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COMPARATIVE STUDY BETWEEN SOME DIFFERENT COMBINE SIZES IN RESPECT TO UNIT PLOT AREA

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ABSTRACT: The performance of three different combines (Yanmar- 1.45m width, Local- 2.1m width and claas- 4.5m width) in terms of harvesting time, field capacity and field efficiency, total grain losses, fuel consumption, energy and cost was experimentally investigated as a function of change in unit plot area, combine forward speed and grain moisture content.

Two main experiments were carried out. The first experiment was conducted to select optimum combine size suits for a certain field size. While the second experiment was conducted to estimate the optimum parameters for operating the combines during harvesting rice crop.

The experimental results reveal to the following:

- **The lowest harvesting time of (31 min/fed.) was recorded under the use of claas combine in unit plot area of 5.0 fed. at a forward speed of 4 km/h and grain moisture content of 22%.**
- **The highest field capacity of (3.43 fed./h) was recorded under the use of claas combine in unit plot area of 5.0 fed. at a forward speed of 4 km/h and grain moisture content of 22%.**
- **The highest field efficiency of (89.3%) was recorded under the use of yanmar combine in unit plot area of 1.0 fed. at a forward speed of 1km/h and grain moisture content of 22%.**
- **The lowest total grain losses of (2.12%) was noticed under the use of yanmar combine in unit plot area of 1.0 fed. at a forward speed of 1 km/h and grain moisture content of 22%.**

- **The lowest fuel consumption of (4.74 l/fed.) and the lowest energy requirement of (13.12 kw.h/fed.) were determined with the use of yanmar combine at a forward speed of 4 km/h, unit plot area of 1.0 fed. and grain moisture content of 22%.**
- **The lowest criterion cost of (148.42 L.E./fed.) was recorded under the use of yanmar combine in unit plot area of 1.0 fed. at a forward speed of 3km/h and grain moisture content of 22%.**

INTRODUCTION

Rice crop is considered one of the most important economical crops as it participate in the international income added to the local consumption in feeding and different aspects.

Direct combining is the successful answer to harvest rice crop. So, such care had to be taken to operate the harvesting machines under the optimum conditions to minimize both losses and cost.

There are many factors that control the performance of harvesting machines. These factors can be divided into two sections : machine and plant. Machine variables include combine forward speed, peripheral speeds of combine devices, and feeding rate. Moreover, the plant variables are considered critical factors. These variables are variety, moisture content and degree of maturity.

The academic and applied researches indicated that rice grain losses, occurring through different stages of rice production, is a vital problem to be solved. One of these stages is rice harvesting. As known, rice crop is too sensitive to harvesting operation due to the high percentage of grain losses affecting on the total yield.

Awady, (1974) calculated the total operation time for the combine harvester and estimated the costs and their mathematical relations to size of holding in Saudi Arabia. He found that : 1. The total operating time and consequently the operating costs increase by the decrease of the size of holding due to travel (transport) time for field to field and due to the increase of the turning time, he also found that. 2. The rate of change in operating time is not greatly varied up to 50 donums, so that it was considered the least economical area to operate the combine harvesters, the operating time was found 0.27 h/1000 m^2 at this area and the operating costs was 52.2L.S/1000m^2.

Arnaout, (1980) estimated the field capacity and efficiency in rice harvesting by using combine harvester and found that :

1. The field efficiency increased by the increase of harvested area when ratio of field length to width constant.
2. The field efficiency was highly affected the turning time in respect to the forward speed.
3. The field efficiency was highly affected by travel time from field to another.
4. The affective field capacity increased by increase of harvested area.

Ghazy, (1988) found that increasing harvesting forward speed from 1.33 to 2.64 km/h increased the total grain losses under different grain moisture content levels. He added that if 5% of total grain losses is allowed as the maximum possible losses, the speed up to 2.63 km/h can be used when the rice grain moisture content is around (17.2 – 20.7%), while forward speed of 1.33 km/h. should be used when the grain moisture content is about (15 – 16%) or less.

Fouad *et al.*, (1990) stated that increasing the average harvesting speed of the rice combine from 0.89 to 2.83 km/h caused a significant increase of total grain losses. This increase in total grain losses is mainly due to the increase of header and drum losses which were attributed to the lodged condition of the crop.

El-Shal and Morad (1993) investigated eight different manual and mechanical method of harvesting rice in small holdings. They found that the Yanmar combine gave the lowest value of grain losses (1.6%) and the lowest value of criterion cost (120 L.E/fed) at the forward speed of 2.5 km/hr and moisture content of 22%.

Morad and Arnout (1994) noticed that increasing the plot area from 0.25 to 5.00 fed. decreased fuel consumption per fed. from 7.2 to 6.4, using Yanmar combine in rice crop. They added that increase of fuel consumption is attributed to the variation of forward speed, accompanied with small length of the harvested area also the increase of turning time of harvested area and consequently fuel used.

Helmy *et al.*, (1995) noticed that the grain damage decreased by increasing the forward speed. This is due to the dense layer of material passing between cylinders and concave bars at high feed rates which provide more production and reducing the repeated impacts by the cylinder bars. They added that the increase of forward speed and grain moisture content tend to increase the both total grain losses and effective field capacity. And also, they added increasing forward speed of rice combine form 0.85 to 2.27 km/h tends to increase the total grain losses from (3.12 to 5.64%), (5.19 to 10.43%) and (3.12 to 6.53%) while, it was increased from (1.45 to 3.04%), (2.18 to 4.42%) and (1.66 to 3.47%) for rice variety Giza-171 and Giza-175 at three different harvesting times, respectively.

The objectives of this study are :

1. Comparing the performance of three different combines (yanmar combine -1.45 m width, local combine -2.1 m width and claas combine -4.5m width) in terms of harvesting time, grain losses, fuel consumption, energy and cost requirements.
2. Estimating optimum combine size (optimum combination of combine width and power) suits for a certain unit plot area during the harvesting operation of rice crop.
3. Selecting optimum conditions (combine forward speed and grain moisture content) during the harvesting operation.

MATERIALS AND METHODS

The main experiments were carried out through two successful agricultural seasons 2002 and 2003 at Gemmiza Agricultural faım Research station, Gharbia Governorate to evaluate the performance of some different combines and select the optimum combine suits for a certain field size during the harvesting operation of rice crop (Sakha 101) variety.

The following combines were used to carry out the harvesting operation of rice crop.

