efficiency from 84.96 to 62.35% at cutting height of 0.2 m by using the combine without control system. The other cutting heights and combine systems had the same above mention trend. **El-Hanfy and Shalby (2009)** stated that the power consumption for cutting rice straw was increased with increasing forward and cutting speed. The minimum value of power consumption was (15 kW) noticed at (0.35 m/sec and 450 rpm) forward and cutting speed respectively. **Helmy et al. (2010)** indicated that development of the combine cutting device during harvesting rice crop gave to maximum field capacity, field efficiency, wearing resistance and minimum required power, energy, wearing rate and cost requirements. **Ismail and Abdel-Mageed (2010)** studied the workability and machinery performance for wheat harvesting. The total costs required per ton "LE/ton" were about 88.57; 87.25; 82.4 and 110.25 LE/ton for harvesting systems for combine with tank, combine with bagger, "reaper + thresher" and "manual + thresher" systems respectively. **Patel and Varshney (2014)** studied the modeling of wheat crop harvesting losses. The cutter bar loss was observed to be 0.19%, 0.26% and 0.58% at 1.0, 1.5 and 2.0 km/h, respectively. Similarly at 10.35% moisture content it was calculated as 0.32%, 0.41% and 0.67% at 1.0, 1.5 and 2.0 km/h, respectively. Further at 9.16% moisture content this loss was 0.57%, 0.58% and 0.87% at the above three levels of speeds, respectively. **Murmkar et al. (2014)** studied the performance evaluation of self propelled vertical conveyer reaper. A self propelled vertical conveyor reaper (KAMCO Model KR 120) was used for harvesting of wheat crop. The overall performance of the self propelled vertical conveyor reaper was quite satisfactory. The actual field capacity of the power reaper was found to be 0.29 ha/h with a field efficiency of 70% at an average operating speed of 3.00 km/h. The fuel consumption was 0.8 l/h. the cost of cultivation of wheat crop could be reduced through mechanization of harvesting operations. Cost of mechanical harvesting was 690 Rs./ha compared to 2500 Rs./ha as in case of traditional method i.e. manual harvesting using local sickle. The overall cost of harvesting was found to be decreased in case of mechanized harvesting by self propelled vertical conveyor reaper. Hence, the mechanical harvesting would be feasible and economical compared to traditional method in terms of time, labour requirement and money.

The objectives of the present work are

- Manufacturing and evaluate a self propelled vertical conveyor reaper.
- Access to the higher efficiency of the process of harvesting wheat crop and reduce the total cost
- Contribute in solving the problems of the farmers smallholders in the process of harvesting wheat crop.
- Providing hard currency as a result of not import of machinery and Using local manufacturing
- To encourage the Egyptian researcher on innovating and inventing

MATERIALS AND METHODS

Field experiments were carried out on wheat crops at a private farm in Elmorabain, Kafr El-Sheikh Governorate during the agricultural season 2013/2014. The soil structure was identified as a clay soil. The total experimental area was about 2 feddans planted with wheat (Sakha-93) crops. The manufactured self propelled vertical conveyor reaper was used to harvest the proposed wheat crop.

General technical specifications of a self propelled vertical conveyor reaper which were manufactured:

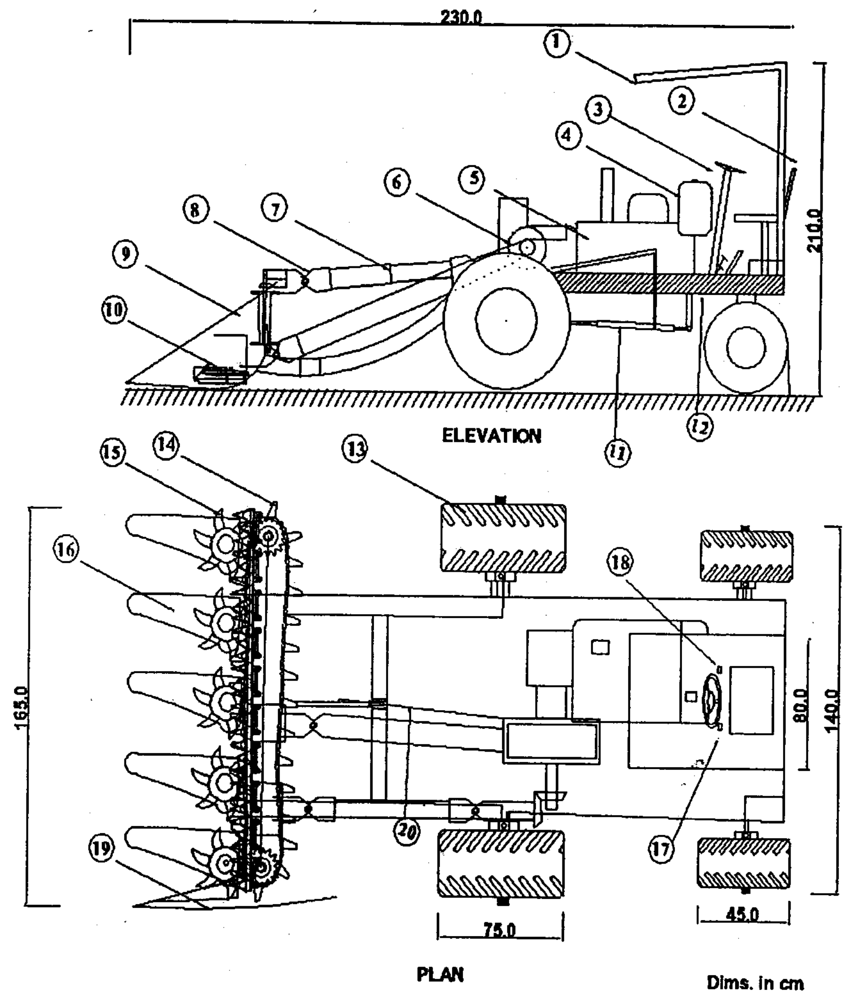
The general specifications of a self propelled vertical conveyor reaper are presented in Table 1 and sketched in Fig. 1 and plate 1.

Table 1: Specifications of a self propelled vertical conveyor reaper which were manufactured

Specification	Value
Function	Harvesting and the transfer of the crop in regular rows on the side in single operation.
Power unit	9KW, 12 HP single cylinder, air cooled, kerosene run engine
Clutch	Mono disc, dry
Gearbox	4 forward speeds—1 reverse speed
Speeds, Km/h	1st/3.4- 2nd/5.1 - 3rd/8 - 4th/10 -Rev:6.1
Cutter bar, m	1.5
Fuel Consumption, l/h	1.5
Crop release	Right side of the machine (viewed from rear)
Number vertical conveyor	2
Total weight	296 Kg.
Number star wheel	5
Cutting height, cm	5-25 cm from ground level (adjustable)
Number crop dividers	6

A self propelled vertical conveyor reaper to harvest wheat crop .

