A COMPARATIVE STUDY BETWEEN WHEEL AND CRAWLER TYPE COMBINE HARVESTERS FOR LOCAL MANUFACTURING

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Abstract

The main objective of this investigation is to study and evaluate the technical and economical conditions for the appropriate performance of a multi-purpose combine harvester for local manufacturing under Egyptian conditions.

Four different parameters were considered using two different types of combine harvesters, namely, Yanmar 760 (Crawler type, 2.10m harvesting width and reel type header) and Kader-Cicoria combine (Wheel type, 2.10m harvesting width and reel type header) while harvesting wheat (Sakha 69 variety) and rice (Sakha 101 variety) crops.

1)-The effect of soil compaction induced by combine harvesters on physical properties of soil under two different levels of soil moisture content: 42.55% and 28.81% (db.), two different weights for combine harvester (with empty and full grain tank) and two levels of tire inflation pressure (2.0 and 2.5 bar, for drive Wheel of Kader-Cicoria combine only, while harvesting rice crop only.

2)- Field capacity and efficiency for both types of combines during harvesting wheat and rice crops under different forward speeds of (0.42, 0.69 and 0.94 m/s) for wheat crop and (0.33 , 0.60 and 0.78 m/s) for rice crop.

3)- Total grain losses for each combine were determined at grain moisture contents of (14.70, 17.50 and 20.24%) for wheat crop and (16.23, 20.91 and 24.85 %) for rice crop.

4)- Harvesting costs indicators were evaluated for both types of combine harvesters .

The main results show the following:

- Wheel type combine harvester at any inflation pressure and soil moisture content gave the highest values of soil compaction represented by soil bulk density and soil penetration resistance.
- It could be used at soil moisture less than 40% (at late harvesting).
- Using Crawler type combine harvester gave low values of the total grain losses and total grain damage during harvesting wheat or rice crops at any combine forward speed and grain moisture content.
- Crawler type combine gave the highest criterion cost although it gave the lowest grain losses and damage compared with Wheel type combine for harvesting wheat and rice crops. The main reason may be the initial cost of the Crawler type .

INTRODUCTION

It was noticed that during operation of these machines Wheel traffic caused the soil to be compacted and the problem of soil compaction due to machinery are more sever in soils with high moisture content specially, when the harvesting equipment carries several tons of grain in addition to its own weight.

Davies *et al.*, (1972) concluded that Wheel slip proved to be more important cause of compaction than additional Wheel loading. This effect was more pronounced with the greater power of tractor. Wheel slip changes as a function of tire size, tire shape, tire flexibility, inflation pressure, Wheel load, forward speed, soil type and soil strength (which varies with moisture content). Raghavan et al., (1977) stated that an increase in dry density of 0.12 g/cm^3 (50%) and 0.25 g/cm^3 (100%) was obtained due to slip in the field tests for sand and sandy loam, respectively. The compaction was found to be maximum between 15 and 25% Wheel slip and reduced as slip increased. A further study by Raghavan *et al.,* (1978) in a clay soil. They found that the compaction reached a maximum between 10 and 50% Wheel slip and reduced at higher slip rates. An increase of dry density up to 25 g/cm3 occurred to Wheel slip. Stafford and Mattos, (1981) found that effect of Wheel speed was greater at the shallow depths. There was no effect of speed at 200 mm depth

Ahmed *et al.,* (1988) found that the average percentage reduction in yield was 11.48, 38.8, 44.35 and 51.6% for treatments compacted with 1, 5, 10 and 15 passes, respectively by Beylara's (MTZ-80) tractor in silt loam soil, while, the average percentage reduction in yield was 12.1, 24.5, 56.5 and 89.8% after 1, 5, 10 and 15 passes, respectively by Ford (TW-15) tractor in sandy clay soil. Siemens, (1989) indicated that the pressure on the soil in contact with tire is approximately equal to the tire inflation pressure. For a given load on a tire, decreasing the tire inflation pressure decreases the soil pressure, especially near the soil surface. He also indicated that the increase in soil compaction due to tire traffic would be greatest when the moisture content is near field capacity.

Hamad and Abo- Habaga (1990) indicated that using specialized rice combine harvester (Kubota, Rx -2750) had no effect on soil compaction at soil moisture contents of 44.6and 47.2 % while the track depth after the specialized one was 2 cm at soil moisture content of 53%. The track depth after using general harvesting combine (Deutz-Fahr, M-980) were 4.9 and 13 cm after one pass at soil moisture contents of 44.6, 47.2 and 53%, respectively. EL-Iraqi, (1991) studied the soil compaction induced by mechanical harvesters during rice harvesting. His results recommended that, if rice has been harvested at soil moisture content higher than 54.31%, it is better to use Crawler type combine harvesters . While, at 42.57% or less moisture content, Wheel type combines can be used, especially at lower tires inflation pressure (1.0 bar), keeping the grain tank always near empty.