- Small size – Yanmar combine – 1.45 m width –27.9 kW (38 hp) power, Medium size - Local combine – 2.10 m width – 42.6 kW (58 hp) power and Large size – Claas combine – 4.50 m width – 136 kW (185 hp) power.

- The main experiments were carried out using different types of combines for harvesting rice (Sakha 101) variety.

1. The first experiment :

The first experiment was conducted to select optimum combine size suits for a certain field size.

The experimental area of the first experiment was about 114 feddans divided into three equal main plots (38 feddans each). Every combine was used for harvesting rice in one of the mentioned main plots.

The area of the main plot (38 feddans) was divided into another four plots (9.5 feddans each) in order to operate the combines at different forward speeds (1, 2, 3, and 4 km/h).

Each plot (9.5 feddans) was classified into six sub plot areas with different sizes of 0.25, 0.50, 0.75, 1.0, 2.0 and 5.0 feddans.

In this experiment, the three combines were operated at constant grain moisture content of 22%.

2. The second experiment :

The second experiment was conducted to evaluate the performance of the different combines.

The experimental area of the second experiment was about (6 feddans) divided into three equal plots (2 feddans each). One of the three plots was harvested by yanmar combine (small size), the other by local combine (medium size), and the third by claas combine (large size).

The performance of the combines was measured under four different forward speeds of 1, 2, 3 and 4 km/h and four different grain moisture contents of 16, 20, 22 and 25%.

Measurements and determinations :

Selection of combine size as well as evaluation of the performance of each combine was based on the following indicators :

1. Field capacity and field efficiency :

Theoretical field capacity was determined by the following equation :

$$C_{th.} = \frac{W \times V}{4.2}$$

where :

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

W = Theoretical width, m.

V = Harvesting speed, km/h.

Actual field capacity was the actual average rate of field average by the amount of actual time (lost + productive time) consumed in the operation. It can be determined from the following equation:

$$C_{act.} = \frac{60}{Tu + Ti} \quad (fed./h.)$$

Where :

$C_{act.}$ = The actual capacity of the machine, fed/h.

Tu = The utilization time per feddan in minutes.

Ti = The summation of lost time per feddan in minutes.

Field efficiency is calculated by using the following equation:

$$E_{F.} = \frac{C_{act.}}{C_{th.}} \times 100$$

Where:

$E_{F.}$ = The field efficiency of the machine (%).

$C_{act.}$ = The actual capacity of the machine.

$C_{th.}$ = Theoretical productivity of the machine.

2.Total grain losses measurement:

The percentage of total grain losses per plot area (kg) was calculated by using the following equation :

Total combine losses = (pre-harvest + cutting + threshing, cleaning + uncutting) losses (%)

Total losses per fed. (kg/fed.) were determined by using the following formula :

$$\text{Total losses per feddan} = \frac{\text{Total losses per plot area (kg)}}{\text{Plot size (fed.)}}$$

3. Fuel, power and energy requirements Fuel per feddan (l/fed.) was determined using the following formula:

$$\text{Fuel per feddan (l/fed.)} = \frac{\text{Fuel per plot area (l)}}{\text{Plot size (fed.)}}$$

Power required :

The following formula was used to estimate the engine power.

EP = [F.C. (1/3600) P.F. x L.C.V. x 427 x η_{thb} x η_m x 1/75 x 1/1.36], k.W.

Where :

F.C. = The fuel consumption, L/h.

P.E. = The density of fuel, kg/l (for solar = 0.85)

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

(average L.C.V. of solar is 10.000 k.cal/kg)

η_{thb} = The thermal efficiency of the engine.

(consider to be about 35% for diesel engine)

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

(considered to be about 80% for diesel engine).

Engine power = 2.77 F.C., kW

Energy requirements :

The energy requirements for the harvesting operation can be calculated as follows :

$$\text{Energy requirement} = \frac{\text{Engine power (kW)}}{\text{Harvesting capacity (fed./h)}}, \text{ kW.h /fed.}$$

4. Criterion cost :

The criterion cost required for the harvesting operation was estimated using the following equation.

Criterion cost / fed. = operating cost + grain losses, (cost/fed.)

Where :

$$\text{Operating cost/fed.} = \frac{\text{Machine cost (L.E./h)}}{\text{Actual field capacity (fed./h)}}$$

The machine cost was determined by using the following equation:

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

Where :

C = Hourly cost, L.E./h.

P = Price of machine, L.E.

h = Yearly working hours, h/year.

a = Life expectancy of the machine, h.

i = Interest rate / year.

t = Taxes, over heads ratio.

r = Repairs and maintenance ratio.

F = Fuel price, L.E./L.

m = the monthly average wage, L.E.

0.9 = Factor accounting for lubrications.

W = Engine power, HP.

S = Specific fuel consumption, L/hp.h.

144 = Reasonable estimation of monthly working hours.

RESULTS AND DISCUSSION

The selection of the combine size (width and power) is affected by many parameters. These parameters can be arranged into five groups. The first group is concerned with the harvesting time; the second group is related to combine field capacity and field efficiency; the third to grain losses;

the fourth to fuel consumption and the fifth to harvesting cost.

The obtained results will be discussed under the following items :

1. Harvesting time :

Harvesting time using different combines is affected by the size of the harvested plot area and the combine forward speed.

Influence of unit plot area as well as forward speed on harvesting time using different combines is illustrated in fig. 1.

Results obtained show that increasing unit plot area increased harvesting time per plot area at any forward speed and any grain moisture content, and the vice versa was noticed with the harvesting time per feddan.

Increasing unit plot area from 0.25 to 5 feddans, measured at different forward speeds of 1, 2, 3 and 4 km/h, increased harvesting time per unit plot area by 94.63, 94.80, 94.87 and 95.07% using yanmar combine; by 94.15, 94.29, 94.39 and 94.44% using local combine; and by 87.18, 87.43, 88.61 and 89.03% using claas combine respectively at constant grain moisture content of 22% on the other hand increasing unit plot area from 0.25 to 1.0 feddan decreased harvesting time per feddan by 34.29, 31.30, 31.15 and 30.91% using yanmar combine; by 35.71, 33.33, 32.99 and 31.87% using local combine; and by 72.41, 72.00, 70.45 and 70.00% using claas combine under the same previous conditions. As the plot area increased from 1.0 to 2.0 feddans, harvesting time per feddan increased by 11.39, 12.08, 12.86 and 15.38% using yanmar combine, while decreased by 12.00, 11.70, 11.49 and 10.98% using local combine, and by 16.00, 13.64, 7.32 and 5.26% using claas combine under the same previous conditions. when the plot area increased from 2 to 5 feddans, harvesting time per feddan increased by 9.71, 9.97, 10.26 and 10.96% using yanmar combine and by 23.08, 23.27, 23.68 and 24.07% using local combine, while decreased by 28.21, 25.71, 24.24 and 22.58% using claas combine under the same previous conditions of speed and grain moisture content.