The constructed cutting machine was manufactured and constructed to overcome the problems which noticed clearly at harvesting wheat crop using the traditional harvesting method which consumed more time and labor and then more cost requirements. To overcome these problems, the developed cutting machine was constructed and manufactured to give the minimum limit of the grain losses, high field capacity and efficiency and also save total cost requirements. Reapers are used for harvesting of crops mostly at ground level. It consists of crop row divider, star wheel, cutter bar, and a pair of lugged track conveyor belts. This type of machines cut the crops and conveys vertically to one end and windrows the crops on the ground uniformly. Collection of crop for making bundles is easy and it is done manually. Self-propelled walking type,. The elevation view and plan view of a self propelled vertical conveyor reaper show in Fig. 1 and plate 1



1- Umbrella 2- Driver's seat 3- Steering wheel 4- Solar tank 5-Motor 6- Gearbox 7- Link to run a knife cutting 8- Link to run Tracked pay crop 9- Conveyor belt 10- Knife cutting 11-Link transmission 12- Chassis machine 13- Wheel ground 14- Fingers push the crop 15- Star wheel 16- Divider 17- Clutch pedal 18- Brake pedal 19- Specified machine 20- Hedrolk hose

Fig. 1 : An elevation and plan of a self propelled vertical conveyor reaper

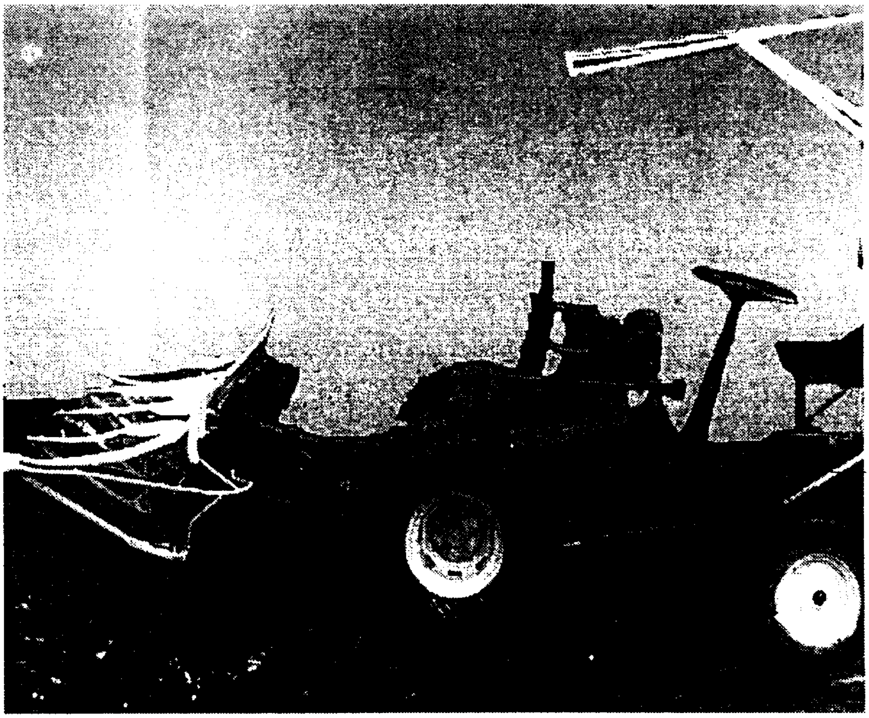


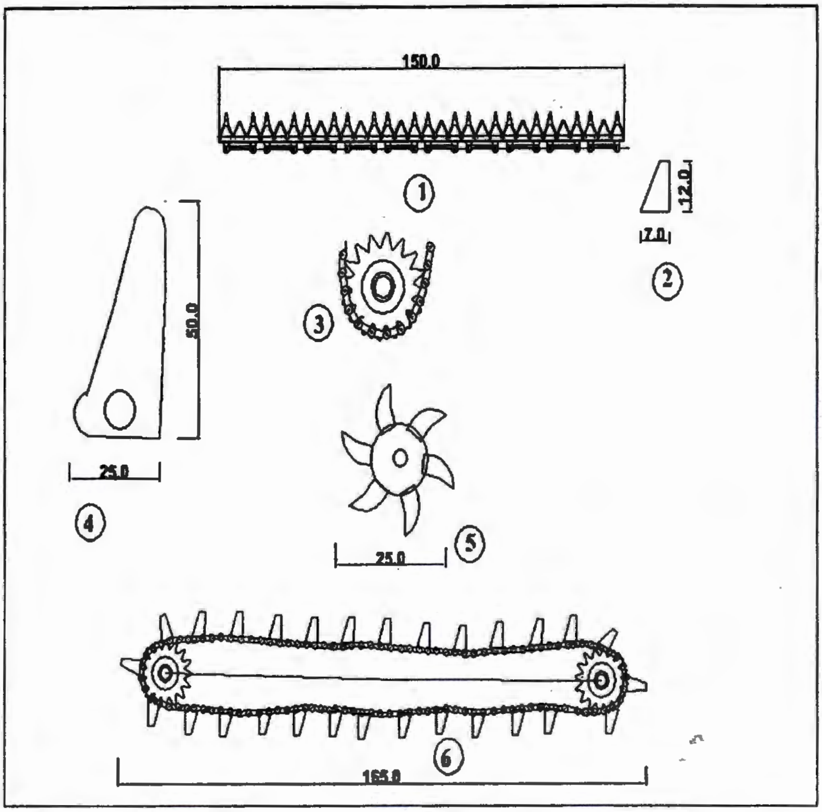
Plate 1:A self propelled vertical conveyor reaper which were manufactured:

Cutter bar

The cutter bar consists of a single action cutter bar, which has 28 knives triangular in shape located above fixed one has the same number of guards. The cutter bar is 150 cm in length takes its reciprocating motion from the machine engine through transmission system. The power-transmitting consists of an axle, gears, and power shaft from gear box to give a centric movement as shown in Fig. 2.

Vertical conveying reaper

It consists of 6 crop row divider, 5 star wheels, cutter bar and a pair of lugged tracked conveyor belts. This type of machines cut the crops and conveys vertically to one side where, the crops gathered on the ground uniformly. Collecting of crop for making bundles become easier and it is done manually.

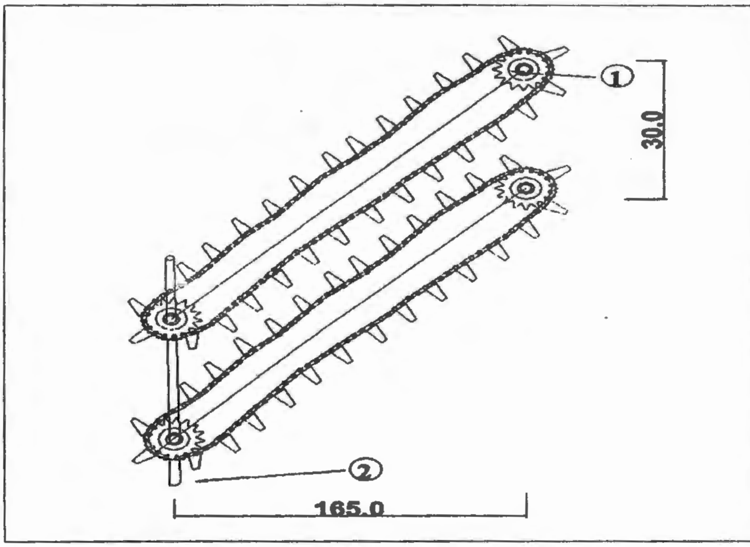


1- Knife of cutting 2- Fingers push the crop 3- Track and gear transmission 4- Divider 5- Star wheel 6- Group pull the crop at one side Dims. In cm

Fig. 2: The plan view of some parts of the manufactured reaper.

Track guidance

There are two tracks, upper and lower having a vertical distance of 30 cm between each other. There are respective number of fingers used to guide the crop. The proposed machine takes into consideration to be taller than the existing machines imported by 2 cm to give greater opportunity to control the steering crop to one side to the right of the machine as shown in Fig. 3.



1- Sprocket 2- Transmission shaft

Fig. 3 : Sketch matic of the track guidance for the machine .

