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Development of Tractor Front Mounted Mower for Harvest Wheat Crop

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ABSTRACT

The main objective of this research was to fabricate and evaluate a new design of tractor front mounted mower to improve its performance, reduce harvesting costs (operation cost and losses cost) and to minimize energy consumption. The machine was locally fabricated to suit the small and medium Egyptian farmers, the performance of the developed machine was evaluated under four different tractor forward speeds (2.5, 3.5, 4.5 and 5.5 km/h) and four different conveyor belt speeds (1, 1.2, 1.4 and 1.6 m/sec) at 45° of conveyor belt angle with horizontal level and constant speed of the P.T.O at 540 rpm. The traditional mower was evaluated to compare its performance with the developed mower at the same previous four forward speeds, also the same conveyor belt speeds with conveyor chain in the other front mower and used tilting angle of 90° with vertical level. The maximum effective field capacity was 1.34 fed/h, the minimum total grain losses, operating cost and specific energy consumed were 0.8%, 61.5 L.E/fed and 9.5 kW.h/fed compared to 1.04 fed/h, 1.5%, 80 L.E/fed and 13 kW.h/fed for traditional machine at the optimum operating parameters of 4.5 km/h forward speed, conveyor belt, chain speed 1.6 m/s and conveyor belt, chain angle 45, 90° respectively. The cutting efficiencies for the developed and traditional machine were acceptable.

Keywords: field capacity, total grain losses, cutting efficiency, energy requirements and economic evaluation.



INTRODUCTION

Wheat crop is considered one of the most important grains in Egypt and other parts of the world as a rich source of carbohydrates found in bread. The cultivated area of wheat in Egypt is about 3.65 million fed., yearly producing about 10.8 million ton with an average yield of 3.2 tons/ fed., according to Ministry of Agriculture statistics (2018). EL-Ashkar *et al.* (1989) recommend that using mounted mowers at the front of the tractor either by fabricating the mower locally or importing the similar one and apply the necessary modifications to suit under Egyptian condition. Awady *et al.* (1988) found that when designing a small rotary mower for lawns mowing, the height of stubs after cutting for each speed was registered for the evaluation. In general, the mower operating at low speed of 1.8 km/h gave low field efficiency (57.14 %) with short stubs of 6.5 cm average height. Other side, a higher speed of 3.2 km/h, on the other hand, gave high field efficiency (72.73 %) with longer stubs of 9.5 cm mean height. finally they found, the most economical speed (2.45 km/h) represents the least criterion of cost per feddan. Habib *et al.* (2002) stated that the parameters affecting cutting process are related to the cutting tool, machine specifications and plant materials properties. They added that, the cutting energy consumed in harvesting process is much lower than the energy consumed in crushing process due to the effect of moisture content.

El-Sharabasy (2006) illustrated that the decreasing or increasing grain moisture content less or more than 20.10 % for wheat leads to increase the total grain losses. For the first case due to more grain shattering by cutter bar action during cutting operation and for the second case due to increase un-cutting plants and more lodging of plants in the field. Also, stated that machine forward speed is direct

proportional with field capacity at different grain moisture contents. On the other side, Murmkar *et al.* (2014) informed that the overall performance of the self-propelled vertical conveyor reaper was actual field capacity of 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. For more, the workability and machinery performance for wheat harvesting was identified by Ismail and Abdel-Mageed (2010). They indicated that, 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. Abdrabo (2015) stated that the maximum total grain losses of 2.6% was recorded at forward speed of 5.1 km/h, level of cut of 5cm and grain moisture content of 16.3 %. Whereas, minimum field capacity of 0.61 fed/h at forward speed of 2.1 km/h, levels of cut of 5 cm and grain moisture content of 23.5 %. While, by increasing forward speed to 5.1 km/h the energy consumed recorded about 5.0 kWh/fed with plant cut level of 15 cm at grain moisture content of 16.3 %. Moreover, 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 %.

So, the objectives of the present work are to fabricate and evaluate a new machine able to increase the efficiency of wheat harvesting and reduce the total cost. By solving the problems of the traditional front mower in the process of harvesting wheat crop and improve the performance of the front mounted mowers attached to

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tractor by working to reduce the breakdowns and obstacles facing this type of mowers.

MATERIALS AND METHODS

A new machine for wheat crop was designed and locally fabricated at private workshop in Qesina city, El Menofiya governorate while the field evaluation experiments of the designed machine were carried out in Meet khalaf village, El Menofiya governorate during summer season of 2018. The total experimental area was about 5 feddans planted with wheat crop (Gemiza 9) by seed drill machine.

Description of the traditional machine

The front mounted reaper consists of reciprocating knife width 150 cm star shaped roller to direct the crop after cutting and chain between two conveyors, fingers fixed on them and the vertical distance between them 17cm and distance between fingers 5cm, also it depends on the existence of devices to direct the crop towards the cutting knife.