The larger values of time per feddan in the small plot areas are attributed to the increase of turning time at the ends of the small fields. As to both yanmar combine and local combine, the increase of

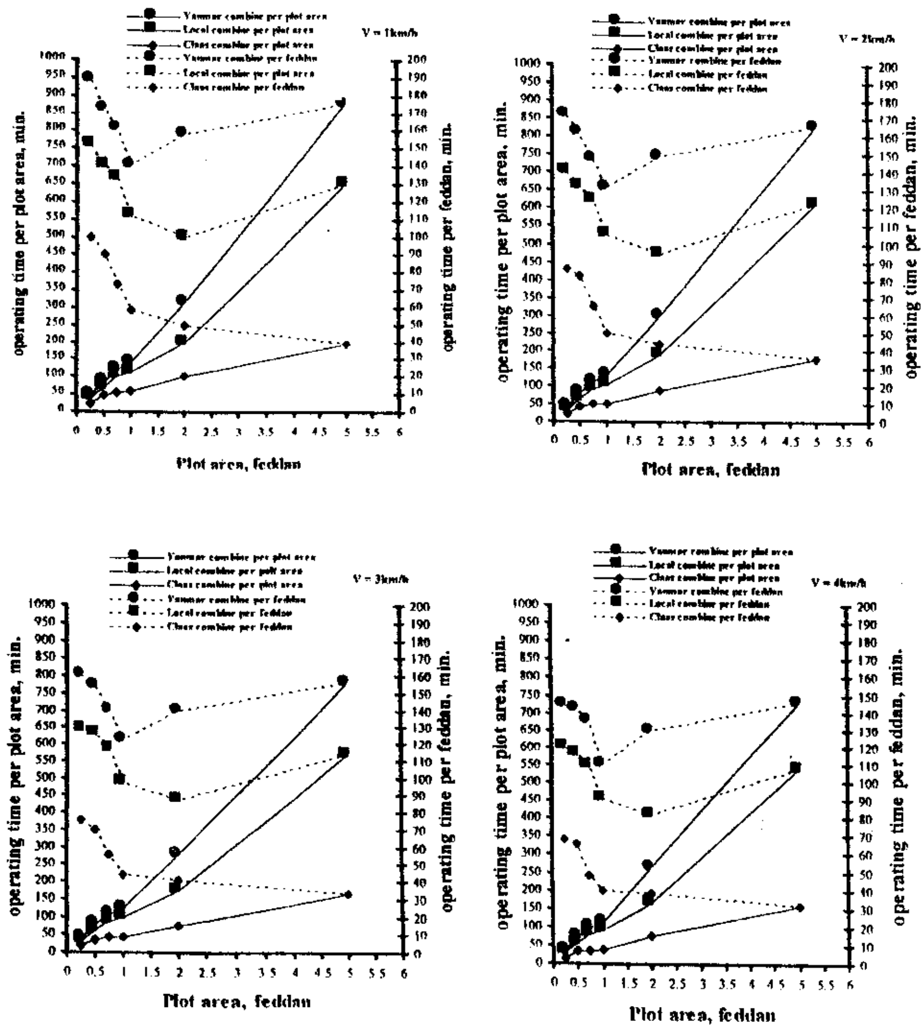

Fig. 1: Effect of combine size on harvesting time under different unit plot areas and different combine forward speeds.

harvesting time per feddan at areas more than one feddan for yanmar combine and two feddans for local combine up to 5 feddans is attributed to the lost time consumed in minor field repairs and maintenance.

2. Field capacity and field efficiency :

Field capacity and field efficiency significantly varies from one combine to another due to the wide variation of working width, combine power, combine speed and unit plot area.

Representative values of both field capacity and field efficiency versus unit plot area at any forward speed and any grain moisture content using different combines are given in fig. 2.

The obtained results show that increasing unit plot area increased both field capacity and field efficiency but only to a certain extent for each combine. Any plot area increase after this extent, field capacity and field efficiency will decrease.

Concerning yanmar combine, results show that increasing unit plot area from 0.25 to 1.0 feddan measured at different forward speeds of 1, 2, 3 and 4 km/h, increased field capacity from 0.28 to 0.31, from 0.55 to 0.60, from 0.80 to 0.88, and from 1.04 to 1.14 fed/h, also increased field efficiency from 82.6 to 89.3, from 80.3 to 87.4, from 77.7 to 85 and from 75.5 to 82.7% respectively at constant grain moisture content of 22% while increasing unit plot area from 1.0 to 5.0 feddans, decreased field capacity from 0.31 to 0.24, from 0.60 to 0.47 from 0.88 to 0.69 and from 1.14 to 0.91 fed/h, also decreased field efficiency from 89.3 to 69.5, from 87.4 to 68.2, from 85.0 to 66.8 and from 82.7 to 65.7% under the same previous conditions.

Relating to the local combine, obtained data show that increasing unit plot area from 0.25 to 2.0 feddans, measured at different forward speeds of 1, 2, 3 and 4 km/h, increased field capacity from 0.33 to 0.41, from 0.65 to 0.8, from 0.95 to 1.19, and from 1.24 to 1.56 fed/h, also increased field efficiency from 65.9 to 81.4, from 64.8 to 80.4, from 63.2 to 79.2, and from 62 to 78% respectively at constant grain moisture content of 22%. Any further increase in unit plot area from 2.0 to 5.0 feddans, field capacity will decrease from 0.41 to 0.38, from 0.80 to 0.75 from 1.19

