Misr J. Ag. Eng., 24(1): 1-17 FARM MACHINERY AND POWER

TOTAL GRAIN LOSSES, ENERGY AND COST REQUIREMENTS FOR HARVESTING RICE CROP MECHANICALLY IN DELTA EGYPT

Moheb M. A. El-Sharabasy

ABSTRACT

Three rice harvesting systems namely: traditional harvesting, partial mechanization and full mechanization were deduced and compared. Experiments were carried out in rice fields to determine total grain losses, energy consumed and total cost requirements for harvesting rice crop. The results indicated that, in partial mechanization, the minimum total grain losses of 4.73 % resulted from machine forward speed of 2.1 km/h and higher grain moisture content of 25.91%. While in full mechanization, the minimum total grain losses of 1.84 % resulted from lower forward speed of 1.6 km/h and grain moisture content of 21.85 % compared with traditional harvesting system, which recorded about 3.64 %. In both partial and full mechanization, the minimum energy consumed of 44.91 and 40.62 kW.h/fed resulted from higher machine forward speed of 3.1 and 2.8 km/h at lower grain moisture content of 19.64%. Compared with traditional harvesting which consumed about 45.00 kW.h/fed. at lower grain moisture content of 19.64 %. Results indicated in both partial and full mechanization, the minimum cost requirements of 227.83 and 140.91 L.E/fed resulted from higher machine forward speed of 3.1 and 2.8 km/h and lower grain moisture content of 19.64 %. Compared with traditional harvesting system which recorded the maximum cost requirements of 327.21 L.E/fed.

INTRODUCTION

Rice crop is considered one of the most important foods and export crops in Egypt. In the last ten years, the annual cultivated area increased from 1.08 to 1.56 million feddans and the grain yield increased from 3.14 to 5.80 million tons. The average grain productivity was 3.42 ton/fed. (**Ghonimey and Rostom, 2002**). At present it is estimated that 20 % of the cultivated area is harvested using rice combine harvesters.

· Lecturer of Agric. Eng. Dept., Fac. of Agric., Zagazig Univ., Egypt.

The remaining area is harvested using hand sickles or other cutting machines and threshed using either rice thresher of multi-crop type thresher (Baiomy, 2002). The cutting process of the agricultural crops during harvesting operation plays an important role in the agricultural engineering fields. **Arnaout (1980)** estimated the field capacity and efficiency in rice harvesting using combine harvester and found that the effective field capacities increased by increasing both combine harvesting speed and harvesting area. He also found that field efficiency was highly affected by the lost in both turning time in respect to the forward speed and travel time from field to another. **Fouad *et al.* (1990)** compared the performance of two types of combines in harvesting rice crop in Egypt. The combines were operated at three forward speeds of 0.9, 2.3 and 2.8 km/h for rice combine, and 0.8, 2.1 and 2.9 km/h for the conventional combine. There was a highly significant decrease in total harvesting costs with an increase in operation speed from 0.9 and 0.8 km/h to 2.3 and 2.2 km/h for the rice and conventional combines, respectively. **Hassan *et al.* (1994)** reported that the performance of combine device was experimentally investigated during harvesting operation of both wheat and rice crop. The experimental results revealed that the total grain losses and criterion cost were minimum and performance efficiency was maximum under following conditions:

- Forward speed of 2.1 km/h for rice and 2.8 km/h for wheat.
- Cutter bar speed of 1.2 m/s for both rice and wheat crop.
- Cylinder speed of 25 m/s for rice crop and 30 m/s for wheat crop.
- Concave clearance of 9.0 mm for rice crop and 12.0 mm for wheat crop.
- Grain moisture content of 22.30 % and 19.20 % for rice and wheat crops.