Power transmission system

The modified reaper was driven by using gasoline engine 9 kW(12 hp), single cylinder air cooled. The engine is fixed in the chassis of reaper. Hence the transmission system consists of dry mono disc clutch, gear box, hydraulic device, ground and steering wheels and broke. The power transmitted from the engine to the gear box through transmission shaft. However the power transmitted to the star wheel, cutter-bar and the conveyor belt through the gear box as shown in Fig. 4 and plate 2.

The main gearbox

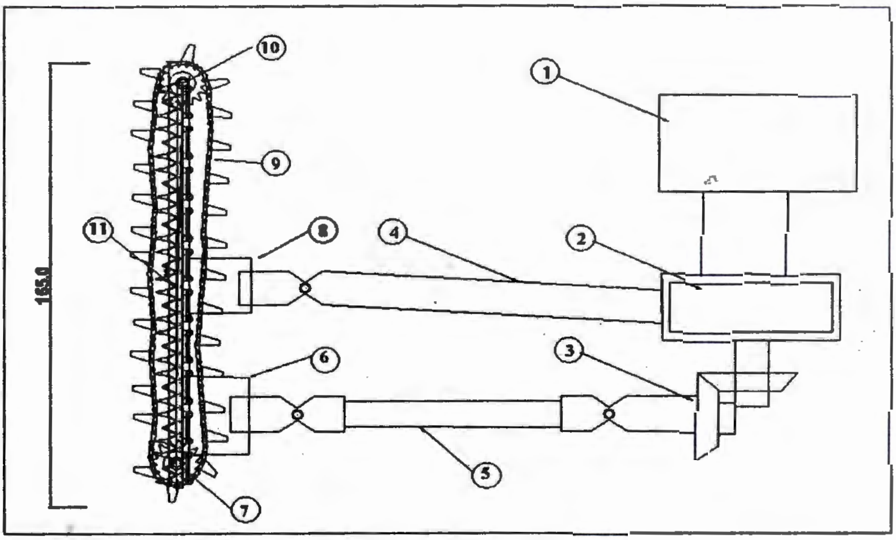
The gearbox is fixed in main frame to transmit rotary speed from the engine by universal joint. It has a set of different diameters gears that gave four-front speeds and one reversed speed. The speed will be changed by using lever which installed near the driver's seat. There is a column by gearbox installed by mid Bearings are central to the movement of traffic to be given a knife cutting. At the end of the column there are conical gears 10 teeth matched by last conical gears 10 teeth from the side to give movement to the two sets of vertical transmission crop.

Hydraulic system

The hydraulic system which serves as the source of power to the other systems consists of the hydraulic tank, filter, pump, motor, control valve and the hoses. The hydraulic system is responsible for raising and lowering the header of machine. It takes its motion through the hydraulic pump motor connected with the machine.

The main frame (chassis)

The main frame (chassis) is fabricated from U shape iron with cross sectional area of 100 x 50 x 5 mm. The minimum outer dimensions of the frame are 150 cm length, 120 cm width and 210 cm height. This frame includes elements to fix a hitching system, gear box, parts of power train, harvesting unit and the ground wheels. The machine has four rubbers tire wheels of 75 and 45 cm diameter each. The frame and the other elements were made at local workshops in , Kafrel-Sheikh city.



1-Main gearbox 2- Centric movement 3- Bevel gear 4- The transfer of the centric shaft movement 5- Link to run Tracked pay crop 6- Gearbox movement knife cutting 7- Toothed gear 8- auxiliary gearbox movement knife cutting 9- Tracked 10- Reel pull Track 11- Knife cutting

Fig. 4: Transmission system

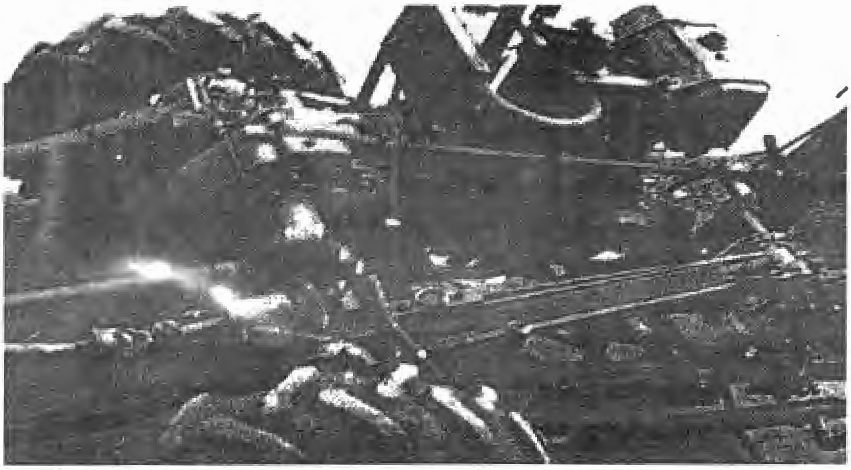


Plate 2 : Transmission system of a self propelled vertical conveyor reaper

Wheat crop characteristics

The proposed machine were evaluated by using wheat variety Sakha 93 and its crop characteristics were as follows: plant height of 95 cm, number of panicle per square meter 546 and the average weight of 1000 grain were 30.2 gm .

Design of the experiment

The experiment were conducted in an area of 2 feddans and were carried out during agricultural season of 2013- 2014 at Almorabin village, Kafr El–Sheikh Governorate. in order to evaluate the performance of a self propelled vertical conveyor reaper. The variables of this study were; four different forward reaper speeds (2.1, 3.0, 4.2 and 5.1 km/h), four grain moisture contents of (23.5, 21.3, 19.1 and 16.3 %, w.b.) and four levels of cut of,(5, 8, 12 and 15 cm) The effect of the above mentioned factors on total grain losses % ,harvesting efficiency %, effective field capacity fed/h, energy consumption, kW.h/fed, total cost, L.E./fed and criterion cost, L.E./fed were taken into consideration

Primary studies from Search

Was the work of a preliminary study on the importance of cutting the crop levels. Found with items that the user crop every 1 cm from the plant / fed given 27.76 kg of wheat straw. The total production per fed of wheat straw for this class of wheat given the 2500 kg. The price of a kilo hay equivalent to 0.7 pounds. The usual cutting heights with most harvesting machines is 10 cm. When using the machine manufacturer is cutting the level of at least 10 cm is added to the total return of the fed and a reduction of the total costs. While the larger pieces levels of 10 cm are considered to reduce the yield per fed and increase the overall costs.

Methods

Field tests were carried out to study the effect of different operating parameters on the performance of manufacture a self propelled vertical conveyor reaper.

Determination of grain moisture content

An electrical oven was used for determining the moisture content of wheat grain. The samples were dried for 24 hours at 105^{C}. The grain moisture content was determined based on wet basis by using the following formula, **ASAE, (2005)**

$$M.C. = -m_1 - m_2 / m_1 \times 100 \quad \text{------} 1$$

Where:

M.C. = moisture content, %;

m_1 = mass before drying, g and

m_2 = mass after drying, g .

levels of cut

The height of cut were adjusted by using iron buoy placed down the machine. This buoy placed on both sides to maintain a constant height of knife cutting.