The main problem caused by soil compaction was restricting root penetration and proliferation at soil depths higher than 1 foot (30.5cm) during early stages of plant growth. Also, an increase in bulk density and a decrease in root growth were obtained with increasing the degree of compaction ((Das 1972 and Eavis 1972).

Chanceller, (1977) indicated that soil compaction could be caused by animal trampling and pressure and deformation resulting from traffic. Burger et al. (1985) reported that soil compaction might be the most damaging factor of the extent of the area affected and the longevity of the impact. They also concluded that soil compaction changed bulk density, soil strength and structure, and pore size distribution. Changes in these factors can adversely affect yield due to restricted root growth and movement of gases, water and nutrients. Abo-Habaga, (1989) reported that soil compaction had two forms, the first was artificial and the second was natural. He showed that soil compaction might be affected by soil type and moisture content, weight of machine and type of traction device and the number of passes in the field. Consequently, might affect soil bulk density and strength per size distribution and root growth. In addition, the compacted soil need higher energy to be prepared for the next crop and gives lower crop yield.

Kepner *et al.* (1982) stated that drum effectiveness is related to cylinder speed, cylinder concave clearance, type of crop and its moisture content. Yunus (1987) stated that the factors affecting grain losses at harvesting and threshing of paddy are the travelling speed, grain moisture content, drum speed and plant properties. Dilday (1987) studied the influence of drum speed and grain moisture content at harvest-on milling yield of grains. Grain moisture content of 12-26% was threshed at drum speeds of 600 or 1000 rpm showed that the percentage of broken grain virtually was doubled .

Hassan *et al.* (1994) indicated that the main effective parameters, which affect combine header performance, are combine forward speed, cuter bar speed and grain moisture content. Helmy *et al.* (1995) reported that increasing the forward speed tends to increase the actual field capacity and to decrease the field efficiency.

Kamel, (1999) proved that, all kinds of losses (header, drum, straw walker and shoe losses) increased with the increase of cutting height and harvesting speed for both tested combines and three rice varieties .

MATERIALS AND METHODS

The field experiments were carried out at " Rice Mechanization Center (R.M.C) farm. Meet EL- Deyba, Kafr EL- Sheikh Governorate". The experiments were conducted using two types of combine harvesters with general specification as summarized in Table 1.

Table 1. The specification of Yanmar and Kader-Cicoria combine harvesters

Technical specification	Yanmar / Crawler type	Kader-Cicoria/ Wheel type
Type	CA 760-T	KC 1600
Engine	4 cylinders, diesel engine, water cooled, 76 hp	4 cylinders, diesel engine, air cooled, 60 hp
Speed transmission and speed range	Hydrostatic transmission (HST) 0-2.3 m/s	Hydrostatic variable, 0-5 m/s
Overall dimensions, mm Length × width × height	2600 × 2430 × 2650	3200 × 2850 × 2620
Weight, kg	3910	3200
Tank capacity, kg	300	850
Traction device (drive system type)	Rubber Crawler	Rubber tire Wheel , 15.0/55-17
	Width × Length (mm) 500×1710	Diameter× width (mm), 850 × 38
Contact pressure, kg/cm^2	0.21	-------------
Threshing system	Screw rotor	Axial flow
Width × diameter (mm)	2170 × 650	1600 × 525
Drum speed / controller	716 / fixed	360-1100 / (pulley)
Cleaning system	Suction air and shaking sieve	Axial flow
Cleaning area	1.46 m^2	0.38 m^2

Measurements

Some of soil physical properties such as: soil moisture content, bulk density and penetration resistance, track , were measured before and after passing combine harvester during harvesting rice crop only. Other measurements such as field capacity, efficiency, total grain losses and grain damage were taken to evaluate the performance of both types of combine harvesters as follows:

1-Soil moisture content

The moisture content of the soil was determined using the electric oven method at (105°c) . Soil samples were taken at soil depths of 0-10 cm by a screw auger immediately before cultivation, and the moisture content percentage was calculated on dry basis using the following equation:

$$M = \frac{Mw - Md}{Md} \times 100$$

Where:

M = Soil moisture content percentage,

Mw = Wet soil mass (g),

Md = Dry soil mass (g)

2- Soil bulk density

Soil samples were taken with cylindrical cores (100 cm^3 volume) at soil depths of 0-10 cm taken under the center of the tire Wheel or Crawler before and after passing the combine. The soil bulk density was calculated after drying the soil samples at (105°c) accordina to El- Iraqi (1991) using the following equation:

$$D = \frac{M_d}{V_t}$$

Where:

D = Soil bulk density (g/cm^3),

M_d = Dry soil mass (g),

V_t = Total soil volume (cm^3)

3- Soil penetration resistance

Soil penetration resistance was measured at surface of soil and various depths below the surface with 5 cm increment up to a depth of 30cm using a Japanese cone penetrometer, model SR-2 Dik 5500 immediately before and after passing the combine.