Theory of operating the new designed machine

The theory of operation of the new mower depends on creating direct contact of crop after cutting with the conveyor belt which pushes the crop outward by means of fingers fixed on the conveyor without star shaped rollers and without need to move the crop flow to the conveyor belt.

Consideration of investigated wheat harvesting

Crop not contacting any moving parts of machine directly after cutting.

Increase the contacting area with the crop to increase its transferring efficiency directly after cutting.

Transfer the crop directly after cutting to mower side in a uniform shape and can be easily bind it.

Avoid occurring any friction with spike to avoid any loss of grains.

Easy transfer any cutting weeds with crop directly without representing any obstacle in transferring the crop.

Work on reducing transferring time after harvesting in which due to increase field efficiency and hence increase performance rate and reduce costs and power consumed.

Description of the investigated machine

The designed machine (Figs. 1 and 2) consists of five essential parts, main frame, cutter bar, conveyor, transmission system and hydraulic system.

Main frame (chassis): The main frame is constructed from U shape iron with cross sectional area of (60 * 40 * 40 cm). A square box made from iron shaped, length 6 cm and 3 cm thickness. Three hitch points with category 2 were constructed on the main frame to attach the machine with the tractor.

Cutter bar: The cutter bar consists of a single action cutter bar, which has 28 knives triangles in shape located above fixed one with the same number of guards. The cutter bar is 150cm in length takes its reciprocating motion through transmission system.

Conveyor system: It consists of conveyor belt and drive system.

Conveyor belt: The conveyor belt was made of special plastic and rubber 6 ply rating. The conveyor dimensions were 150 cm, length, 60cm width and 0.5cm, thickness. Both ends of the belt were welded by laser instrument using computer program.



Fig.1. General view of the investigated machine.

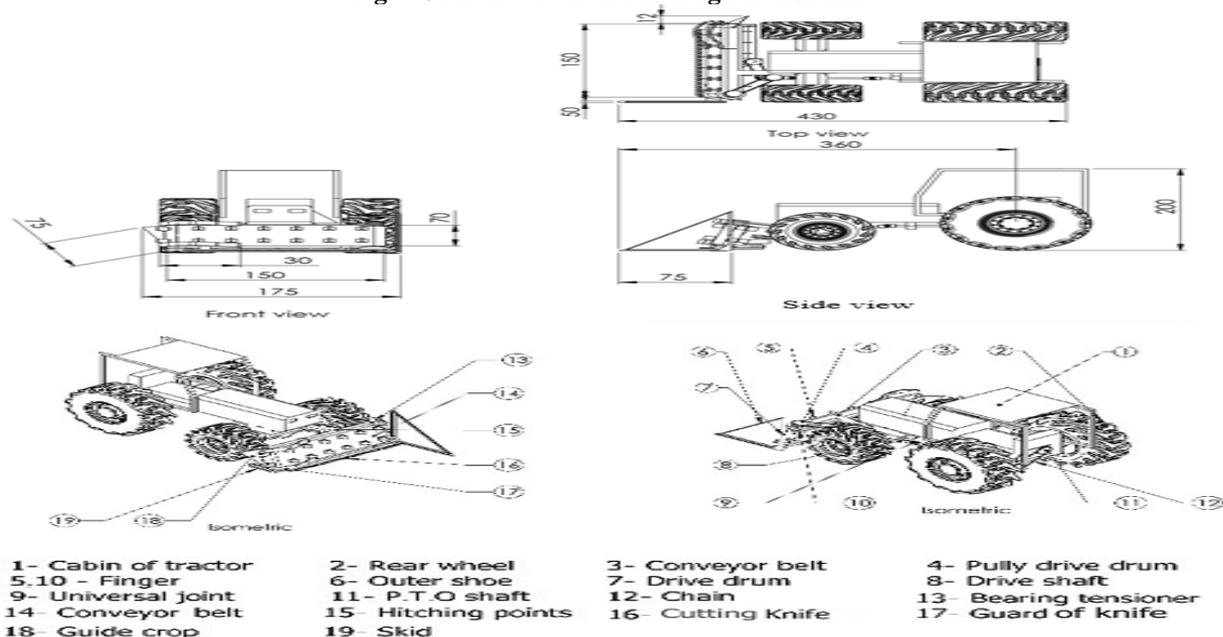


Fig. 2. Schematic diagram for the main components of the new machine

Drive and driven drums: The drive and driven drum were made of steel pipe with diameter of 7.5cm, thickness of 0.4cm and length of 60cm. An axle of 5cm diameter with 80cm length was fixed along the center of the drum. The drive and driven drum axle were rolled on two ball bearing housing and equipped with double ball bearing and greaser. The bearing housing equipped with threaded bolt to adjust the tension of the conveyor. The motion was transferred to the drive drum via a pulley of 14cm diameter (Figs 2 and 3).