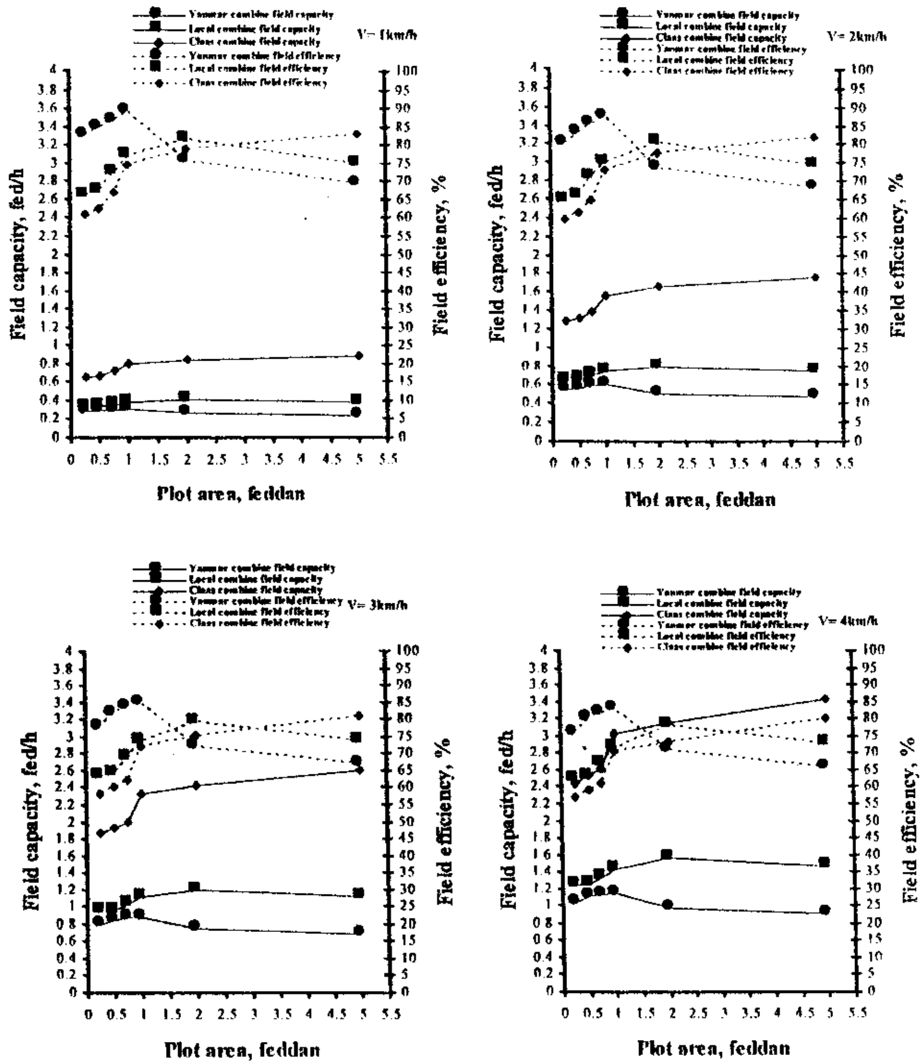

Fig. 2 : Effect of combine size on field capacity and field efficiency under different unit plot areas and different combine forward speeds.

to 1.11, and from 1.56 to 1.46 fed/h, and field efficiency will also decrease from 81.4 to 75 from 80.4 to 74.5, from 97.2 to 73.8, and from 78 to 73% under the same conditions.

As to claas combine, the obtained results show that increasing unit plot area from 0.25 to 5.0 feddans, measured at different forward speeds of 1, 2, 3 and 4 km/h, increased field capacity from 0.65 to 0.89, from 1.28 to 1.76, from 1.86 to 2.6, and from 2.44 to 3.43 fed/h, also increased field efficiency from 61 to 83.2, from 59.5 to 82 from 58 to 81, and from 57 to 80% respectively at constant grain moisture content of 22%.

The decrease in both field capacity and field efficiency in unit plot areas more than 1.0 feddan for yanmar combine and more than 2.0 feddan for local combine is attributed to the larger values of operational time that required for the harvesting operation as well as for minor field repairs and maintenance.

3. Grain losses :

Grain losses are more sensitive to different factors such as: combine size, unit plot area, combine forward speed, grain moisture content and others.

3.1. Influence of unit plot area on grain losses using different combines :

Plot area has a great effect on grain losses. This relation can be remarked in fig. 3.

The obtained results show that increasing unit plot area increased the amount of grain losses per plot area at any forward speed and any moisture content, while the increase in unit plot area decreases grain losses per feddan but only to a certain extent for each combine. Any further increase in plot area after this extent, grain losses will increase.

Regarding yanmar combine, results show that increasing unit plot area from 0.25 to 1.0 feddan measured at different forward speeds of 1, 2, 3 and 4 km/h decreased percentage of grain losses from 2.41 to 2.12; from 2.91 to 2.66; from 3.62 to 3.2; and from 4.28 to 3.8% respectively at constant moisture content of 22%. The vice versa was noticed when the unit of plot area increased from 1.0 to 5.0 feddans, the percentage of grain losses increased from 2.12 to 3.5; from 2.66 to 4.1; from 3.2 to 4.74; and from 3.8 to 5.4% under the same pervious conditions.