4- Soil mechanical analysis

To determine particle size distribution, $CaCo_3$, organic matter and soil textural class of the experimental farm at Rice Mechanization Center, five samples were collected and analyzed through the depth (0-30 cm). The average of the obtained data was used as a representative of the experimental soil specification as shown in the following Table(2).

Table 2 . Soil mechanical analysis, $CaCo_3$ and organic matter.

Clay %	Slit%	(Clay + Slit) %	Sand %	$CaCo_3$%	Organic matter %	Soil type
53.32	17.63	70.95	29.05	1.3	1.71	Clay

5- Total grain Losses:

a- Header Losses:

The main effective parameters, which affect the combine header loss, are cutter bar speed, reel speed, forward speed and grain moisture content. The header loss was determined by inserting the V-shaped trays between standing wheat plants. After passing the cutter bar over the trays, the combine harvester was stopped and the trays are packed. The grains shattered by header were collected in the trays and weighed. The percentage of header losses was calculated using the following equation:

$$Header\ loss,\ \% = \frac{Header\ loss,\ ton/fed}{Total\ yield,\ ton/fed} \times 100 \quad \text{.................... (3)}$$

b- Rear Losses:

Rear losses includ drum, separation and cleaning losses. Drum loss was determined by dragging two plastic sheets (10.0 m Length) behind the combine harvester one above the other. The collected material on the upper plastic sheet consists of straw, unthreshed and damaged grain (drum loss). The unthreshed ears were manually threshed and the separated grains were weighed. While, the chaff and free grains discharged from the drum were weighted (separation loss). These losses were calculated using the following equations according to *Marey (1997)*:

$$Drum\ loss\% = \frac{Drum\ loss,\ ton\ fed}{Total yield,\ ton/fed} \times 100 \quad \text{................................(4)}$$

$$Separation\ loss,\ \% = \frac{Separation\ loss,\ ton/fed}{Total\ yield,\ ton/fed} \times 100 \quad \text{...................(5)}$$

The collected material from the lower plastic sheet was winnowed to get the free grains (cleaning loss). The percentage of cleaning loss was calculated by using the following equation:

$$Cleaning\ \ loss, \% = \frac{Cleaning\ loss, ton / fed.}{Total\ \ yield, ton / fed.} \times 100 \quad \text{.............................(6)}$$

6- Grain damage

a-Visible grain damage:

Visible grain damage was determined by separating the damaged grains by hand from a mass of 50 g sample, which was taken by a randomized method from the threshed grains. The percentage of grain damage was calculated based on the original mass of sample.

b-Invisible grain damage:

A germination test was carried out to determine the invisible damage in grains. The samples of these tests were taken from the remained portion of the visible sample after separating damaged grains. The germination test was carried out in five petri dishes on a filter paper, covered with water and incubated at 20^{0}C for 24 hours. The germinated grains were collected in each dish and expressed as a percentage of the original number of grains.

7- Field capacity and efficiency:

Calculations of the field capacity and efficiency were according to ***(Hunt, 1983):***

a- The theoretical field capacity:

$$\text{F.C}_{th} = \frac{W \times S}{4.2}, fed./h \quad \text{...(7)}$$

Where: $F.C_{th}$ = Theoretical field capacity, fed/h .

W = Theoretical width of combine, m .

S = Average working forward speed, Km/h.

b- The effective field capacity :

$$F.C_{eff} = \frac{1}{T_{eff}}, fed./h \quad \text{...(8)}$$

Where: $F.C_{eff}$ = Effective field capacity, fed/h .

T_{eff} = Effective total time in hours per feddan (actual harvesting time + turning time + adjusting or repair time + discharge time).

c- The Field efficiency:

$$\eta_{eff} = \frac{F.C_{eff}}{F.C_{th}} \times 100 \ , \% \qquad \ldots\ldots(9)$$

Where: η_{eff} = Field efficiency, % .

$F.C_{eff}$= Effective field capacity, fed./h .

$F.C_{th}$= Theoretical field capacity, fed./h .

8- Cost analysis:

The total harvesting cost included the total operation cost and the criterion cost. The total operation cost was calculated by estimating both fixed and variable costs (according to Kepner et al. 1982) for each combine under the operating conditions. However, the criterion Function cost (C_f) was calculated to determine the optimum operating parameter for the machine. This function can be calculated as the sum of the unit cost (*Uc*, LE/ton) plus the losses cost (*Lc*, LE/ton) (Helmy, 1988).

$$C_f = U_C + L_C \qquad \ldots\ldots(10)$$

Where: $L_c = (10^{2}\ C_{pw} \times T_L) + (0.67 \times T_{GD})$, LE/ton .

C_{pw} = Current price of one ton of grain wheat or rice .

T_L = Total grain losses, % .

T_{GD} = Total grain damage, % .

0.67= Current price of one ton of broken wheat or rice, LE .