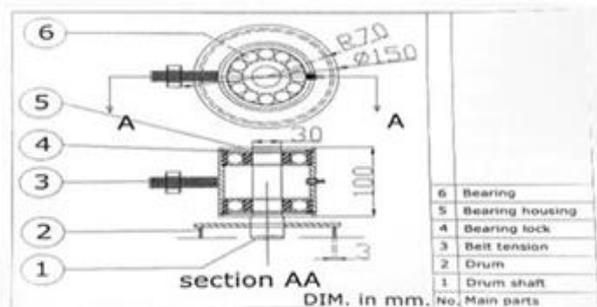


Fig. 3. Drive and driven drums bearing housing and conveyor tension

Balance of conveyor belt: In order to prevent the conveyor deviation the conveyor belt right on left during operation, I beam pulley of 30 cm welded from the end of each drum have a diameter equal to the drum (7.5 cm and 1.7 cm width) in both the drive and driven drum. Belt (v belt) were fixed 1.7 cm width and 150 cm, length on inner surface of the conveyor belt so that the course of a pulley referred to previously and are constantly lieutenants do not deviate from conveyor belt. The belt was welded by leaser instrument using computer program (Figs 4, 5 and 6)

Transmission system: The tractor PTO was transmitting motion through two tooth sprockets wheels (1: 1) and chain as shown in Fig. (5). Then the motion to be transmitted from gear box to conveyor through two pulleys from upper shaft to gear box and the motion transmitted to cutting knife through two other pulleys through lower shaft of gear box.

Hydraulic system: 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 tractor, where the hydraulic device is installed at the machine chassis through a pin.

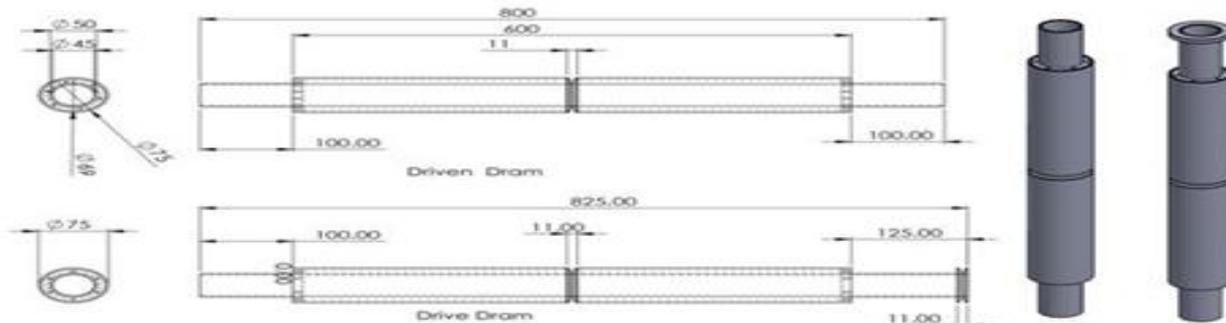


Fig.4. Drive shafts.



Fig. 5. General view of the new machine



Fig. 6. Balance of conveyor belt and drive system.

RESULTS AND DISCUSSIONS

1) Effective field capacity:

Fig.7 shows the effect of tractor forward speed on effective field capacity, at different conveyor belt speeds, 45° conveyor belt angle for new machine and 90° conveyor chain for traditional machine.

In new machine :- The data indicated that the mean of effective field capacity (fed/h) at different forward speeds of 2.5 , 3.5 , 4.5 and 5.5 km/h was 0.75 , 0.85 , 0.95 and 0.74 fed /h, respectively at conveyor belt speed of 1 m/s while it was 0.80,0.90,1.14 and 0.78 fed/h respectively at conveyor belt speed of 1.2 m/s while it was 0.84,0.96,1.24 and 0.82 fed/h , respectively at conveyor belt speed of 1.4 m/s while it was 0.88,1.0,1.34 and 0.86 fed/h. respectively at conveyor belt speed of 1.6 m/s. The maximum value of the effective field capacity was 1.34 fed/h at 4.5 km/h, 1.6 m/s conveyor belt speed while the minimum value of the effective field capacity was 0.74 fed/h at 5.5 km/h and 1.0 m/s conveyor belt speed.

In traditional machine: - The data indicate that the mean of effective field capacity (fed/h) at different forward speeds of 2.5, 3.5, 4.5 and 5.5 km/h at conveyor chain speed of 1.0 m/s and 90° of conveyor chain was 0.6, 0.75, 0.82 and 0.55 fed/h, respectively, while it was 0.79, 0.84, 0.9 and 0.69 fed/h respectively at conveyor chain speed of