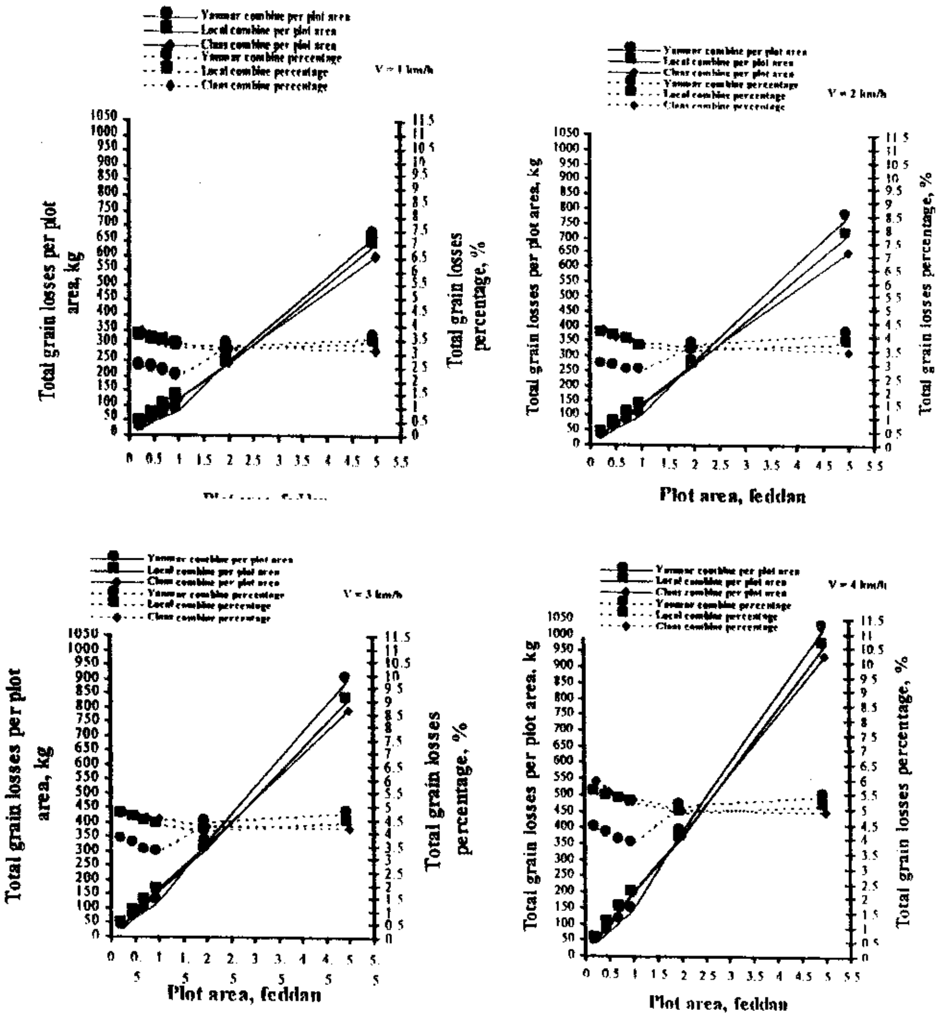

Fig. 3 : Effect of combine size on total grain losses under different unit plot areas and different combine forward speeds.

With regard to local combine, obtained data show that increasing unit plot area from 0.25 to 2.0 feddans measured at different forward speeds of 1, 2, 3, and 4 km/h decreased percentage of grain losses from 3.48 to 3.1; from 3.99 to 3.52; from 4.56 to 4.08; and from 5.5 to 4.85% respectively at constant moisture content of 22%. Any further increase in plot area from 2.0 to 5.0 feddans, percentage of grain losses will increase from 3.1 to 3.36; from 3.52 to 3.75; from 4.08 to 4.35; and from 4.85 to 5.11% under the same pervious conditions.

As to claas combine, results show that increasing unit plot area from 0.25 to 5.0 feddans, measured at different forward speeds of 1, 2, 3, and 4 km/h decreased the percentage of grain losses from 3.73 to 3.13; from 4.2 to 3.42; from 4.73 to 4.16; and from 5.92 to 4.92% respectively at constant moisture content of 22%.

The above results prove that it is difficult to operate the combine harvester in the small plot areas (specially larger combines). This is because a noticeable number of spots were left unharvested due to the sharp turns of combine at field corners. Added to that, small combines are not successful to be operated in harvesting larger plot area due to the great number of turning in high grain losses.

3.2. Influence of forward speed on grain losses using different combines :

Grain losses are greatly affected by the combine forward speed fig. 4.

Results obtained show a remarkable increase in percentage of grain losses by increasing combine forward speed. Increasing forward speed from 1.0 to 4.0 km/h at a constant moisture content of 22%, increased percentage of grain losses from 2.12 to 3.8; from 3.19 to 5.18; and from 3.28 to 5.31% for yanmar combine, local combine, and claas combine respectively.

The increase in grain losses by increasing combine forward speed is attributed to the effect of plants forward deflection and high impact of the cutter bar with the plants.

3.3. Influence of grain moisture content on grain losses using different combines :

The most critical factor causing grain losses is grain moisture content. Fig.5 show the effect of grain moisture content on the percentage of grain losses.

Results show that percentage of grain losses varies inversely

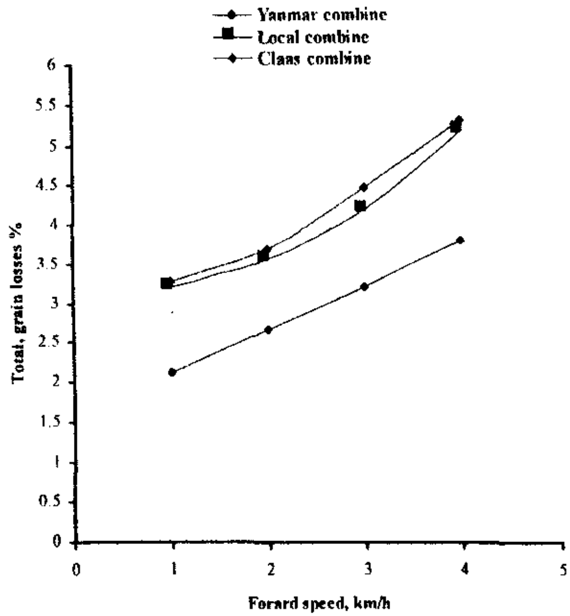

Fig. 4: Effect of combine size on total grain losses under different forward speeds.

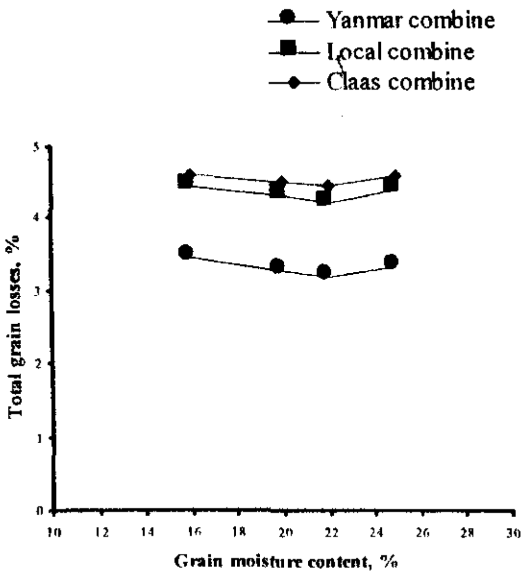

Fig. 5: Effect of combine size on total grain losses under different grain moisture contents.

with grain moisture content. It is clear that percentage of grain losses was significantly decreased by increasing grain moisture content up to 22%. Any further increase in grain moisture content up to 25% grain losse will increase. Increasing grain moisture content from 16 to 22%, at constant forward speed of 3 km/h, decreased percentage of grain losses from 3.47 to 3.2; from 4.45 to 4.19; and from 4.62 to 4.46% for yanmar, local, and claas combines respectively. While the increase of grain moisture content from 22 to 25%, increased percentage of grain losses from 3.2 to 3.33; from 4.19 to 4.39; and from 4.46 to 4.58% under the same previous conditions.