RESULTS AND DISCUSSION

1- Effect of combine traffic on soil bulk density :-

The results in Fig. 1 show the average soil bulk density before and after one pass for both types of combine harvesters at two different soil moisture contents (42.55% and 28.81% db) and three forward speeds (0.36, 0.59 and 0.88 km/h). At the highest soil moisture content (42.55%) there was an increase in soil bulk density . with the Wheel type combine at 2.0 and 2.5 bar tire inflation pressure. The same trend was found with the Crawler type combine. Similar results were obtained at 28.81% soil moisture content, at lower bulk density.

The results also indicated that Wheel type combine at any tire inflation pressure gave the highest values of soil bulk density, than the Crawler type. This may be due to the larger contact area of the traction device for Crawler type combine .However the soil bulk density with 2.5 bar Wheel tire inflation pressure was higher compared with 2.0 bar. Since the smaller the inflation pressure the larger the contact area giving less contact pressure and compaction of soil.

Also, from the Figures 1 and 2, it can be observed that the increase in combine weight due to the filling of grain tank causes a slight increase in soil bulk density. This effect was decreased by decreasing soil moisture content and contact pressure of combine traction device, at a given tire inflation pressure, increasing the load on the tire caused the tire to be flattened on the soil surface, so that the pressure will change between the tire and soil surface could ignored. With respect to the Crawler type traction, the contact area of the combine with soil is always constant. For a given contact area, increasing the load on the Crawler, increases the contact pressure on soil and consequently more compaction. Anyhow, the change in bulk density is very slight because the weight change is very small compared with the large contact area of the Crawler as shown in the Fig. 2.

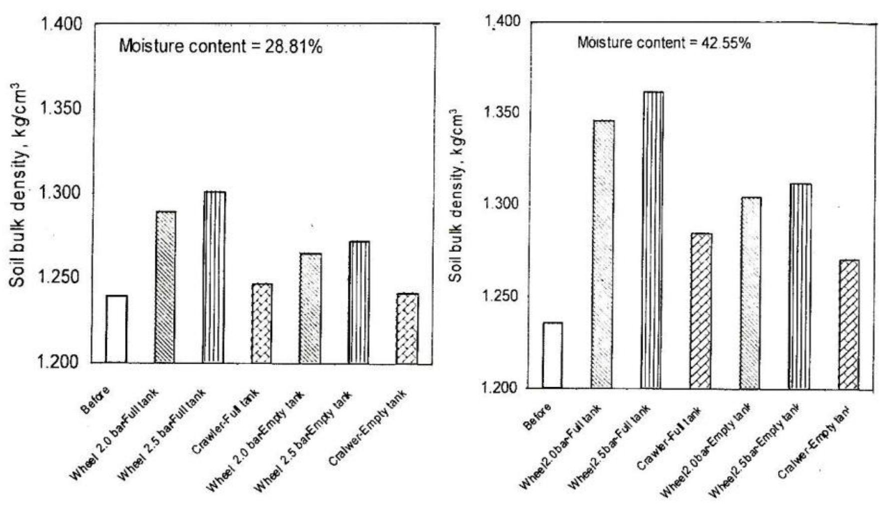

Fig. 1. Soil bulk density before and after wheel type and crawler type combines passing, for different soil moisture contents.

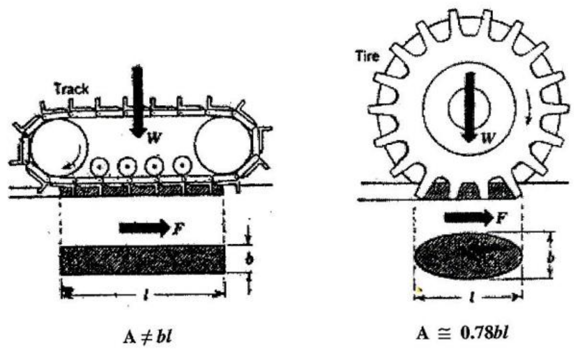

Fig. 2. Comparison of contact area between Crawler type and Wheel type traction devices.

The analysis of variance showed that the effect of full grain tank on soil bulk density was significant for the Wheel combine. This is because the full capacity of Yammer's tank is only 300 kg compared with 850 kg for Kader-Cicoria combine harvester.

2- Effect of combine traffic on soil penetration resistance

The strength properties of any given soil and their change with time can be determined through the measurements of soil shear strength and penetration resistance whose values depend to a great extent on bulk density and moisture. The penetration resistance values are usually employed in characterizing soil in terms of crop growing ability and in the determination of resistance to root penetration and seedling emergence.

Fig. 3 illustrates the results of penetration resistance of soil before and after any traffic movements. These results indicate that as the penetration depth increases, the soil penetration resistance clearly increases at any given soil moisture content. Also, with the increase in combine forward speed, the soil penetration resistance increased.

In general, as moisture content decreases (from 42.55 to 28.81%), the soil penetration resistance clearly increases at any given soil depth under both Wheel and Crawler traction devices of the combine harvester. It was observed that the use of Wheel type combine with tires at 2.5 bar inflation pressure gave the highest increase in soil penetration resistance at all depths up to 30 cm for any given soil moisture content.