Determination of total grain losses measurement

Harvesting grain losses were obtained by locating a frame of square meter on the ground after cutting the crop The grain losses in the frame represent pre-cutting and operating losses together. To estimate the operating losses pre-cutting losses must be subtracted. The percentage of operating losses was calculated by using the following equation,(**Hassan et al., 1994).**

$$\text{Total grain losses, \%} = \frac{\textit{Harvesting grain losses kg / fed}}{\textit{Total yield kg / fed}} x100 \ldots\ldots\ldots.(2)$$

Harvesting efficiency

Harvesting efficiency was calculated by using the following equation **(Roth et al., 1975).**

$$\text{Harvesting efficiency, \%} = \frac{Out\ put\ kg\ /\ fed}{(Out\ put + Total\ losses)\ kg\ /\ fed} x100 \quad ....(3)$$

Where:

Out put is the amount of grain collected in the bin of the harvester.

Total losses is all losses that are actually caused by the machine.

Field capacity

Field capacity was calculated according to **Kepner et al. (1982)** by using the following formula:

$$\text{Effective field capacity,} = \frac{1}{AT} fed\ /\ h \quad ....(4)$$

Where:

AT = the actual total time in hours required per fed. .

Energy consumption

To estimate the engine power during harvesting process the decrease in fuel level accurately measuring immediately after each treatment by fuel consumption device that is connected with the diesel pump. Power requirement was calculate by using the following formula, **Hunt (1983)** Was used to estimate the engine power.

$$E_p = (F_c \ x\ \rho_F \ x\ L.C.V. \ x\ 427 \ x\ \eta_{th} \ x\ \eta_m \ x \ \frac{1}{3600} x \frac{1}{1.36} \ x\ \frac{1}{75} kW,..(5)$$

Where:

E_p = Power required;

F_c = the fuel consumption, L/h;

ρ_F = the density of fuel, 0.85 kg/l ;

L.C.V = the lower calorific value of fuel, 10000 k cal/kg;

η_{th} = the thermal efficiency of engine, 40% for diesel engine.

427 = thermo – mechanical equivalent, kg.m/k.cal, and

η_m = the mechanical efficiency of engine, 80% for diesel engine.

Hence, the specific energy consumed can be calculated as follows :

$$\text{Energy consumption} = \frac{Powerrequrement,\ (kW)}{Field\ capacity, (fed\ /\ h)}, \text{kW.h/fed...........(6)}$$

Operational cost, L.E./fed.

Machine cost was determined by using the following equation **(Awady 1978)**

$$C= \frac{p}{h}\left(\frac{1}{a} + \frac{i}{2} + t + r \right) + (1.2\, W . S. F) + \frac{m}{50} \quad ....(7)$$

Where:

C = hourly cost, L.E /year; P = price of machine, L.E;
H=yearly working hours, hours; a = life expecting of the machine, year
i = interest rate/ year ratio, t = taxes, overheads ratio ,
r = repairs and maintenance ratio , W = power, hP;
S = specific fuel consumption (l/kW.h) and. F = fuel price (L.E.).
50 =Reasonable estimation of monthly working hours.
m=operator monthly salary, L.E/h

Operational cost can be determined using the following equation:

$$\text{Operating cost/fed} = \frac{Hourly\ cost\ (L.E / h)}{Effective\ field\ capacity\ (fed / h)},\ \text{(L.E/fed)} \ ......(8)$$

Criterion cost. (C.V.), L.E./fed

The criterion cost of the harvesting operation was estimated by using the following equation **(Awady et al., 1982)**

Criterion cost/fed.= operating (L.E/fed) + grain losses (L.E/fed) ± wheat straw (L.E/fed) ....(9)

± High level of cutting wheat crop is often at 10 cm from the surface of the ground with most harvesting machines. With this machine manufacturer starts cutting the level of 5 cm to 15 cm. Cutting height less than 10 cm is considered in addition to the profit from wheat straw.

RESULTS AND DISCUSSION

Total grain losses measurement, %

The observations in Fig. 4 shows the effect of forward speed on total grain losses, at different levels of cutting height and moisture content. The data reveal that the percentage of total grain losses increase by the increase of forward speed and decrease of grain moisture content. However, the decrease of grain moisture content from 23.5 to 16.3% at constant forward speed of 5.1 km/h and constant levels cut of 5 cm; tends to increase total grain losses from 2.35 to 2.6 %. It was noticed that as the levels of cut increased from 5 to 15 cm tends to decrease the total grain losses from 2.26 to 1.9 % at forward speed of 4.2 km/h and grain moisture content of 23.5 %.The maximum total grain losses of 2.6, %was recorded at forward speed of 5.1 km/h, cutting height of 5 cm and grain moisture content of 16.3 %. The minimum total grain losses of 1.6 % at forward speed of 2.1 km/h, cutting height of 15 cm and grain moisture content of 23.5 %. Generally, the total grain losses was increased by increasing the forward speed .This is may be due to the vibration occurred on the header of machine which causes the grain losses.

Harvesting efficiency, %

Figure 5 shows the effect of forward speed on harvesting efficiency, at various levels of cut and grain moisture contents. It can be noticed that increasing forward speed from 2.1 to 3.1 and 4.2 to 5.1 km/h tend to decrease the harvesting efficiency from 97.94 to 97.73, and 97.5 to 97.4 % at constant cutting height of 5 cm and grain moisture content of 16.3 %. However, increasing the cutting height from 5 to 15 cm tends to increase the harvesting efficiency from97.7 to 98.1 % at forward speed of 4.2 km/h and grain moisture content of 21.5 %. It was found that as the grain moisture content decreased the harvesting efficiency decreased at all forward speed and all height of cut. The maximum harvesting efficiency of 98.4, % was recorded at forward speed of 2.1 km/h, height of cut of 15 cm and grain moisture content of 23.5 %. The minimum harvesting efficiency of 97.3 % was recorded at forward speed of 5.1 km/h, height of cut of 5 cm and grain moisture content of 16.3 %.

Field capacity

Data presented in Fig.6 shows the effect of forward speed on field capacity, at different levels of cut and different grain moisture contents. It was found that as the levels of cut increased from 5 to 15 cm the effective field capacity increased from 1.2 to 1.5 fed/h at forward speed of 5.1 km/h and grain moisture content of 19.1 %. However. The increase of forward speed from 2.1 to 5.1 km/h tends to increase the effective field capacity from 0.75 to 1.45 fed/h at height of cut of 12 cm and grain moisture content of 16.3 %. On the other hand, the effective field capacity increase by increasing the forward speed, height of cut and decrease of grain moisture content. The maximum effective field capacity of 1.54 fed/h was recorded at forward speed of 5.1 km/h, levels cut of 15 cm and grain moisture content of 16.3 %. The minimum effective field capacity of 0.61 fed/h at forward speed of 2.1 km/h, levels cut of 5 cm and grain moisture content of 23.5 %.

Energy consumption

Data illustrated in Fig.7. shows the effect of forward speed on energy consumption, at levels of cut and different grain moisture content. It can be noticed that the increase of forward speed from 2.1 to 3.1 and 4.2 to 5.1 km/h tend to decrease the percentage of the energy consumed from 11.6, 9.2, 8.3 and 7.0 kW.h/fed at constant levels cut of 8 cm and grain moisture content of 21.5 %. However, the increase of the height of cut from 5 to 15 cm tends to decrease the energy consumed from 7.6 to 6.3 kW.h/fed at forward speed of 4.2 km/h and grain moisture content of 16.3 %. It was found that as the grain moisture content decreased the energy consumed decreased at all forward speed and levels of cut. The maximum energy consumed of 14.0, kW.h/fed was recorded at forward speed of 2.1 km/h, levels cut of 5 cm and grain moisture content of 23.5 %. Moreover, the minimum energy consumed was found to be 5.0 kW.h/fed at forward speed of 5.1 km/h, levels cut of 15 cm and grain moisture content of 16.3 %.

operating cost

Data presented in Fig.8 shows the effect of forward speed on operating cost, at levels of cut and different grain moisture content. It was found that as the levels of cut increased from 5 to 15 cm the operating cost decreased from 14.8 to 12.0 L.E./fed at forward speed of 5.1 km/h and grain moisture content of 16.3 %. However, it can be noticed that the increase of forward speed from 2.1 to 5.1 km/h tends to decrease the operating cost from 28.18 to 14.8 L.E./fed at levels cut of 5 cm and grain moisture content of 16.3 %. On the other hand, the operating cost increase by decreasing the forward speed , levels of cut and the increase of grain moisture content. The maximum operating cost of 30.49 L.E./fed was recorded at forward speed of 2.1 km/h, levels cut of 5 cm and grain moisture content of 23.5 %. The minimum operating cost of 12.0 L.E./fed at forward speed of 5.1 km/h, levels cut of 15 cm and grain moisture content of 16.3 %.