1.2 m/s, while it was 0.82,0.88,0.93 and 0.78 fed/h, respectively at conveyor chain speed 1.4 m/s, while it was 0.86, 0.94, 1.04 and 0.82 fed/h, respectively at conveyor chain speed of 1.6 m/s. The maximum value of the effective field capacity was 1.04 fed/h at 4.5 km/h and forward speed 1.6 m/s at conveyor chain speed while the minimum value of the effective field capacity was 0.50 fed/h at 5.5 km/h forward speed and 1.0 m/s of conveyor chain speed. The lower performance rates of all mowers with the highest front speed of the tractor (5.5 km / h) due to the disproportionate feeding rate with the speed of the conveyor chain and the conveyor chain (1.6 m / s). If the conveyor speed exceeds 1.6 m / s tend to high vibrations in the machine may damage its parts. Referring to the low actual performance of traditional machine compared to the new machine at the same front speeds of the tractor, this is due to feeding rate is not proportional to the speed of the conveyor chain and the occurrence of overlap of the crop with moving parts (pristine star) and the inefficiency of fingers on the chain to transfer the large quantity of the crop on the side of the mower, which causes frequent breakdowns and stopping more than once to remove the crop in front mower. This will increase the harvesting time decrease of field efficiency and decrease of the actual field capacity.

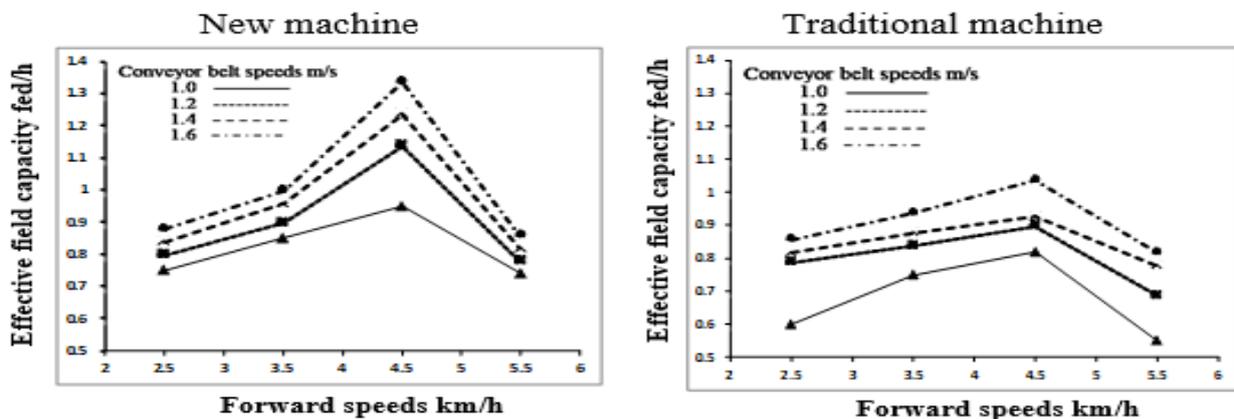


Fig. 7. Effect of forward speeds on actual field capacity under different conveyor belt, chain speeds for new and traditional machine.

2) Total grain losses %:

Fig.8 shows the effect of forward speed on total grain losses, at different conveyor belt speeds, 45° conveyor belt angle for new machine and 90° conveyor chain for traditional machine.

In new machine:- The data indicated that the mean of percentage of total grain losses increase by increasing forward speed and decrease of conveyor belt speed where it was 1.6, 2.2, 2.7 and 4.7 % respectively at conveyor belt speed of 1.0 m/s while it was 1.2, 1.8, 2.3 and 4.1 % respectively at conveyor belt speed of 1.2 m/s while it was 0.9, 1.5, 2.0 and 3.8 % respectively at conveyor belt speed of 1.4 m/s while it was 0.6, 1.25, 1.7 and 3.2 % respectively at conveyor belt speed of 1.6 m/s. The maximum total grain losses of 4.5 % was recorded at forward speed of 5.5 km/h and conveyor belt speed of 1.0 m/s. The minimum total grain losses of 0.6 % was recorded at forward speed of 2.5 km/h and conveyor belt speed of 1.6 m/s.

In traditional machine: - The data indicated that the mean of percentage of total grain losses was 2.4, 2.8, 3.5 and 5.8 % respectively at conveyor chain speed of 1.0 m/s while it

was 2.1, 2.5, 3.0 and 5 % respectively at conveyor chain speed of 1.2 m/s. while it was 1.5, 2.0, 2.5 and 4.5 % respectively at conveyor chain speed of 1.4 m/s. While it was 1.2, 1.7, 2.0 and 4 % respectively at conveyor chain speed of 1.6 m/s. The maximum total grain losses of 5.8% was recorded at forward speed of 5.5 km/h, conveyor chain speed of 1.6 m/s and conveyor chain angle of 90°. The minimum total grain losses of 1.5 % at forward speed km/h and conveyor chain m/s. Increase the total grain loss of the traditional mower compared to the new mower at all forward speeds, conveyor belt speeds and conveyor chain speeds is due to the friction of the crop with the moving parts of the conventional mower and the decrease efficiency of the transport of the crop. On the contrary, with the new mower there is no friction of the crop except with conveyor belt only.