With respect of the effect of combine weight on soil penetration resistance at different soil moisture contents, it can be noted that the Wheel type traction device was found to be more affecting on the soil than Crawler type. The distribution effect through soil depth will be different in case of Wheel type traffic device than Crawler type traffic device due to the different contact and pressure area for each device as shown in Fig. 4. For both type of traction device, an increase in soil resistance was observed with increasing combine weight due to full capacity of grain tank. This effect mainly depends on the volume of grain tank. Therefore, the increment percentage in soil penetration resistance due to full grain tank for Wheel combine was higher than that for Crawler combine . This is because the full capacity of Crawler combine tank is only 300 kg compared with 850 kg for Wheel type combine harvester.

3- Effect of combine type and speed on the total grain losses

The total grain losses of Wheel type combine and Crawler type combine harvesters including header, drum and cleaning losses were estimated and illustrated in Fig. 5 during harvesting wheat and rice crops.

The maximum value of the total wheat grain losses (4.91%) was obtained for of Wheel type combine harvester under forward speed of 0.94 m/s and grain moisture content of 14.70% compared with 4.25% for Crawler type combine under the same conditions. However, the best conditions (the lowest total grain losses) for both types of combines were obtained at 0.42 m/s forward speed and grain moisture content of 14.70 %.

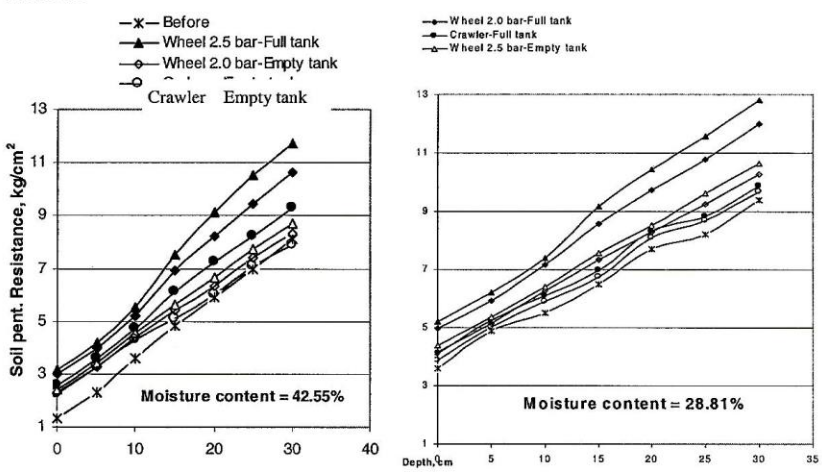

Fig. 3. Soil peneteration resistance before and after wheel type and crawler

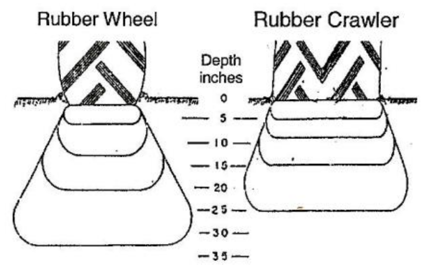

Fig. 4. Effect of the type of traction device on the soil compaction distribution depth.

The maximum value in the total rice grain losses (5.25%) was obtained for Wheel type combine harvester under forward speed of 0.78 m/s and grain moisture content of 20.24% compared with 4.43% for Crawler combine harvester under the same conditions. While, the lowest value in total rice grain losses (2.33%) was obtained for the Crawler combine harvester under forward speed of 0.33 m/s and grain moisture content of 14.77% compared with 2.5% for Wheel combine harvester during harvesting rice crop under the same condition .

The results indicated that using Crawler type combine harvester to harvest wheat or rice crops decreasing the total grain losses compared with Wheel type combine harvester at all forward speeds and grain moisture contents. However, the percentage of the total grain losses for rice crop was lower than that obtained for wheat crop. Also, it could be mentioned that increasing combine forward speed and decreasing grain moisture content increased the total grain losses for both types of combine harvesters.

These results may be due to the large threshing and cleaning area for Crawler combine than that for Wheel combine as indicated in the specification Table 1. in addition to the differences between the used combine forward speeds during harvesting wheat and rice .

4- Effect of combine type and speed on the total grain damage

The total percentage of wheat and rice grain damage which include visible and invisible damage, were greatly influenced by the type of the combine harvester as well as by forward speed and grain moisture content as indicated in Fig 6.

The results showed that using Wheel type combine harvester achieved the highest values of total grain damage (visible and invisible) for wheat and rice crops while the lowest values were associated with Crawler combine. This trend was due to the differences in the threshing, cleaning and grain conveying systems between both types of combine harvester . It could be concluded that the values of total grain damage increased by increasing combine forward speed and decreasing grain moisture content for both types of combine harvesters. However, the values of total grain damage higher with wheat grains than that obtained with rice grains.