Criterion cost (C.V.), L.E/fed

Data illustrated in Fig. 9. Show the effect of forward speed on criterion cost, at different levels of cut and different grain moisture contents. It can be noticed that the increase of forward speed from 2.1 to 3.1 and 4.2 to 5.1 km/h tend to increase the percentage of the criterion cost from 43.78, 45.34, 51.96 and 54.34 L.E./fed at constant levels cut of 5 cm and grain moisture content of 16.3 %. However, by increasing the levels of cut from 5 to 15 cm tends to increase the criterion cost from 54.34 to 205.75 L.E./fed at forward speed of 5.1 km/h and grain moisture content of 16.3 %. It was found that as the grain moisture content decreased the criterion cost increased at all forward speed and levels of cut. The maximum criterion cost of 205.75, L.E./fed was recorded at forward speed of 5.1 km/h, levels cut of 15 cm and grain moisture content of 16.3 %. Meanwhile, the minimum criterion cost of 36.21 L.E./fed was obtained at forward speed of 2.1 km/h, levels cut of 5 cm and grain moisture content of 23.5 %. It is noticed that the criterion cost decreased with cutting height of 5 cm at all forward speeds and grain moisture contents this is due to the addition of 5 cm increase of wheat stem were missing in the total area of fed, making it more than the total income of the fed and reduce the costs per fed.

CONCLUSION

The obtained results were summarized as follows:

The maximum total grain losses of 2.6 % was recorded at forward speed of 5.1 km/h, level of cut of 5 cm and grain moisture content of 16.3 %. The minimum effective field capacity of 0.6 fed/h at forward speed of 2.1 km/h, levels of cut of 5 cm and grain moisture content of 23.5 %. Moreover, the minimum energy consumed of 5.0 kW.h/fed was obtained at forward speed of 5.1 km/h, levels of cut of 15 cm and grain moisture content of 16.3 %. The maximum operating cost of 30.49 L.E./fed was recorded at forward speed of 2.1 km/h, levels cut of 5 cm and grain moisture content of 23.5 %. Meanwhile, the maximum criterion cost of 205.75, L.E./fed was recorded at forward speed of 5.1 km/h, levels of cut of 15 cm and grain moisture content of 16.3 %.

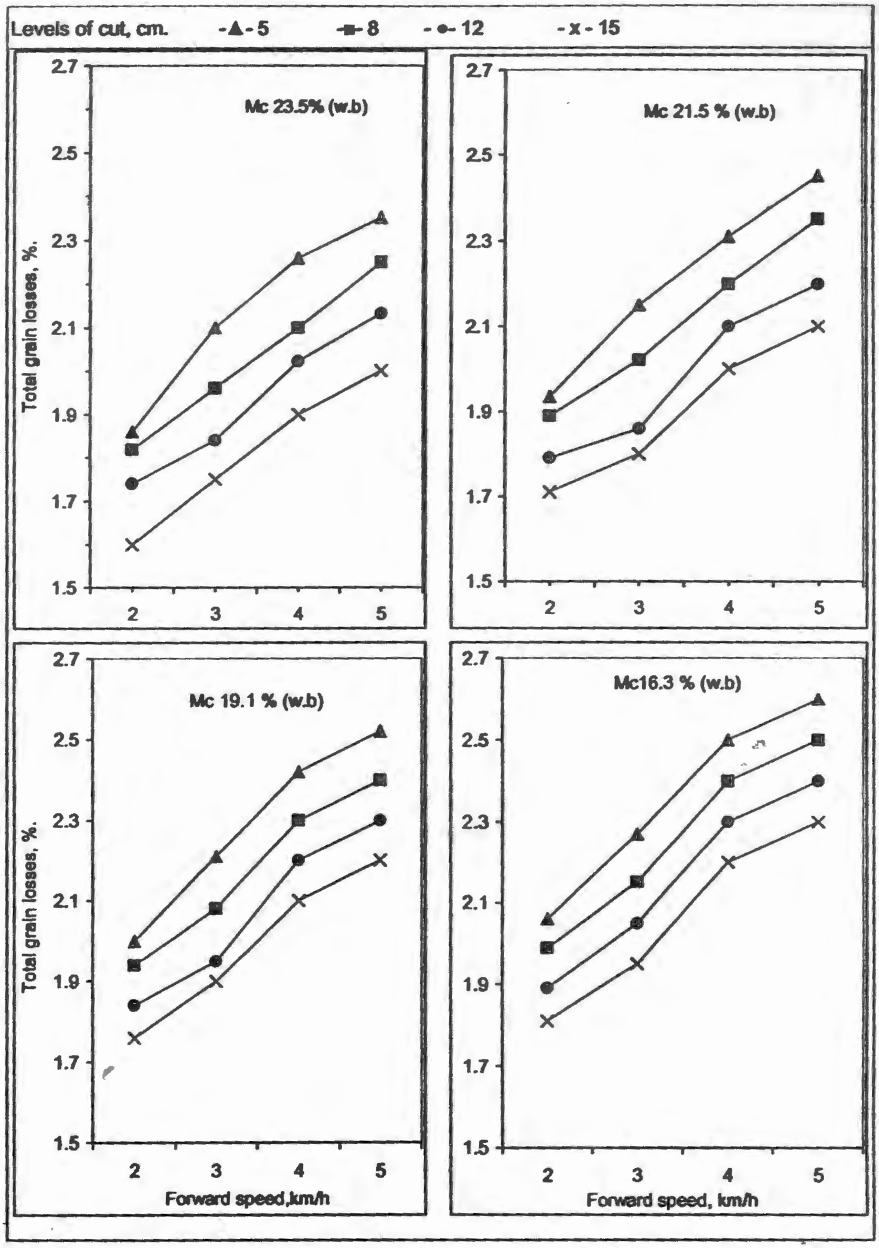


Fig. 5 : Effect of forward speed on total grain losses at different levels of cut and moisture contents.