3) Cutting efficiency:

Fig.9 shows the effect of forward speed on cutting efficiency, at different conveyor belt speeds, 45° conveyor

belt angle for new machine and 90° conveyor chain angle for traditional machine.

In new machine:- The data indicated that the mean of cutting efficiency increase by increasing forward speed at different conveyor belt speeds due to the numbers of knife strokes frequency decrease with forward speed of the tractor where it was 94, 93, 92.5 and 91 % respectively at conveyor belt speed of 1.0 m/s while it was 94.5, 93.5, 93 and 92 % respectively at conveyor belt speed of 1.2 m/s. while it was 95, 94, 93.5 and 92.5 % respectively at conveyor belt speed of 1.4 m/s while it was 96, 95, 94 and 93 % respectively at conveyor belt speed of 1.6 m/s. The maximum percentage of 96 % was recorded at forward speed of 2.5 km/h, conveyor belt speed of 1.6 m/s. The

minimum percentage of 91 % was recorded at forward speed of 5.5 km/h, conveyor belt speed of 1.0 m/s.

In traditional machine:- The data indicated that the mean of cutting efficiency was 93.5, 92.5, 91.5 and 90 % respectively at conveyor chain speed of 1.0 m/s while it was 94, 93, 92 and 91 % respectively at conveyor chain speed of 1.2 m/s. while it was 94.5, 93.5, 93 and 92 % respectively at conveyor chain speed of 1.4 m/s. While it was 95, 94.5, 93.5 and 92.5 % respectively at conveyor chain speed of 1.6 m/s. The maximum percentage of 95 % was recorded at forward speed of 2.5 km/h, conveyor chain speed of 1.6 m/s. The minimum percentage of 90 % was recorded at forward speed of 5.5 km/h, conveyor chain speed of 1.0 m/s.

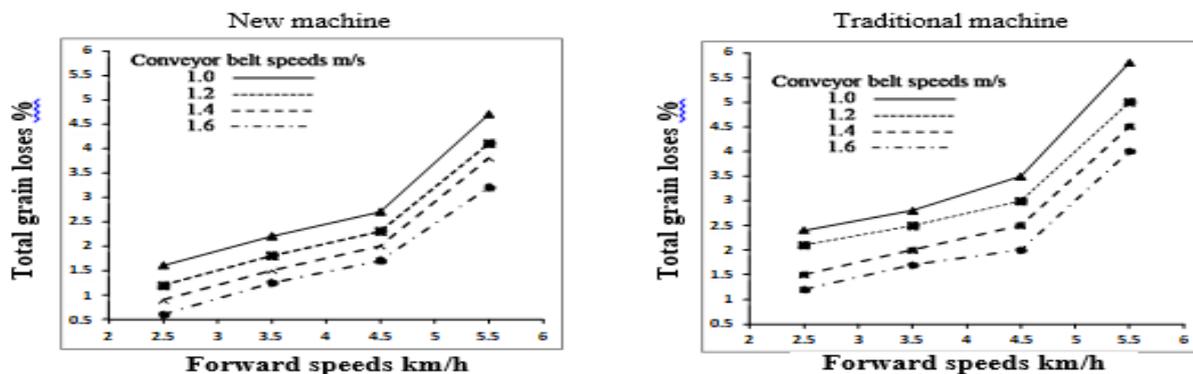


Fig .8. Effect of forward speeds on total grain losses under different conveyor belt, chain speeds for new and traditional machine.

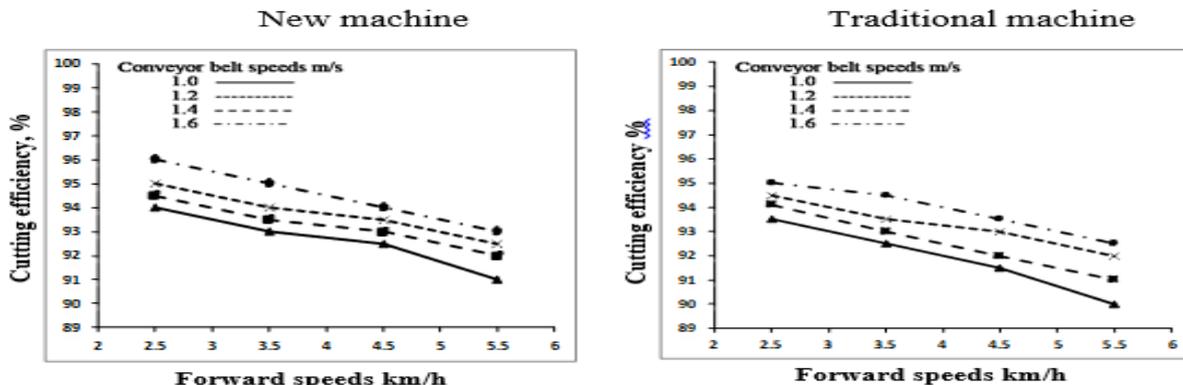


Fig. 9. Effect of forward speeds on Cutting efficiency under different conveyor belt, chain speeds for new and traditional machine.