El-Haddad et al. (1995) reported that combine harvester gave the lowest cost of about 229.0 L.E/fed in comparison with 283.4 L.E/fed for mounted mower and 300.0 L.E/fed for manual sickle system. Helmy et al. (1995) indicated that the effective field capacity increased by decreasing straw moisture content. In addition, increasing forward speed tends to increase the total grain losses with percentage of 10.11 by using Dutz-Fahr combine and 10.43 by using Isaki combine. They found also that increasing combine harvester forward speed from 0.85 to 2.27 km/h tends to decrease harvesting cost from 82.46 to 59.93 L.E/ton for rice (Giza-171) variety and from57.69 to 37.61 L.E/ton for rice (Giza-175) variety. El-Sharabasy (1998) used small combine harvester (Yanmar) to harvest rice crop (Ryho) variety under three forward speeds of 1.5, 2.1 and 2.7 km/h, average grain moisture content of 22.45 % and constant L/W ratio of 2/1. He found that the increase of forward speed from 1.5 to 2.7 km/h led to increase field capacity from 0.36 to 0.60 fed/h and decreased field efficiency from 74.41 to 68.62 %. While both energy consumed and total cost requirements decreased from 36.78 to 49.47 kW.h/fed and 233.51 to 182.43 L.E/fed under the same conditions. He also found that harvesting wheat crop by self-propelled mower + threshing with stationary thresher recorded the minimum energy consumed of 25.38, kW.h/fed. **Kamel (1999)** stated that all kinds of losses for the two combines under investigation increased with the increase of harvesting speed and cutting height for the three selected rice varieties. He added that, the lowest value of total losses obtained at harvesting front speed of 0.3 m/s with cutting height of 7 cm were 3.25, 2.4 and 2.4 % for rice varieties of Giza 178, Sakha 101and Sakha 102, respectively for the combine harvester CA-385 (hold-in) system compared with 3.9, 3.15 and 3.0 % for combine harvester CA-760 (through-in) system for the same rice varieties, the cutting height and forward speed. He also mentioned that the highest value of total grain losses for both combine types did not exceed 5.80 % compared with 25 % when utilizing traditional harvesting system. **Afify *et al.* (2000)** found that the total cost for harvesting rice crop using combine harvester (Yanmar) and traditional method (Manual harvesting + Thresher) were about 151, 133, and 140 L.E/fed and about 279, 253and 278 L.E/fed under three different planting methods (Manual transplanting, Drilling and Mechanical transplanting), respectively. **El-Nakib *et al.* (2003)** used Kubota combine as a mechanical harvester of rice crop (Sakha 102). They found that header, threshing, separating and shoe losses increased with the increase of the forward speed and the decrease of grain moisture content. The optimum operating parameters for harvesting rice crop were, combine forward speed of 4.5 km/h and grain moisture content of 16.5 %. **El-Khateeb (2005)** tested multi-purpose combine harvester (Yanmar model CA-760) and found that the maximum value of actual filed capacity was 2.90 fed/fed at forward speed of 3.0 km/h and grain moisture content of 18 %. He found also, that the highest value of fuel consumption rate was 7.20 *l*/fed at forward speed of 1.5 km/h and grain moisture content of 25 %. He recommended that grain moisture content of 22.0 %, forward speed of 1.5 km/h, cylinder speed of 24.0 m/s and baffle plate angle of (90deg) 1.57rad were the optimum operating conditions for mechanical harvesting rice crop. Also, using combine harvester was the most efficient and economic system (89.70 L.E/fed) compared to manual harvesting and gathering followed by threshing and winnowing (181.60 L.E/fed).

It is very important to apply the most economical methods of harvesting to obtain minimum grain losses and maximum grain yield. In Egyptian delta, harvesting process of rice crop is still carrying out using hand sickles and other self-propelled mowers beside small scale Japanese combine harvester. Therefore, this study aimed to evaluate three systems for harvesting and threshing rice crop to estimate total grain losses, energy consumed and finally total cost requirements for harvesting and threshing rice crop in Egyptian delta.

MATERIALS AND METHODS

Field experiments were carried out on rice crop at a private farm in Damietta governorate during the agricultural summer season 2006. The total experimental area was about four feddans planted with rice (Sakha-101) crop. This study carried out to determine total grain losses, energy consumed and total cost required for harvest rice crop using three different harvesting systems.