The maximum values of the total grain damage of 5.62 and 4.26% were obtained when using Wheel type for harvesting wheat and rice crops, respectively under the lowest values of forward speed and grain moisture content. However, the minimum values of the total grain damage of 2.35 and 1.97% were obtained when using Crawler type for harvesting wheat and rice crops, respectively under the highest values of forward speed and grain moisture content

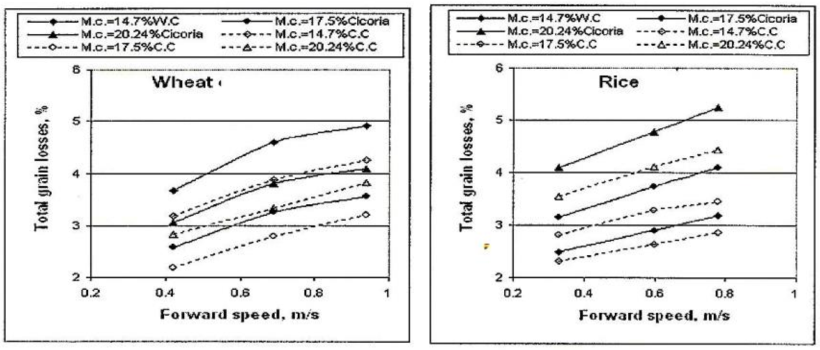

Fig. 5. Effect of combine type, forward speed and grain moisture content on total grain losses for wheat and rice crops .

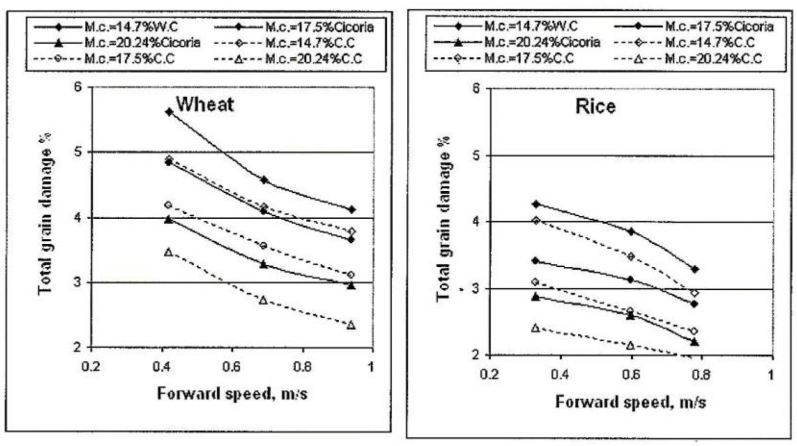

Fig. 6. Effect of combine type, forward speed and grain moisture content on total grain damage for wheat and rice crops

WHERE :

C.C : Crawler type combine .

W.C : Wheel type combine

5- Effect of combine type and speed on effective field capacity and efficiency

Fig. 7 shows the effect of combine forward speed and type of combine harvesters on the effective field capacity and field efficiency for harvesting wheat and rice crops. It could be observed that the values of effective field capacity and field efficiency of Crawler combine harvester were higher than that obtained for Wheel combine harvester under the same harvesting conditions of wheat and rice crops. The effective field capacity increased by 1.85 to 2.90 and the efficiency increased by 0.56 to 0.86% due to the use of the Crawler combine in harvesting wheat crop instead of using Wheel combine harvester. The increase in efficiency was due to the deecrease in the lost time in discharging the grain tank for the Crawler combine harvester, in addition to the saved time in headland turning, adjusting and maintenance of the combine. However, the effective field capacity increased by 9.66 to 12.73% and the field efficiency increased by 1.54 to 2.19% when using the Crawler combine to harvest rice crop compared with Wheel combine harvester.

It could be noticed that the obtained effective field capacity and efficiency for the two combines were higher when harvesting rice crop than with wheat crop. These results ware mainly due to the difference between two crops conditions in addition to the difference in the combine forward speeds and grain moisture contents.

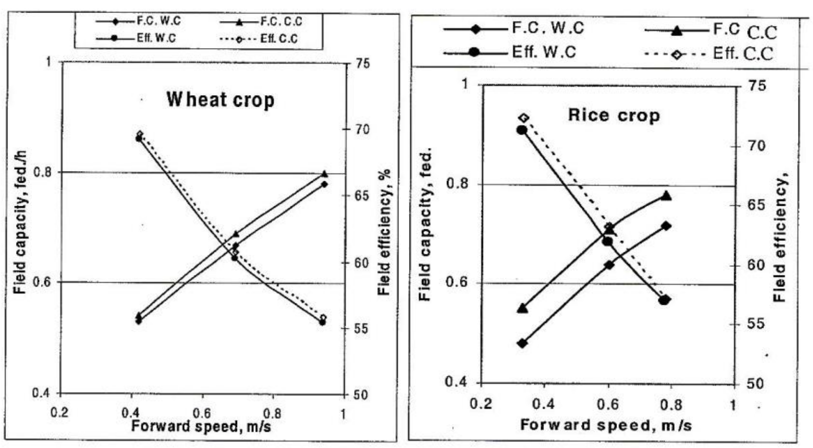

Fig. 7. Effect of combine type and forward speed on field capacity and efficiency for wheat and rice crops.