4) Energy consumption:

Fig.10 shows the effect of forward speed on energy consumption, at different conveyor belt speeds, 45° conveyor belt angle for new machine and different conveyor chain speeds, 90° for traditional machine. The power requirements a function of forward speed, it was also a function of fuel consumption.

In the new machine:- The data indicated that the mean of specific energy requirement kW.h/fed decrees by the increase of forward speed and conveyor belt speeds due to increase of effective field capacity. it was 16.24, 14, 13.5 and 17 kW.h/fed respectively at 2.5, 3.5, 4.5 and 5.5 km/h at conveyor belt speed of 1.0 m/s while it was 15.6, 13.5, 11 and 16 kW.h/fed respectively at conveyor belt speed of 1.2 m/s while it was 15.0, 13.0, 10.25 and 15.5 kW.h/fed respectively at conveyor belt speed of 1.4 m/s while it was 14.5, 12.5, 9.5 and 14.8 kW.h/fed respectively at

conveyor belt speed of 1.6 m/s. The maximum specific energy was 17 kW.h/fed at forward speed of 5.5 km/h and conveyor belt speed of 1.0 m/s while minimum specific energy was 9.5 kW.h/fed at forward speed of 4.5 km/h and conveyor belt speed of 1.6 m/s.

In traditional machine: The data that the mean of specific energy requirement was 18.5, 16.2, 14.8 and 20 kW.h/fed respectively at conveyor chain speed of 1.0 m/s while it was 17, 15, 14.11 and 18.6 kW.h/fed at conveyor chain speed of 1.2 m/s while it was 16, 14.5, 13.5 and 16.5 kW.h/fed respectively at conveyor chain of 1.4 m/s while it was 15.2, 14.11, 13 and 15.5 kW.h/fed respectively at conveyor chain speed of 1.6 m/s. The maximum value of specific energy was 20 kW.h/fed at forward speed of 5.5 km/h and conveyor chain speed of 1.0 m/s while the minimum value of specific energy was 13 kW.h/fed at forward speed of 4.5 kW.h/fed and conveyor chain of 1.6 m/s.

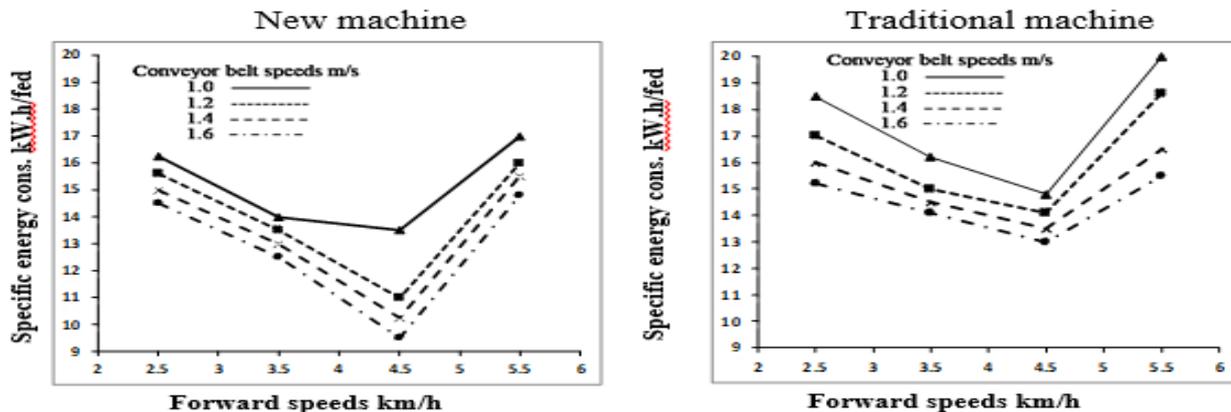


Fig. 10. Effect of forward speeds on Energy consumption under different conveyor belt,chain speeds for new and traditional machine

5) Operating cost:

Fig.11 showed the effect of forward speed on operating cost at different conveyor belt speeds, 45° conveyor belt angle for new machine and 90° conveyor chain for traditional machine:- The data indicated that the operating cost increase by decreasing the forward speed and conveyor belt speed.

In new machine:- The data indicated that the mean of operating cost was 106, 94, 84 and 108 LE/fed respectively at conveyor belt speed of 1.0 m/s while it was 102.5, 89, 73 and 105.2 LE/ fed respectively at conveyor belt speed of 1.2 m/s while it was 100, 87, 67 and 102.5 LE/fed at respectively at conveyor belt speed of 1.4 m/s while it was 95.2, 83.3, 61.5 and 97.5 LE/fed respectively at conveyor belt speed of 1.6 m/s.