(A) MATERIALS:

1- Combine harvester (Kubota):

Type	CA-385 EG Japan
Model	Turbo diesel, 4 stroke, water cooled, 3 cylinder.
Overall length (mm)	4063
Output power (PS/rpm)	35/2800
Overall width (mm)	1904
Overall height (mm)	2000
Weight (kg)	1979

2- Self-propelled mower (Kubota):

Type	AR 120
Model	GS 130 – 2CN
Output power (PS/rpm)	3.4/1800
Overall length (mm)	2390
Overall width (mm)	1470
Overall height (mm)	900
Weight (kg)	116

3- Tractor:

Type	Universal 650-M
Made	Romania
Engine type	Four stroke diesel – Direct injection
Output power (PS/rpm)	75/1440

4- Rice thresher:

Made	Local – Egypt
Type of drum	Spike tooth
Drum diameter (mm)	390
Drum length (mm)	1000

(B) METHODS:

In this study, three harvesting systems were evaluated in rice fields at four average grain moisture contents of (19.64, 21.85, 23.76 and 25.91 %) namely:

1- Traditional harvesting (Hand cutting + Mechanical thresher).
2- Partial mechanization (Self-propelled mower + Mechanical thresher).
3- Full mechanization (Combine harvester).

In traditional harvesting, 10 workers harvested the experimented area using hand sickles. While in the partial and full mechanization, the self-propelled mower and combine harvester were operated at three forward speeds of 2.1, 2.5 and 3.1 km/h; 1.6, 2.1 and 2.8 km/h, respectively. Threshing operation was carried out using a local thresher at average grain moisture content of 18.30 % and drum rotating speed of 650 rpm.

Grain moisture content was determined on dry basic with the oven method at 105°C for 24 hours in laboratory of faculty of agriculture, Zagazig University.

● ***Total grain losses:***

The percentage of total grain losses was calculated by using the following equation:-

Total grain losses = (*Pre-cutt.+Un-cutt.+Operat.+Thresh.*) *losses*, (%)….(1)

● ***Energy consumed:***

To estimate the engine power during harvesting process, the decrease in fuel level accurately measuring immediately after each treatment. The following formula was used to estimate the engine power. Hunt (1983).

$$EP = [f.c\,(1/3600)\,PE \times L.C.V \times 427 \times \eta_{thb} \times \eta_m \times 1/75 \times 1/1.36],\ kW \text{..(2)}$$

Solving equation (2), the consumed energy can be calculated as following:-

$$Engine\ power\ (Diesel) = 3.16\ f.c.\ \ , kW \text{ ....(3)}$$

$$Engine\ power\ (Otto) = 1.96\ f.c.\ \ , kW \text{ ....(4)}$$

Where:-

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

PE = The density of fuel, (kg/*l*), (for Gas oil = 0.85 and Gasoline = 0.72).

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

η_{thb} = Thermal efficiency of the engine (35 % for Diesel and 25% for Otto).

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

η_m = Mechanical efficiency of the engine (80 % for Diesel and 85% for Otto).

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

$$Concumed\ energy = \frac{Engine\ power, (kW)}{Field\ capacity, (fed/h)},\ \ kW.h/fed \text{............(5)}$$

● ***Energy of manual worker:***

Manual labor could be determined as mechanical power equal to (0.075 to 0.10 kW) at continuous work (Lijedahl *et al.* 1951).

Worker power = 1.36 *hp* (0.10 *kW*) ....(6)

So, the energy can be calculated as following:-

$$Consumed\ energy = \frac{Worker\ power,(kW)}{Field\ capacity,(fed/h)},\ kW.h/fed\ ....(7)$$

• *Harvesting cost:*

The total cost of harvesting operation was estimated using the following equation (Awady 1982):-

$$Operating\ cost = \frac{Machine\ cost\,(L.E/h)}{Actual\ field\ capacity\,(fed/h)},\quad (L.E/fed)\ ....(8)$$

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

$$C = \frac{P}{h}\left(\frac{1}{a} + \frac{i}{2} + t + r\right) + (0.9W.S.F) + \frac{m}{144}\ ....(9)$$

Where:-

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

144 = Reasonable estimation of monthly working hours.

RESULTS AND DISCUSSIONS

In this study, the discussions will cover the effect of harvesting system, machines forward speeds and grain moisture contents on total grain losses, field capacity and efficiency, energy consumed and total cost requirements for harvesting and threshing rice crop.

1- Data obtained from traditional harvesting system:

Fig.(1) shows the total grain losses during harvesting and threshing rice crop using traditional harvesting system. Total grain losses were about 3.88, 3.64, 3.52 and 3.35 % under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively. The Decrease of grain moisture content leads to increase total grain losses due to more increasing in both pre-harvest losses and cutting losses, which cause more shattering losses by hand sickles.