The increase in grain losses by increasing grain moisture content is due to the elastic conditions of high moisture content materials.

4. Fuel, power, and energy requirements :

The matching of combine width and power has an important effect on fuel, power and energy requirements.

It should be pointed out that the increase of combine workable width is accomplished by the increase of power level and consequently fuel used.

4.1. Influence of unit plot area on fuel consumption using different combines:

Unit plot area is considered an important factor, which affects combine fuel consumption fig.6.

Results show that increasing unit plot area increased the amount of fuel per unit plot area at any forward speed and any grain moisture content, while the increase in unit plot area decreases fuel consumption per feddan but only to a certain extent for each combine any further increase in plot area after this extent, fuel consumption will increase.

With regard to yanmar combine, results show that increasing unit plot area from 0.25 to 1.0 feddan measured at different forward speeds to 1, 2, 3 and 4 km/h, decreased fuel consumption from 16.79 to 12.90, from 9.45 to 7.33, from 7.0 to 5.57, and from 5.96 to 4.74 l/fed respectively at constant grain moisture content of 22%. The vice versa was noticed when the plot area increased from 1.0 to 5.0 feddans, fuel consumption increased from 12.90 to 20.83, from 7.33 to 12.13, from 5.57 to 9.28, and from 4.74 to 7.36 l/fed under the same conditions.

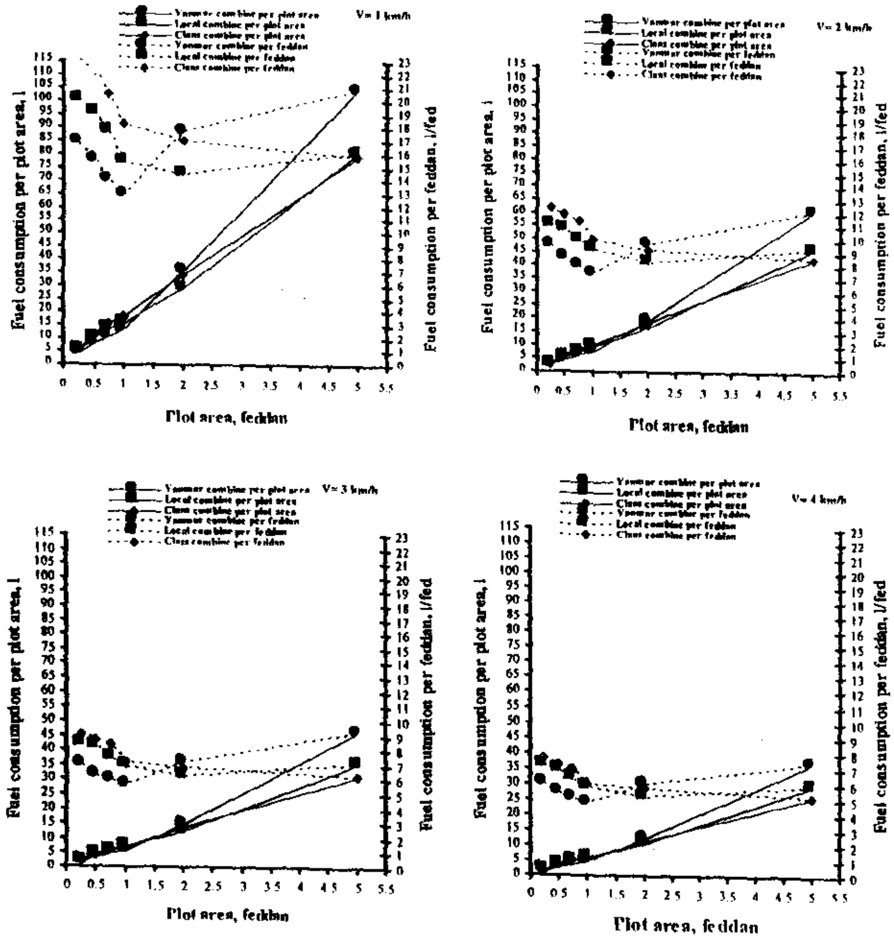

Fig. 6: Effect of combine size on fuel consumption under different unit plot areas and different combine forward speeds.

Considering local combine, obtained results show that increasing unit plot area from 0.25 to 2.0 feddans measured at different forward speeds of 1, 2, 3, and 4 km/h, decreased fuel consumption from 20.00 to 14.39, from 11.08 to 8.25, from 8.42 to 6.22, and from 7.18 to 5.19 l/fed respectively at constant grain moisture content of 22%. Any further increase in plot area from 2.0 to 5.0 feddans, fuel consumption will increase from 14.39 to 16.05, from 8.25 to 9.33, from 6.22 to 7.03, and from 5.19 to 5.89 l/fed under the same mentioned conditions.

As to claas combine, results show that increasing unit plot area from 0.25 to 5.0 feddans, measured at different forward speeds of 1, 2, 3, and 4 km/h, decreased fuel consumption from 23.08 to 15.73, from 12.34 to 8.58, from 9.09 to 6.23, and from 7.58 to 5.19 l/fed respectively at constant grain moisture content of 22%.

The above results show that during the harvesting operation of one feddan at constant forward speed of 3 km/h and constant grain moisture content of 22%, yanmar combine consumed minimum amount of fuel (5.57 l/fed), local combine csombine consumed (6.85 l/fed), while claas combine consumed maximum amount of (7.16 l/fed).

4.2. Influence of forward speed on fuel, power, and energy requirements :

Fuel consumption as well as power and energy requirements are too related to the combine forward speed fig.7.

Results show that power required increased as the forward speed increased. While the vice versa was noticed with both fuel and energy requirements.

Relating to yanmar combine, increasing forward speed from 1.0 to 4.0 km/h, at constant grain moisture content of 22%, decreased fuel consumption from 12.90 to 4.74 l/fed, while increased power required from 11.08 to 14.96 kw, and decreased energy requirements from 35.74 to 13.12 kw.h/fed.