6- Criterion cost

The total operating cost of harvesting wheat crop ranged from 98.33 to 136.04 LE/fed when using Wheel type combine harvester compared with 151.48 to 214.74 LE/fed for Crawler combine. However, the corresponding operating cost for harvesting rice crop ranged from 106.53 to 150.21 LE/fed when using Wheel combine harvester compared with 155.6 to 210.84 LE/fed for Crawler combine.

From these results it could be observed that the Crawler combine gave the highest values of operating cost in comparison with that for Wheel combine at any given forward speed. These results may be due to increasing the total yearly hours for Wheel combine than that for Crawler combine used mainly for harvesting rice and wheat but the Wheel combine was used as a multi crop combine in harvesting rice, wheat, barely, sunflower...etc.

In addition, due to excessive wearing in the Crawler compared with the Wheel especially in harvesting wheat crop where the soil is more dry and cracked which increased the wearing rate in the Crawler combine due to the large contact area and frictional forces. The cost rate for changing Crawler combine was 10 LE/h compared with 3.33 LE/h for Wheel combine.

The values of criterion cost for Wheel and Crawler combines which included the operating cost and the cost of grain losses and damage under different combine forward speeds and grain moisture contents are summarized in Table 2.

It could be concluded that, using Wheel combine harvester gave the lowest values of the criterion cost compared with Crawler combine harvester at any given forward speed and grain moisture content for harvesting wheat and rice crops. The criterion cost for harvesting wheat crop was lower that that for harvesting rice crop for both types of combine harvesters. Also the criterion cost was found to be highly affected by the forward speed and grain moisture content which affected directly the grain losses and damage.

The criterion cost values of Wheel ranged from 212.2 to 243.4 LE/fed for harvesting wheat crop and ranged from 253.9 to 312.7 LE/fed for harvesting rice crop. However, these values for Crawler combine ranged from 241.9 to 307.9 LE/fed for harvesting wheat crop and ranged from 271.0 to 357.4 LE/fed for harvesting rice crop.

Table 2. Criterion cost of Wheel and Crawler combine harvesters under different forward speeds and grain moisture contents.

speed, m/s	Wheel Combine			Crawler Combine		
	Moisture content of wheat grains, %					
	14.7	17.5	20.24	14.7	17.5	20.24
0.42	243.4	213.1	223.9	307.9	279.8	295.6
0.69	241.1	204.6	217.9	281.8	252.0	265.3
0.94	236.0	199.2	212.2	271.0	241.9	257.1
	Moisture content of rice grains, %					
	16.23	20.91	24.85	16.23	20.91	24.85
0.33	253.9	277.5	312.7	307.6	324.4	351.4
0.6	235.2	265.9	305.0	275.0	298.3	329.3
0.78	235.1	269.2	312.5	271.0	292.3	329.4

CONCLUSION

- The Wheel type combine at any tire inflation pressure and moisture content, gave the highest soil compaction than Crawler type. At 28.81% soil moisture content, the Crawler combine had no effect on compaction. Also, increasing the inflation pressure of tires significantly increases the compaction of the soil.
- Using Crawler combine harvester results in decreasing the values of the total grain losses and the values of the total grain damage during harvesting wheat and rice crops, compared with Wheel combine harvester under all grain moisture contents and forward speeds .
- The obtained values of effective field capacity and efficiency for Crawler combine harvester was found to be higher than that obtained for Wheel combine harvester by 1.85 to 12.73% and by 0.56 to 2.19% for field capacity and efficiency, through harvesting wheat and rice crops, respectively
- Using Crawler type combine gave the highest criterion cost although this combine gave the lowest grain losses and damages compared with Wheel type combine for harvesting wheat and rice crops.
- It is recommended to consider the Wheel type combine for local manufacturing due to the lowest criterion cost, multi-crop harvesting and its slight effect on soil compaction.

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دراسة مقارنة بين آلاتى حصاد ميكانيكى (عجل – كتينه) تحت ظروف التشغيل الحقلى لمحصولى القمح والأرز بغرض التصنيع المحلى

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نظرا للتباين الشديد بين حاصدات محاصيل الحبوب من حيث طريقة التشغيل والحجم وجهاز الجر بالإضافة إلى ارتفاع أسعار استيرادها بشكل تضاخمى كان من الضرورى التفكير فى إجراء دراسة مقارنة بين نوعين من آلات الحصاد المتعددة الأغراض والمتوسطة الحجم لتحديد أفضلها من الناحية الفنية والاقتصادية للقيام بتصنيعها محلياً تحت الظروف المصرية. حيث تم دراسة تأثير مرور آلات الحصاد على انضغاطية التربة وتأثيرها على بعض الخواص الطبيعية للتربة مثل الكثافة الظاهرية ومقاومة التربة للاختراق وكذلك دراسة تأثير كل منها على الفقد والكسر الكلى بالحبوب والسعة الحقلية الفعلية والكفاءة الحقلية تحت ظروف التشغيل بسرعات أمامية مختلفة وذلك لكل من محصولى القمح والأرز .