Field capacity of manual harvesting rice crop was depended on total time consumed during cutting operation. Table (1) shows that, total time consumed, field capacity and energy during cutting rice crop with 10 workers at different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %. Increasing grain moisture content from 19.64 to 25.91 % leads to increase field capacity from 0.217 to 0.256 fed/h while the energy consumed decreased from 4.61 to 3.91 kW.h/fed.

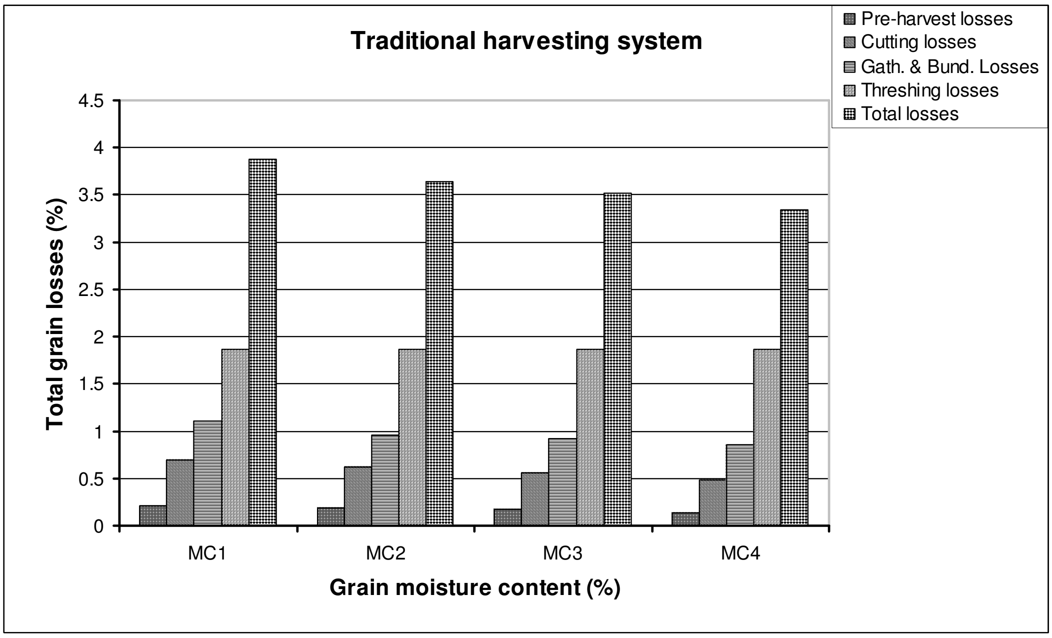


Fig.(1): Effect of grain moisture content on total grain losses under traditional harvesting system.

Table (1): Data obtained from traditional harvesting system for rice crop.

Grain M. C. (%)	Cutting time (min)	Field capacity (fed/h)	Power (kW.h)	Energy (kW.h/fed)	Cutting cost (L.E/h)	Gathering cost (L.E/h)	Threshing cost (L.E/h)	Total cost (L.E/h)
MC1	277	0.217	1.00	4.61	115.21	25	187.00	327.21
MC2	260	0.231		4.33	108.23			320.23
MC3	246	0.244		4.10	102.46			314.46
MC4	234	0.256		3.91	97.66			309.66

Also, table (1) shows that, the total cost of harvesting rice crop with 10 workers at different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %. Increasing grain moisture content from 19.64 to 25.91 % leads to decrease total cost requirements from 327.21 to 309.66 L.E/fed.

2- Data obtained from threshing rice crop using stationary thresher:

The experimental study in threshing rice crop with local stationary thresher was confined by some parameters such as actual machine productivity, fuel and energy consumed. Drum rotating speed for threshing rice crop was 650 rpm at average grain moisture content of 18.30 %.

Table (2) show that during threshing rice crop at drum rotating speed of 650 rpm and average grain moisture content of 18.30 %, total time consumed for threshing one feddan was 145 min (2.42 h) with actual machine productivity of 0.41 fed/h. On the other hand, threshing rice crop at drum rotating speed of 650 rpm and average grain moisture content of 18.30 % consumed about 12.46 *l*/fed, 16.15 kW.h and 39.39 kW.h/fed from fuel, power and energy, respectively.