In relation to local combine, increasing forward speed from 1.0 to 4.0 km/h, at constant grain moisture content of 22%, decreased fuel consumption from 15.38 to 5.76 l/fed, increased power required from 16.62 to 22.99 kw, and decreased energy required from 42.62 to 15.97 kw.h/fed.

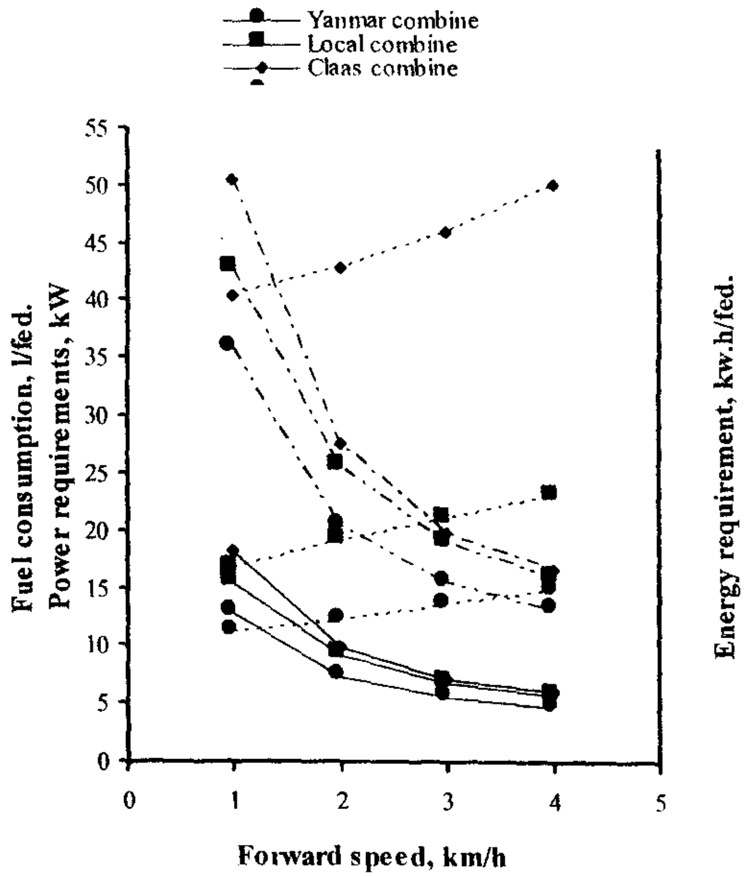

Fig. 7: Effect of combine size on fuel, power and energy requirements under different forward speeds.

As to claas combine, the increase in forward speed from 1.0 to 4.0 km/h, at constant grain moisture content of 22%, decreased fuel consumption from 18.25 to 5.99 l/fed, increased power required from 40.44 to 50.14 kw, and decreased energy requirements from 50.55 to 16.60 kw.h/fed.

The increase in power by increasing combine forward speed is attributed to the excessive load of plants on the cutter bar and the high impact of cutter bar with plants added to the excessive load of plants on the other combine devices. While the decrease in both fuel and energy is attributed to the increase in field capacity.

5. Harvesting cost

Harvesting cost is greatly affected by the unit plot area as well as combined forward speed. This relation can be remarked in fig. 8.

Results obtained show that increasing unit plot area decreased both operational and criterion costs but only to a certain extent for each combine. Any further increase in unit plot area after this extent, both operational and criterion costs will increase.

Concerning yanmar combine, results show that increasing unit plot area from 0.25 to 1.0 feddan, measured at different forward speeds of 1, 2, 3 and 4 km/h and constant grain moisture content of 22%, decreased operational cost from 160.71 to 145.16, from 81.82 to 75, from 56.25 to 51.14 and from 43.27 to 39.47 L.E./feds; also decreased criterion cost from 233.99 to 209.64, from 170.3 to 155.8, from 166.33 to 148.42 and from 173.35 to 154.99 L.E./fed respectively. The vice versa was noticed when the unit plot area increased from 1.0 to 5.0 feddans, the operational cost increased from 145.16 to 187.5, from 75 to 95.74, from 51.14 to 65.22 and from 39.47 to 49.45 L.E./fed, while criterion cost increased from 209.64 to 293.9, from 155.8 to 220.38, from 148.42 to 209.22 and from 154.99 to 213.45 L.E./fed under the same previous conditions.

Relating to local combine, obtained results show that increasing unit plot area from 0.25 to 2.0 feddans measured at different forward speeds of 1, 2, 3 and 4 km/h and constant grain moisture content of 22%, decreased operational cost from 196.97 to 158.54, from 100 to 81.25, from 68.42 to 54.62 and

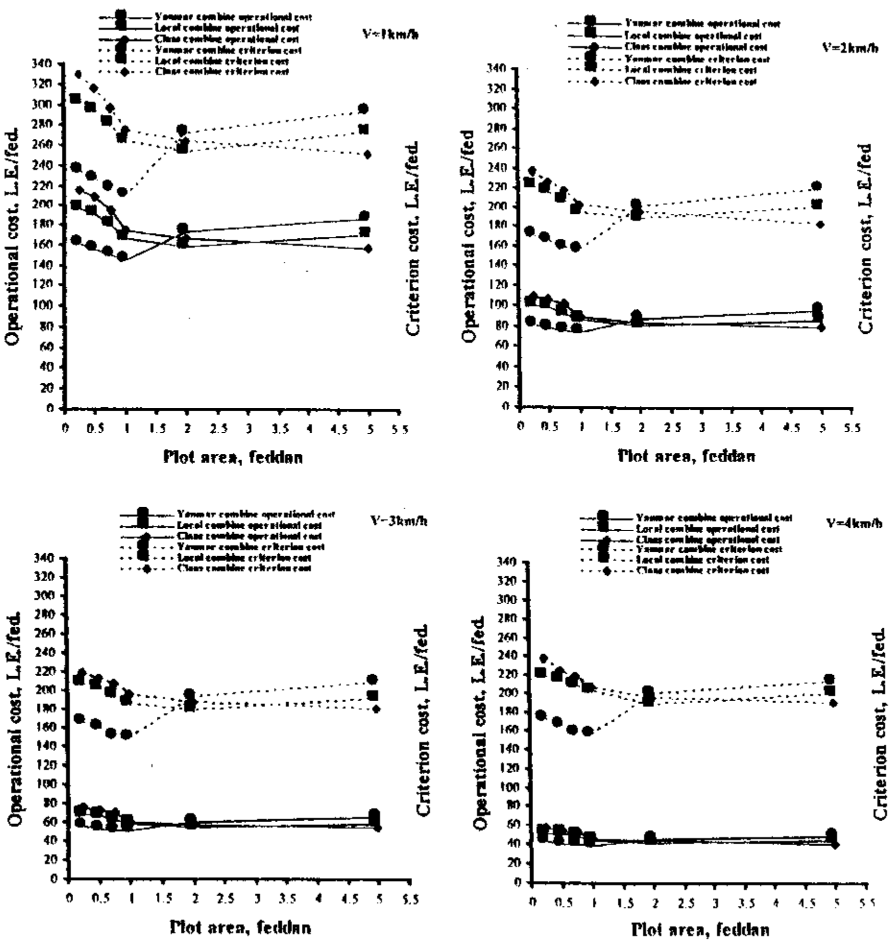

Fig. 8: Effect of combine size on operational and criterion costs under different unit plot areas and different combine forward speeds.