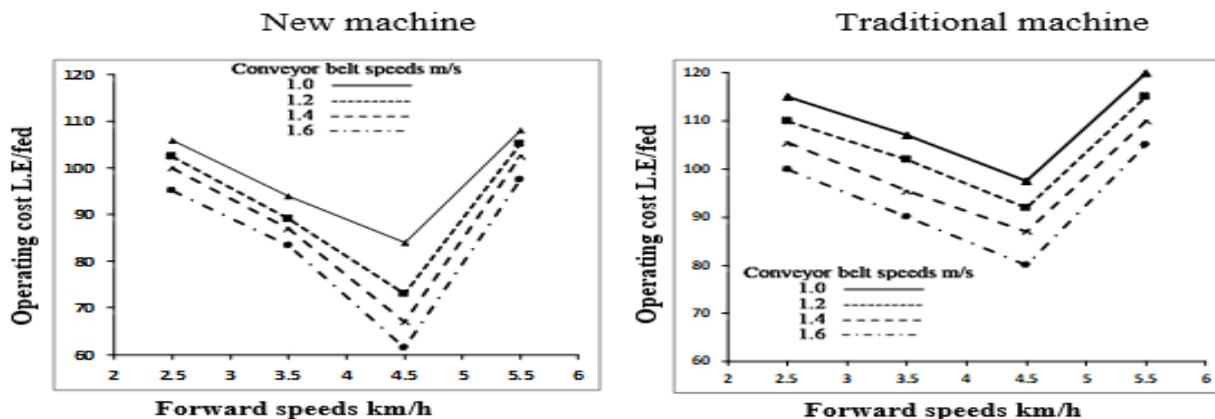


Fig. 11. Effect of forward speed on operating cost under different conveyor belt, chain speeds for new and traditional machine.

6) Criterion cost:

Fig.12 shows the effect of forward speed on criterion cost, at different conveyor belt speeds, 45° conveyor belt angle for new machine and 90° conveyor chain for traditional machine. It can be noticed that the increase of forward speed tends to increase the value of the criterion cost.

chain for traditional machine. It can be noticed that the increase of forward speed tends to increase the value of the criterion cost.

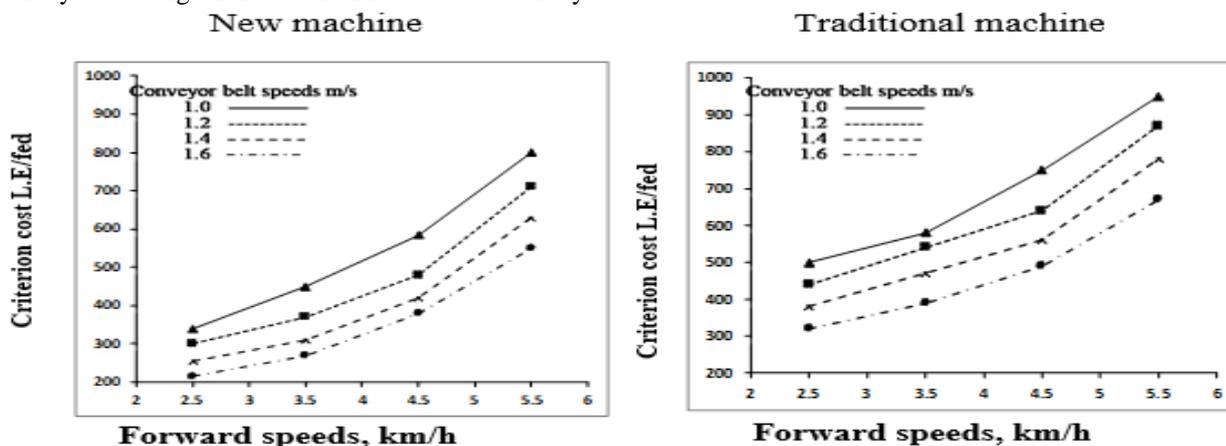


Fig. 12. Effect of forward speeds on Criterion cost under different conveyor belt, chain speeds for new and traditional machine.

In new machine :- The data indicated that the mean of criterion cost was 430 , 450 , 584 and 800 LE/fed respectively at conveyor belt speed of 1 m/s while it was 300 , 370 , 480 and 710 LE/fed , respectively at conveyor belt speed of 1.2 m/s while it was 255 , 310 , 420 and 630 LE/fed , respectively at conveyor belt speed of 1.4 m/s while it was 215 , 260 , 380 and 550 LE/fed , at conveyor belt of 1.6 m/s. The maximum criterion cost was 800 LE/fed at forward speed of 5.5 km/h and conveyor belt speed of 1 m/s while the minimum criterion cost was 215 LE/fed at forward speed of 2.5 km/h and conveyor belt speed of 1.6 m/s.