Also, table (2) show that, the total cost of threshing rice crop at drum rotating speed of 650 rpm and average grain moisture content of 18.30 % was about 212.00 L.E/fed, which was the sum of gathering cost (25.00 L.E/fed), and threshing cost (187.00 L.E/fed).

Table (2): Data obtained from threshing rice crop using stationary thresher.

No. of workers	Threshing time (min)	Machine product. (fed/h)	Fuel cons. (*l*/fed)	Power (kW.h)	Energy kW.h/fed	Gathering cost (L.E/h)	Threshing cost (L.E/h)	Total cost (L.E/h)
10	145	0.41	12.46	16.15	39.39	25	187.00	212.00

3- Effect of harvesting and threshing system on total grain losses:

Total grain losses were affected by crop variety, maturity, time of harvesting, field conditions, machine forward speed and handling crop by the harvesting machine or the workers. It is impossible to have uniform conditions for all the test runs.

The effect of grain moisture content on total grain losses is shown in fig. 2. In full mechanization system, the minimum grain losses of 1.84, 2.11 and

2.43 % were obtained under grain moisture content of 21.85 % at three combine forward speeds of 1.6, 2.1 and 2.8 km/h.

While the maximum grain losses of 2.48, 2.78 and 3.16 % were obtained under higher grain moisture content of 25.91 % at three combine forward speeds of 1.6, 2.1 and 2.8 km/h. These results may be attributing to more grain losses occurred by uneven conditions for threshing at low moisture content.

In partial mechanization system, the minimum grain losses of 4.73, 5.04 and 5.63 % were obtained under grain moisture content of 21.85 % at three mower forward speeds of 2.1, 2.5 and 3.1 km/h. While the maximum grain losses of 5.41, 5.70 and 6.13 % were obtained under lower grain moisture content of 19.64 % at three mower forward speeds of 2.1, 2.5 and 3.1 km/h. These results may be attributing to more grain shattering by cutter bar at lower moisture content.

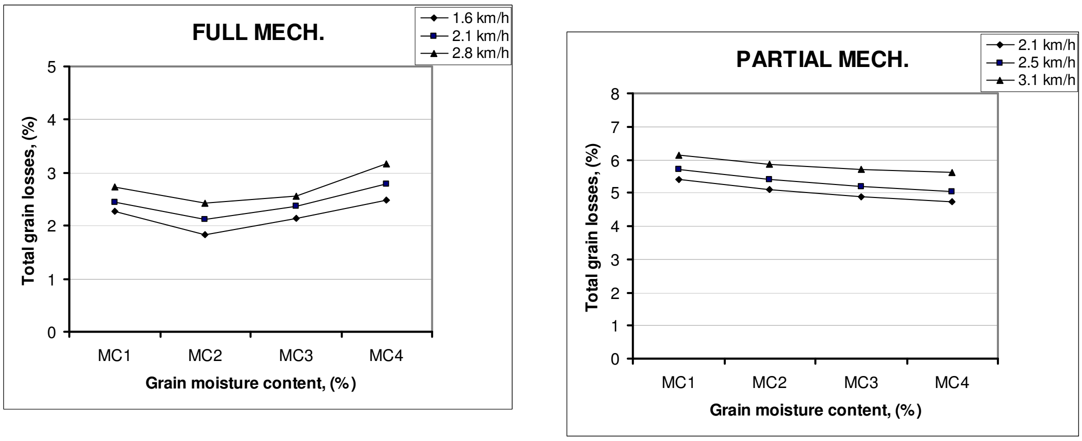
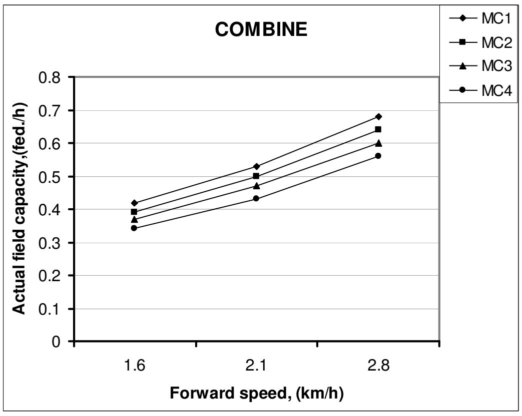


Fig.(2): Effect of grain moisture content on total grain losses at different machine forward speeds.