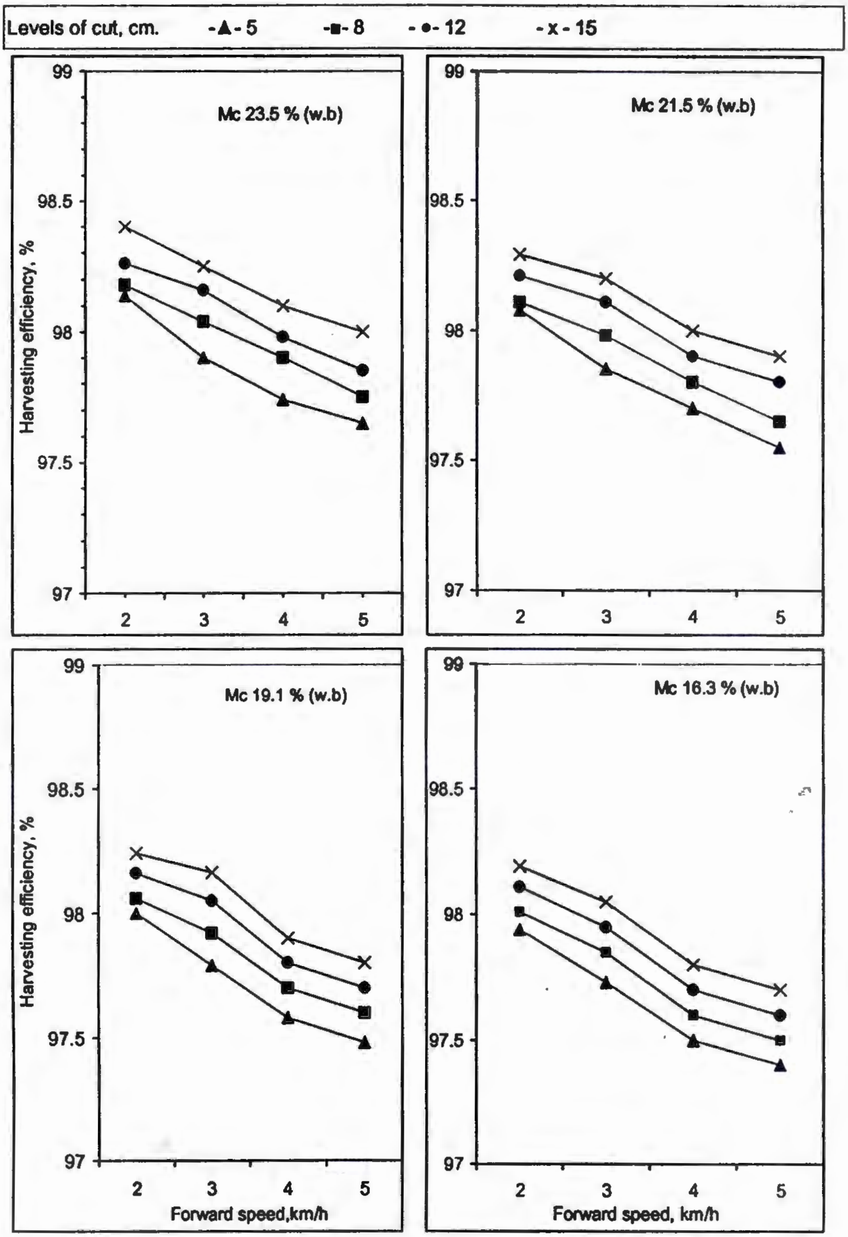


Fig. 6 : Effect of forward speed on harvesting efficiency at different levels of cut and moisture contents

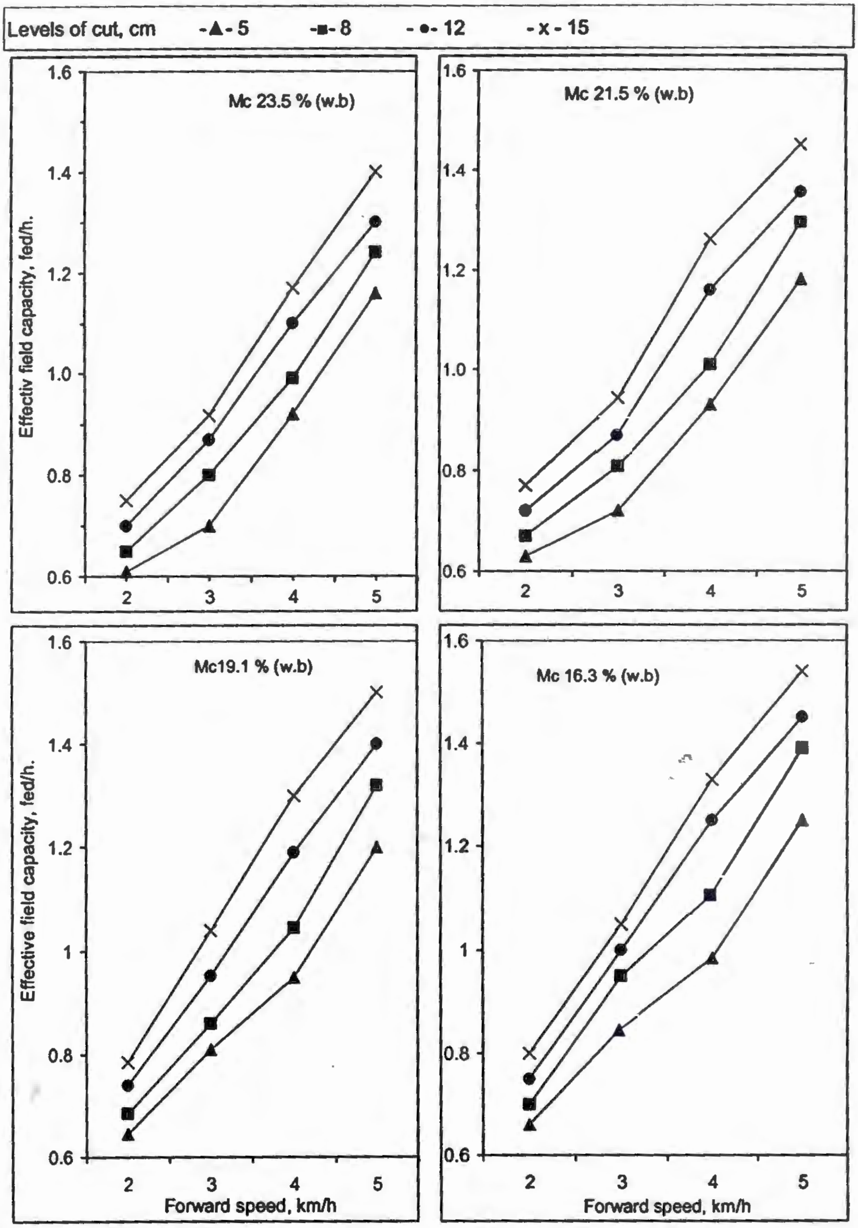


Fig. 7: Effect of forward speed on effective field capacity at different levels of cut and moisture contents