In traditional machine :- the data indicate that the mean of operating cost LE/fed was 115 , 107 , 97.5 and 120 LE/fed respectively at conveyor chain speed of 1 m/s while it was 110 , 102 , 92 and 115 LE/fed , respectively at conveyor chain speed of 1.2 m/s while it was 105.5 , 95.5 , 87 and 110 LE/fed , respectively at conveyor chain speed of 1.4 m/s while it was 100 , 90 , 80 and 105 LE/fed , respectively at conveyor chain speed of 1.6 m/s .The maximum value of operating cost was 120 LE/fed at forward speed of 5.5 km/h and conveyor chain of 1 m/s while the minimum value of operating cost was 80 LE/fed at forward speed of 4.5 km/h and conveyor chain of 1.6 m/s.

CONCLUSION

The obtained results were summarized as follows:

- The maximum field capacity was 1.34 fed/h for the new machine compared to 1.04fed/h for the traditional machine.
- The minimum total grain losses were 0.8 % for the new machine compared to 1.2 % for the traditional machine.
- The maximum cutting efficiency was 95% for the new machine compared to 97% of the traditional machine.
- The minimum energy consumption was 9.5 kW.h/fed for the new machine compared to 13 kW.h/fed for the traditional machine.
- The minimum value of criterion cost was 215 LE/fed for the new machine compared to 320 LE/fed for the traditional machine.

The study recommend using the new machine at the following parameters of operation forward speed 4.5km/h, conveyor belt speed 1.6 m/s and conveyor belt angle 45°.

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تطوير محشة معلقة أمامياً على الجرار لحصاد محصول القمح عادل محمد عمر الأشقر

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نظراً لأهمية محصول القمح بالنسبة للعالم بصفه عامه ولجمهورية مصر العربية بصفة خاصة ولوجود عجز بين حجم الإنتاج والإستهلاك بالنسبة لمحصول القمح. ونظراً لأن المحشات الامامية التقليدية والتي تعمل بنظام البكر النجمي قد ظهر بها بعض المشاكل (ضعف معدل الاداء - زيادة الفاقد) فقد تم وضع تصور بسيط لمحشة أمامية تعلق أمام الجرار وتأخذ حركتها من عمود الإدارة الخلفي للجرار وتتكون من سكينه حش بعرض 150 سم و سير ناقل بعرض 150 سم و ارتفاع 60 سم مصنوع من الكورتش و تم لحام أطرافه في ورشة متخصصة باستخدام الكمبيوتر من خلال برنامج خاص ويتم نقل الحركة الي السكينه الترددية و السير الناقل عن طريق جيربوكس له 3 أكسات أحدهما يأخذ الحركة من عمود الإدارة الخلفي للجرار والأكس الثاني يعطي حركة للسكينه و الأكس الثالث يعطي حركة للسير الناقل. و تم تقييم هذه الآله المعدله و مقارنتها بالآله التقليديه تحت نفس ظروف التشغيل و ذلك علي محصول القمح (صنف جميزه 9) و عند مستوي رطوبة للحبوب موسمي به و هو 20 % (الشرباصي 2006) و قد تم دراسة تأثير العوامل الأتية : إستخدام أربع سرعات أماميه للتشغيل و هي 2.5 و 3.5 و 4.5 و 5.5 كم / ساعه - إستخدام أربع سرعات للسير الناقل و هي 1 و 1.2 و 1.4 و 1.6 م / ثانيه في الآله المعدله ونفس السرعات للجرار الناقل في الآله التقليديه - إستخدام زاوية 45 درجة في الآله المعدله لأنها انطبقت زاوية لتشغيل الآله المعدله بعد اجراء التجارب الحقلية الاولي و في الآله التقليديه 90 درجة فقط لأنها مصممه علي هذه الزاويه. ولتقييم أداء الألتين تم أخذ القياسات التاليه : معدل الأداء الفعلي فدان / ساعه - نسبة فواقد الحبوب % - كفاءة القطع % - تكاليف التشغيل جنيه / فدان - التكاليف الكليه (تكاليف التشغيل + تكاليف فاقد الحبوب و القش) - القدرة المستهلكه كيلوات . ساعه/فدان، وقد اتضح من الدراسة أن الآله المعدله كانت أفضل في النتائج من الآله التقليديه وأوصت الدراسة بإستخدام الآله المعدله عند سرعة أماميه لا تزيد عن 4.5 كم / ساعه و سرعة سير ناقل 1.6 م/ث و زاوية سير 45 درجة حيث بلغ أفضل معدل للأداء الفعلي 1.34 فدان/ساعه للآله المعدله مقابل 1.04 فدان/ساعه للآله التقليديه و كذلك بلغت أقل نسبة فاقد حبوب 0.6% للآله المعدله مقابل 1.5% للآله التقليديه و أقل تكاليف تشغيل 61.5 جنيه / فدان للآله المعدله مقابل 80 جنيه / فدان للآله التقليديه و أقل تكاليف كلية 215 جنيه / فدان مقابل 320 جنيه / فدان و أقل قدرة نوعية مستهلكه 9.5 كيلو وات/ساعه / فدان للآله المعدله مقابل 13 كيلو وات. ساعه / فدان للآله التقليديه .