4- Effect of machine forward speed on field capacity and efficiency:

The field capacity and efficiency are very important parameters, which should be taking into consideration when we evaluate machine performance. The actual field capacity is affecting by many factors such as effective machine width, machine forward speed, cutter bar velocity and grain moisture content.

The effect of machine forward speed on actual field capacity is shown in fig. 3. Increasing forward speed for combine harvester from 1.6 to 2.8 km/h increased actual field capacity from 0.42 to 0.68, 0.39 to 0.64, 0.37 to 0.60 and 0.34 to 0.56 fed/h at different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.



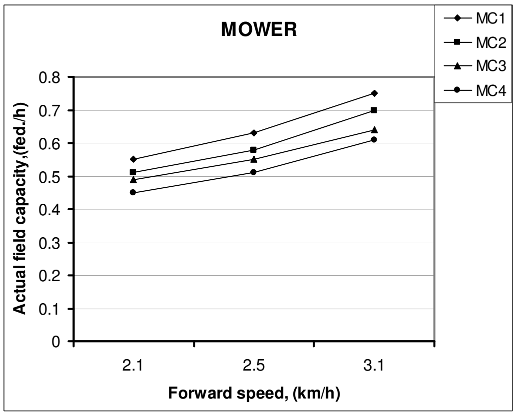


Fig.(3): Effect of machine forward speed on actual field capacity at different grain moisture contents.

On the other side, increasing forward speed for self-propelled mower from 2.1 to 3.1 km/h increased actual field capacity from 0.55 to 0.75, 0.51 to 0.70, 0.49 to 0.64 and 0.45 to 0.61 fed/h at different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

The effect of machine forward speed on field efficiency is shown in fig. 4. Increasing forward speed for combine harvester from 1.6 to 2.8 km/h decreased field efficiency from 87.50 to 81.93, 81.25 to 77.11, 78.12 to 71.80 and 70.83 to 67.47 % at different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

On the other side, increasing forward speed for self-propelled mower from 2.1 to 3.1 km/h decreased actual field efficiency from 91.67 to 84.27, 85.00 to 78.65, 81.67 to 71.91 and 75.01 to 68.54 % at different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

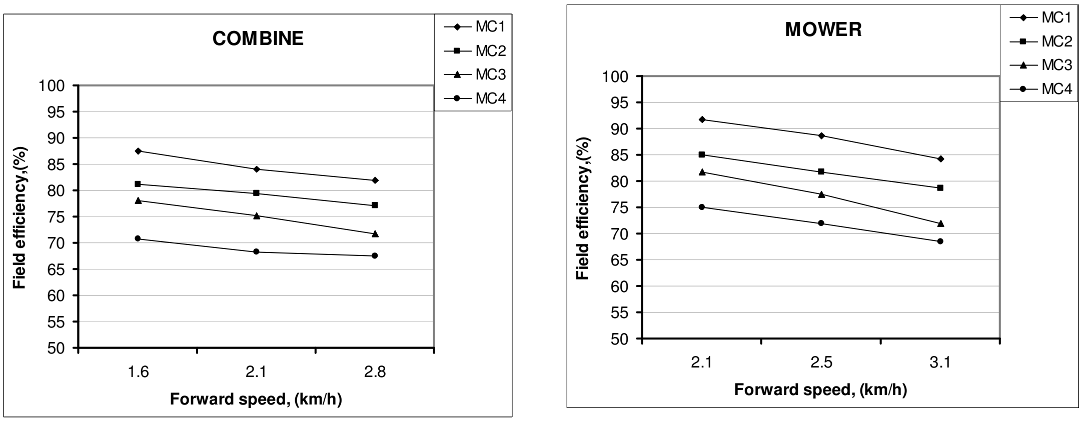


Fig.(4): Effect of machine forward speed on field efficiency at different grain moisture contents.