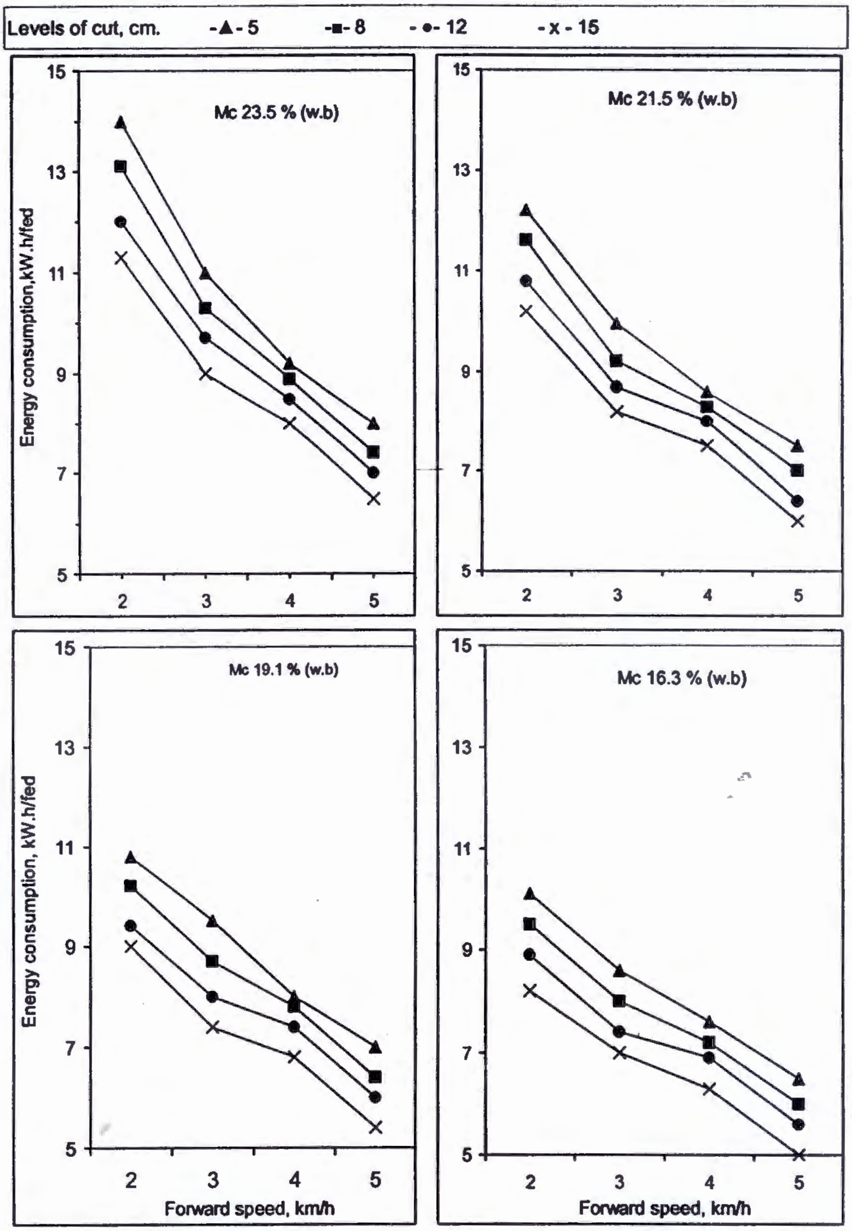


Fig. 8 : Effect of forward speed on energy consumption at different levels of cut and moisture contents

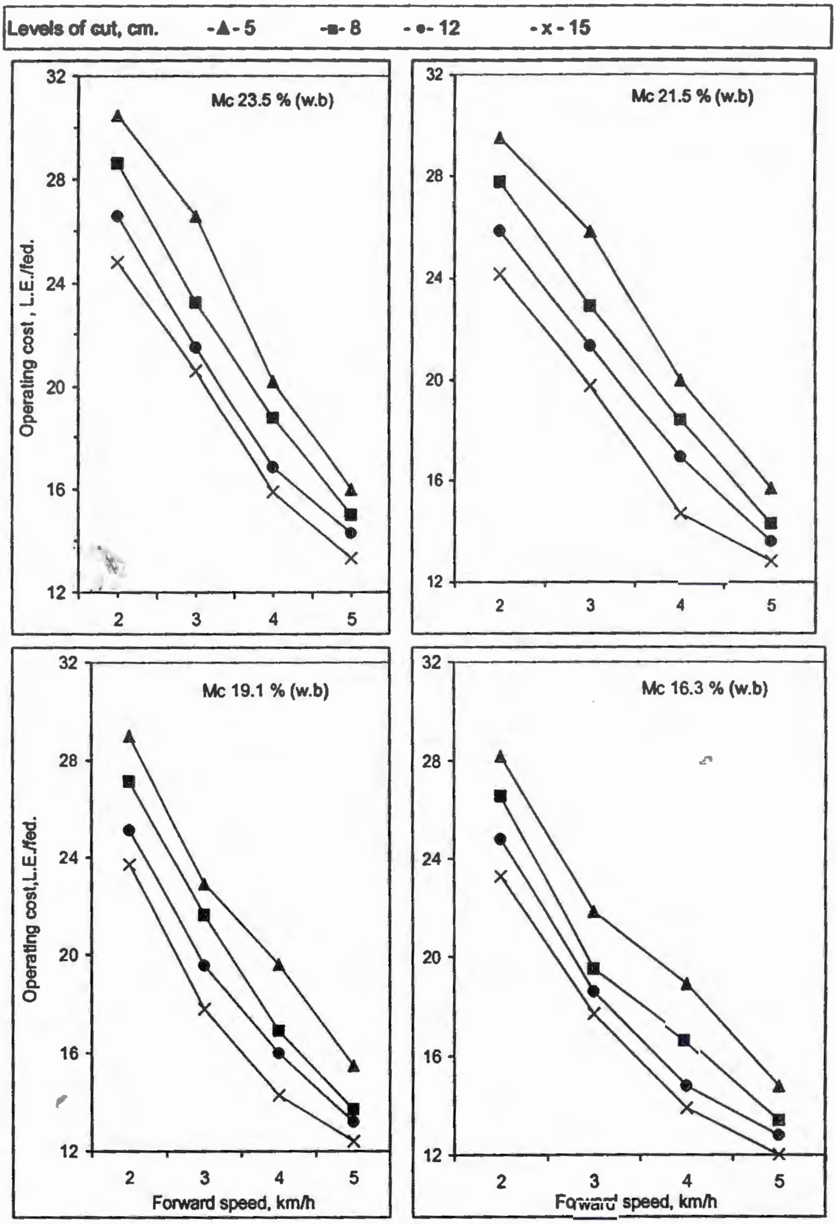


Fig.9 : Effect of forward speed on operating cost at different levels of cut and moisture contents