ولتحقيق الهدف من هذا البحث استخدم كومباين حصاد ذو عجل كاوتش مصنع محلياً فى مصنع قادر مقارنة بالكومباين المستورد اليابانى ذو الكتينة الكاوتش حيث يتساوى كل منهما فى عرض التشغيل (٢,١٠متر) لإجراء التجربة أثناء الحصاد .

وقد تم دراسة تأثير ضغط انتفاخ العجل للكومباين ذو العجل المصنع فى مصنع قادر عند ٢,٠ ، ٢,٥ بار للعجل الخلفى فقط) بالإضافة إلى تأثير وزن الكومباين (وخزان الحبوب فارغ وأيضا وهو ممتلىء بالحبوب) على انضغاطية التربة وذلك عند محتويين مختلفين (٤٢,٥٥، ٢٨,٨١%) لرطوبة التربة أثناء حصاد محصول الأرز فقط. بينما تم تقييم الفواقد الكلية والكسر الكلى بالحبوب وكذلك السعة والكفاءة الحقلية لكل من آلاتى الحصاد تحت الدراسة عند سرعات أمامية ٠,٤٢ ، ٠,٦٩، ٠,٩٤ م/ث ومحتوى رطوبى للحبوب ١٤,٧٠ ، ١٧,٥٠ ، ٢٠,٢٤% لمحصول الأرز بينما كانت السرعات الأمامية للكومباين ٠,٣٣ ، ٠,٦٦ ، ٠,٧٨ م/ث والمحتوى الرطوبى للحبوب ١٦,٢٣ ، ٢٠,٩١ ، ٢٤,٨٥% أثناء حصاد محصول القمح. هذا وقد تم حساب مؤشرات التقييم الاقتصادى لتقدير التكاليف الكلية لحصاد محصولى القمح والأرز شاملة تكاليف التشغيل وتكاليف الفقد والكسر وتكاليف التآكل فى جهاز الجر (العجل الكاوتش والكتينة الكاوتش) لكلا من آلاتى الحصاد تحت الدراسة

وقد أوضحت النتائج ما يلى:

١- أعطى كومباين الحصاد ذو العجل المصنع فى مصنع قادر أعلى معدلات لقـيم الانضـغاطية (كثافة ظاهرية ومقاومة تربة للاختراق) عند كلا من ضغطى الانتفاخ لعجلتـى الجـر. كمـا أوضحت الدراسة أيضا أن انضغاطية التربة تزداد بزيادة نسبة الرطوبة بها ويختلـف معـدل الزيادة باختلاف نوع الكومباين ووزنه ونوع جهاز التلامس به . ولقـد وجـد أن زيـادة وزن الكومباين نتيجة لامتلاء خزان الحبوب يزيد من انضغاطية التربة بقدر بسيط خاصة عند نسب الرطوبة المنخفضة للتربة وعند ضغط الانتفاخ المنخفض لجهـاز الـتلامس (العجـل) وكـان الكومباين اكثر تأثرا بامتلاء خزان الحبوب.

٢- أدى استخدام الكومباين المستورد اليابانى ذو الكتينة الكاوتش إلى انخفاض قـيم الفاقـد الكلـى للحبوب وأيضا انخفاض قيم الكسر الكلى بالحبوب أثناء حصاد محصولي القمح والأرز مقارنة باستخدام الكومباين قادر– شيكوريا فى حصاد كلا المحصولين.

٣- كانت السعة والكفاءة الحقلية للكومباين المستورد اليابانى ذو الكتينـة الكـاوتش اعلـى منهـا للكومباين ذو العجل المصنع فى مصنع قادر بنسب تراوحت من ١,٨٥ إلى ١٢,٧٣% للسـعة الحقلية الفعلية و من ٠,٥٦ إلى ٢,١٩% للكفاءة الحقلية أثناء حصاد محصولى القمح والأرز

٤- كانت مؤشرات التكاليف الكلية (جنيه/فدان) للكومباين المصنع فى مصنع قادر اقل بكثير مـن مثيلتها للكومباين المستورد اليابانى ذو الكتينة الكاوتش وتأثرت هذه التكاليف بشكل مباشر بعدد ساعات التشغيل السنوى للكومباين اليابانى بالاضافة إلى ارتفاع سعر الكتينة الكاوتش وسرعة تآكلها بمعدلات اكبر من العجل الكاوتش.

٥- يوصى الباحث بالتوسع فى التصنيع المحلى لما له من مميـزات مثـل انخفـاض التكـاليف الرأسماليه و تكاليف التشغيل وكذلك استخدامه فى حصاد أكثر من محصول وكـذلك لتـأثيره البسيط على انضغاطية التربة لخفة الوزن وزيادة سعة خزان الحبوب.