5- Effect of machine forward speed on consumed energy:

Fig.(5) show that, in full mechanization, the minimum energies consumed of 40.62, 48.39, 53.13 and 62.18 kW.h/fed were obtained at the higher forward speed of 2.8 km/h under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

While the maximum energies consumed of 57.64, 64.97, 70.97 and 79.56 kW.h/fed were obtained at the lower forward speed of 1.6 km/h under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

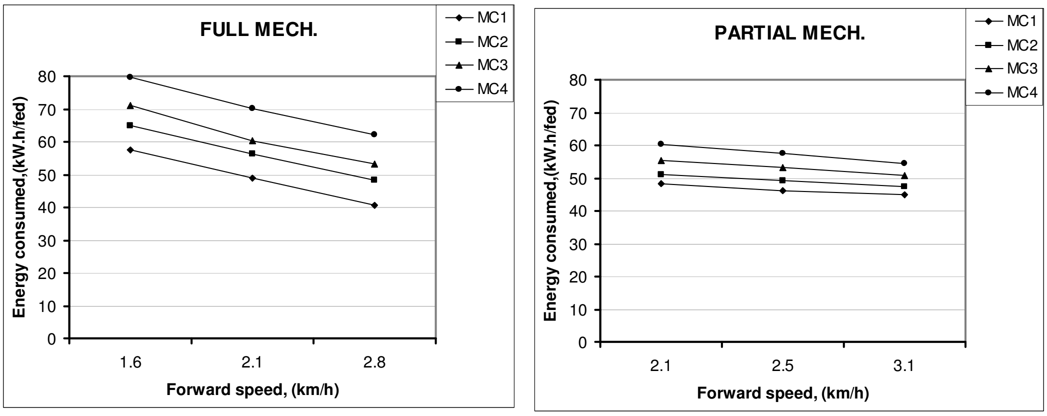


Fig.(5): Effect of machine forward speed on consumed energy at different grain moisture contents.

On the other side, in partial mechanization, the minimum energies consumed of 44.91, 47.50, 50.89 and 54.45 kW.h/fed were obtained at the higher forward speed of 3.1 km/h under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively. While the maximum energies consumed of 48.25, 51.16, 55.34 and 60.25 kW.h/fed were obtained at the lower forward speed of 2.1 km/h under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

6- Effect of harvesting system on total cost equipments:

The total cost for harvesting rice crop depends on some variables such as; machine price, engine power, specific fuel consumption, fuel price and yearly working hours. The effect of machine forward speed on total cost requirements under different grain moisture contents is shown in fig. 6.

Fig.(6) show that, in full mechanization, the minimum total cost requirements of 140.91, 149.72, 159.70 and 171.11 L.E/fed were obtained at the higher forward speed of 2.8 km/h under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively. While the maximum total cost requirements of 228.14, 245.69, 258.97 and 281.82 L.E/fed were obtained at the lower forward speed of 1.6 km/h under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

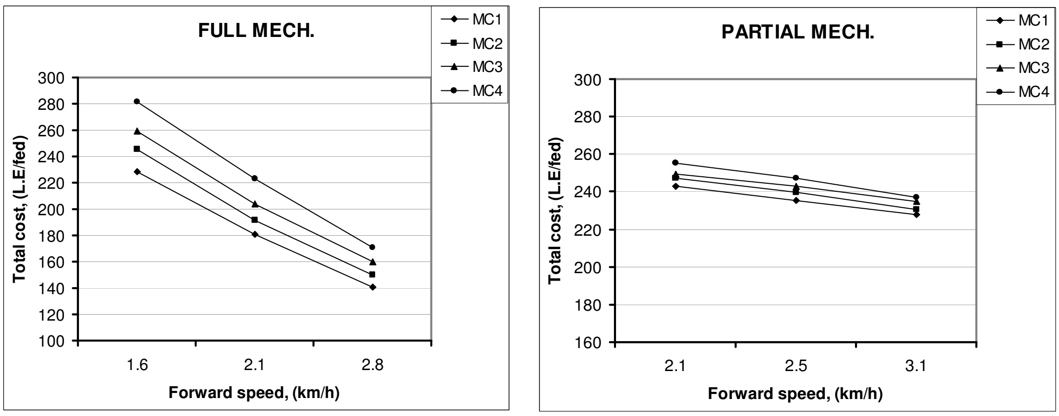


Fig.(6): Effect of machine forward speed on total cost required at different grain moisture contents.

On the other side, in partial mechanization, the minimum total cost requirements of 227.83, 230.74, 234.84 and 237.20 L.E/fed were obtained at the higher forward speed of 3.1 km/h under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively. While the maximum total cost requirements of 242.67, 247.04, 249.49 and 255.04 L.E/fed were obtained at the lower forward speed of 2.1 km/h under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

Compared with manual harvesting which recorded the highest total cost requirements of 327.21, 320.23, 314.46 and 309.66 L.E/fed under different grain moisture contents of 19.64, 21.85, 23.76 and 25.91 %, respectively.