from 52.42 to 41.67 L.E./fed; also decreased criterion cost from 302.73 to 252.78, from 221.28 to 188.29, from 207.06 to 178.62 and from 219.62 to 189.11 L.E. /fed. Respectively. Any further increase in plot area from 2.0 to 5.0 feddans, operational cost will increase from 158.54 to 171.05, from 81.25 to 86.67, from 54.62 to 58.56 and from 41.67 to 44.52 L.E./fed; as well as increase criterion cost from 252.78 to 273.21, from 188.29 to 200.67, from 178.62 to 190.8 and from 189.11 to 199.88 L.E./fed under the same previous conditions.

As to claas combine, results show that increasing unit plot area from 0.25 to 5.0 feddans, measured at different forward speeds of 1, 2, 3 and 4 km/h and constant grain moisture content of 22%, decreased operational cost from 215.38 to 157.3, from 109.38 to 79.55, from 75.27 to 53.85 and from 57.38 to 40.82 L.E./fed; also decreased criterion cost from 328.74 to 252.5, from 237.06 to 183.55, from 219.03 to 180.25 and from 237.38 to 190.42 L.E./fed respectively.

The major reason for the increase of cost at small plot areas was attributed to both excessive time and fuel requirements. While the increase of cost at large plot areas especially for yanmar and local combines is due to excessive grain losses.

The above cost analysis also reveal that for areas less than 1.5 feddans, the small combine (yanmar) might be more economical than the middle (local) and large (claas) combines. Meanwhile for areas more then 3.0 feddans, the large combine (claas) might be more Economical than the small (yanmar) and middle (local) combines. As to areas of approximately between 1.5 to 3.0 feddans, middle combine (local) can be used as the economical one in relation to small (yanmar) and large (claas) combines.

CONCLUSIONS

The experimental results reveal the following :

Small combines (yanmar) are recommended to be used in areas of less than 1.5 feddans, middle combines (local) are recommended to be used in areas of between 1.5 to 3.0 feddans, while large combines (claas) are recommended to be used in areas of more than 3.0 feddans, It is recommended to operate the used combines at a forward speed of about 3 km/h. and It is recommended to harvest rice crop at grain moisture content of about 22%.

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دراسة مقارنة بين بعض أنواع آلات الحصاد والدراس المختلفة مع أخذ المساحة فى الاعتبار

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أجريت هذه الدراسة فى محطة البحوث الزراعية بمزرعة الجميزة بمحافظة الغربية خلال موسمين زراعيين بنجاح عامى (٢٠٠٢ – ٢٠٠٣) وذلك عن طريق تقييم أداء ثلاث أنوع من آلات الحصاد والدراس وهما آلة الحصاد والدراس يانمار ذات عرض ١,٤٥م وآلة الحصاد والدراس المحلية ذات عرض ٢,١م وآلة الحصاد والدراس كلاس ذات عرض ٤,٥م وقد تم أخذ المؤشرات الآتية فى الاعتبار (زمن الحصاد – السعة الحقلية والكفاءة الحقلية – الفواقد الكلية للحبوب – معدل استهلاك الوقود – الطاقة المطلوبة – تكاليف الحصاد) وقد تمت الدراسة من خلال أخذ وحدات مساحة وسرعات أمامية ومحتوى رطوبى للحبوب بقيم مختلفة بهدف الوصول إلى أفضل ظروف يمكن أن تعمل خلالها الآلة.

لقد تم تنفيذ تجربتين رئيسيتين، توصلت التجربة الأولى إلى الاختيار الأمثل لحجم آلة الحصاد والدراس خلال وحدة مساحة محددة بينما توصلت التجربة الثانية إلى استنتاج الأبعاد المناسبة لتشغيل الآلات أثناء حصاد محصول الأرز.

أظهرت النتائج التجريبية الآتى :

١- أقل قيمة لزمن الحصاد هى (٣١ دقيقة/فدان) باستخدام الكومباين كلاس فى مساحة قدرها ٥فدان بسرعة ٤كم/س ومحتوى رطوبى للحبوب قدره ٢٢%.

٢- أعلى قيمة للسعة الحقلية هى (٣,٤٣ فدان/س) باستخدام الكومباين كلاس فى مساحة ٥ فدان بسرعة ٤كم/س ومحتوى رطوبى للحبوب قدره ٢٢%.

٣- كانت أعلى قيمة للكفاءة الحقلية هى (٨٩,٣%) باستخدام الكومباين يانمار فى مساحة ١ فدان بسرعة ١كم/س ومحتوى رطوبى للحبوب ٢٢%.

٤- كانت أقل نسبة لفواقد الحبوب الكلية هى (٢,١٢%) باستخدام الكومباين يانمار فى مساحة قدرها ١فدان وبسرعة ١كم/س ومحتوى رطوبى للحبوب ٢٢%.

٥- أقل قيمة لإستهلاك الوقود هى (٤,٧٤ لتر/فدان) وأقل قيمة للطاقة المطلوبة هى (١٣,١٢ كيلووات. س/فدان) باستخدام الكومباين يانمار عند سرعة ٤كم/س ومساحة قدرها ١ فدان بمحتوى رطوبى للحبوب قدره ٢٢%.

٦- كانت أقل قيمة لتكاليف الحصاد هى (١٤٨,٤٢ جنيه/فدان) بواسطة الكومباين يانمار فى مساحة ١ فدان وسرعة قدرها ٣كم/س ومحتوى رطوبى قدره ٢٢%.