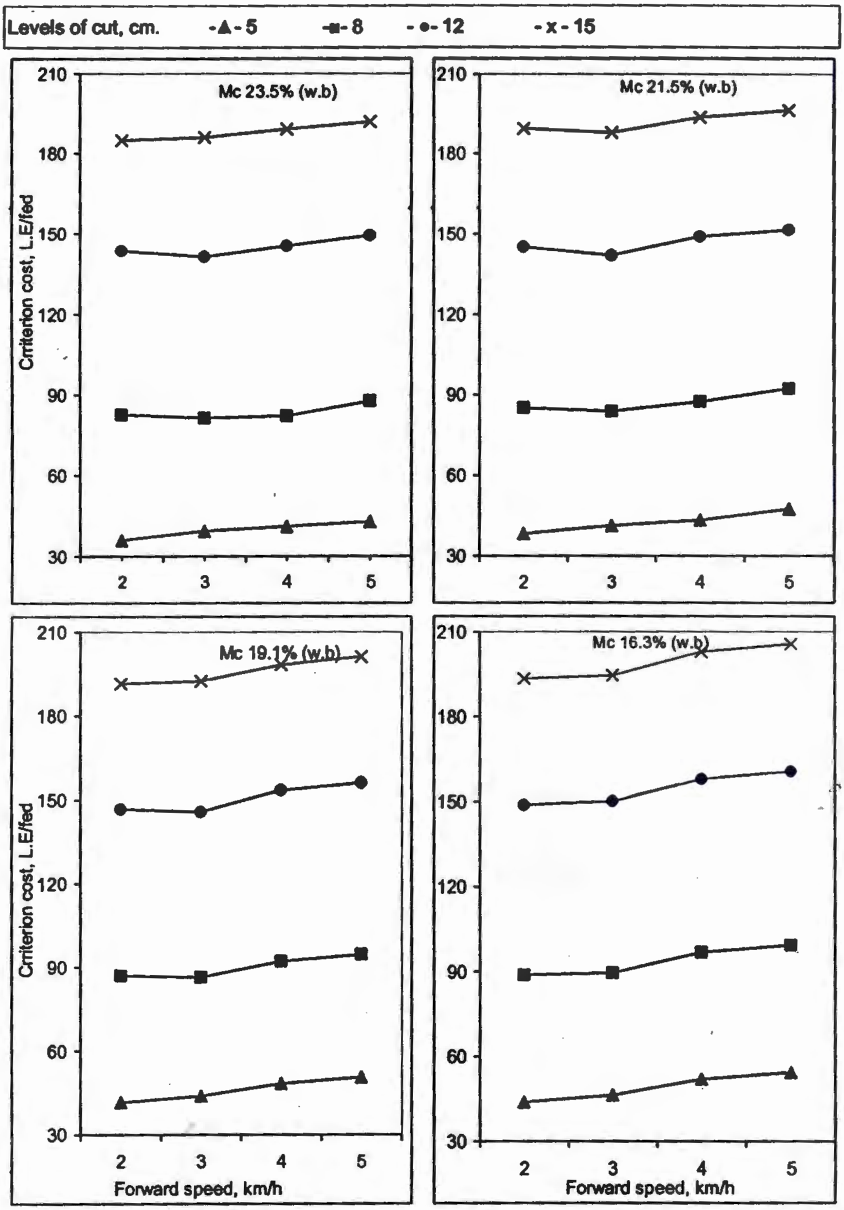


Fig. 10 : Effect of forward speed on criterion cost at different levels of cut and moisture contents.

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الملخص العربي

تطوير آلة حصاد ذاتية الحركة لمحصول القمح

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يعتبر محصول القمح من المحاصيل الإستراتيجية الهامة في مصر .ونظرا لتفتيت الحيازات الزراعية في الدلتا فإن الحاجة مازالت قائمة لاستخدام العديد من الآلات التي تقوم بحصاد محصول القمح عوضاً عن آلة الحصاد الجامعة (الكومباين),والذي يسبب إهدار تبن القمح والذي يستخدمه الفلاح المصري في تغذية الحيوانات المز رعية ,مما اضطر الفلاح إلى استخدام آلات الحصاد الصغيرة المستوردة وهذا يتطلب عملة صعبة كثيرة والدولة في حاجة إلى العملة الصعبة أو اللجوء إلى عملية الحصاد اليدوي والذي من أهم مشاكله زيادة فواقد الحبوب وزيادة استهلاك الجهد والمال وإطالة فترة إخلاء الأرض مما يعيق زراعة المحصول التالي. ولذلك يهدف هذا البحث إلى تصنيع آلة ذاتية الحركة تقوم بعملية الحصاد وتجميع القمح في اتجاه واحد بشكل مصفوفة منتظمة يسهل تجميعها. ويتم تصنيع الآلة بالخامات المحلية مما يعطيها ميزة تقليل تكاليف الإنتاج كما روعي في التصنيع إن تناسب هذه الآلة العديد من المحاصيل مما يعطيها الفرصة في العمل معظم فترات العام.

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بالإضافة إلى سهولة الفك والتركيب وتقليل الطاقة المستهلكة والتكاليف الكلية وتقليل فواقد الحبوب والقش وبذلك يؤدى إلى سهولة تملك الفلاحين مثل هذه الآلة. هذ ه الآلة تتركب من سكينة القطع :طولها ١٥٠ سم وهو من النوع الفردي وتحتوي على ٢٨ شفرة مثلثة الشكل وتقوم بقطع المحصول من أسفل وبمستوى ثابت . كما يوجد عدد ٥ بكرات نجميه تساعد على توجيه المحصول. وعدد ٦ موجهات لدخول المحصول لسكينة القطع. نقل المحصول الرأسي وهو يتكون من مجموعتين رأسيتين المسافة بينهما ٣٠ سم وكل مجموعة تحتوى على جنزير بطول ٣,٢ متر ومثبت بة عدد من أصابع توجيه المحصول. جهاز نقل الحركة يتكون من المحرك وهو مصدر الحركة الرئيسي بالآلة وبقدرة ١٢ حصان وهو تبريد هواء والدبرياج وصندوق التروس والجهاز الهيدروليكي لرفع وخفض صدر الآلة والفرامل وعجلة القيادة. و يقوم صندوق التروس بإعطاء أربع سرعات أمامية وسرعة خلفية ويعطى الحركة لباقي أجزاء الآلة عن طريق وصلات لنقل الحركة. أجهزة التلامس مع الأرض (أربع عجلات للحركة) الاثنين الخلفيتين بقطر ٤٥ سم والأماميتين بقطر ٧٥ سم. وقد أجريت التجارب بقرية المرابعين التابعة لمركز ومحافظة كفرا لشيخ في موسم حصاد ٢٠١٣- ٢٠١٤ وعلى مساحة ٢ فدان وكان المحصول المستخدم هو قمح سخا ٩٣ ولقد تناول البحث دراسة تأثير كلا من أربع سرعات أمامية وهى ٢,١ – ٣,٠ – ٤,٢ – ٥,١ كم/ساعة . أربع محتويات رطوبة للحبوب ٢٣,٥ – ٢١,٣ – ١٩,١ – ١٦,٣ % . وأربع مستويات قطع ٥ – ٨ – ١٢ – ١٥ سم وذلك على معدل أداء الآلة من خلال الفواقد الكلية للحبوب % و كفاءة عملية الحصاد % والسعة الحقلية فدان/ساعة والطاقة المستهلكة كيلوات.ساعة/فدان والتكاليف الكلية جنية/فدان والقيمة المقارنة جنية/فدان.

أظهرت النتائج المتحصل عليها ما يلي:-

- اكبر نسبة للحبوب المفقودة ٢,٦ ٪ سجلت عند السرعة الأمامية ٥,١ كم/ساعة ومستوى قطع ٥ سم ومحتوى رطوبة للحبوب ١٦,٣٪
- اقل سعة حقلية ٠,٦١ فدان/ساعة سجلت عند السرعة الأمامية ٢,١ كم/ساعة ومستوى قطع ٥ سم ومحتوى رطوبة للحبوب ٢٣,٥٪
- اقل طاقة مستهلكة محسوبة ٥ كيلوات.ساعة/فدان سجلت عند السرعة الأمامية ٥,١ كم/ساعة ومستوى قطع ١٥ سم ومحتوى رطوبة للحبوب ١٦,٣٪
- اكبر قيمة للتكاليف ٣٠,٤٩ جنية/فدان سجلت عند السرعة الأمامية ٢,١ كم/ساعة ومستوى قطع ٥ سم ومحتوى رطوبة للحبوب ٢٣,٥٪
- اكبر قيمة للقيمة المقارنة ٢٠٥,٧٥ جنية/فدان سجلت عند السرعة الأمامية ٥,١ كم/ساعة ومستوى قطع ١٥ سم ومحتوى رطوبة للحبوب ١٦,٣٪

-وبالتالي فإن أنسب العوامل لتشغيل هذه الآلة والتي تعطي أقل تكاليف حرجة هي:

من خلال التجارب وجد إن انسب ظروف تشغيل باستخدام مستوى القطع ٥ سم ويليه مستوى القطع ٨ سم مع جميع السرعات الأمامية وقيم المحتويات الرطوبية المستخدمة في التجربة وذلك من خلال نتائج القيمة المقارنة والتي تشمل على التكاليف الكلية للآلة مضاف إليها الفواقد الكلية وفاقد قش القمح فوق مستوى ١٠ سم اى عند المستويين ١٢ و ١٥ سم.