CONCLUSION

Three different harvesting systems were carried out to determine total grain losses, energy and total cost requirements for harvesting and threshing rice crop in Delta Egypt.

Data from this study led to the following conclusions:-

- In full mechanization, the minimum grain losses obtained at lower forward speed and grain moisture content of 21.85 %. In partial mechanization, minimum grain losses obtained at lower forward speed and higher grain moisture content of 25.91 %. Compared with traditional system, which recorded minimum grain losses of 3.35 % at lower grain moisture content of 19.64 %.
- In both full and partial mechanization, the minimum energy consumed resulted from higher machine forward speed at lower grain moisture content. Compared with traditional harvesting which consumed about 45.00 kW.h/fed at lower grain moisture content.
- In both full and partial mechanization, the minimum cost requirements resulted from higher machine forward speed and lower grain moisture content. Compared with traditional harvesting system, which recorded the maximum cost requirements of 327.21 L.E/fed.

From this study, data obtained recommended that using both full and partial mechanization system for harvesting and threshing rice crop at the higher forward speeds and lower grain moisture contents, recorded minimum consumed energy and cost requirements. Also using partial or full mechanization for harvesting rice crop save time, effort, and total cost requirements and also clear the rice crop from the field as fast as possible than traditional system.

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الملخص العربي

فواقد الحبوب، احتياجات الطاقة والتكاليف الكليةلحصاد محصول الأرز آلياً في دلتا مصر

د. محب محمد أنيس الشرباصي*

يعتبر الأرز من المحاصيل الإستراتيجية الهامة في مصر وفي كثير من دول العالم. وتعتبر عملية الحصاد من أكثر العمليات الزراعية أهمية في إنتاج محصول الأرز، فالطريقة المناسبة للحصاد من شأنها أن توفر الوقت، الجهد وكذلك المال وتعطي الفرصة لزراعة المحاصيل اللاحقة في وقتها.

*مدرس – قسم الهندسة الزراعية– كلية الزراعة – جامعة الزقازيق – مصر.

وفي دلتا مصر بسبب تفتت الحيازات الزراعية مازال العديد من المزارعين يحصدون الأرز بالطريقة التقليدية أو يستخدمون المحشات ذاتية الحركة لحصاد الأرز ومن ثمَ دراسه باستخدام آلة الدراس الثابتة. وقد أجريت هذه الدراسة بغرض حساب كلٍ من فواقد الحبوب الكلية، الطاقة المستهلكة وكذلك التكاليف الكلية اللازمة لعملية حصاد ودراس محصول الأرز وذلك من خلال نظم حصاد مختلفة وهي: (النظام التقليدي) حصاد يدوي+ دراس آلي، نظام الميكنة الجزئي(حصاد بالمحشة الذاتية+ الدراس الآلي و(نظام الميكنة الكلي(حصاد ودراس آلي باستخدام الكومباين.

وقد تم في هذا البحث دراسة بعض عوامل التشغيل التي تؤثر على أداء آلة الحصاد في النظامين الجزئي والكلي وهي السرعة الأمامية للآلة ونسبة رطوبة الحبوب عند الحصاد وذلك بغرض تحديد أنسب تلك العوامل التي يتحقق عندها أقل فواقد كلية للحبوب، طاقة مستهلكة وتكاليف كلية في عملية الحصاد والدراس لمحصول الأرز. وقد اشتملت عوامل الدراسة على استخدام ثلاث سرعات أمامية لكلٍ من المحشة الذاتية الحركة والكومباين وهي 2.1 ، 2.5 و 3.1 كم/س للمحشة الذاتية الحركة و 1.6 ، 2.1 و 2.8 كم/س للكومباين عند أربع مستويات لرطوبة الحبوب أثناء الحصاد وهي 19.64 ، 21.85 ، 23.76 و 25.91 % ، لكلٍ منهما.

وقد أظهرت النتائج المتحصل عليها ما يلي:-

- في نظام الميكنة الجزئي، أقل فواقد للحبوب كانت 4.73 % عند السرعة الأمامية المنخفضة 2.1 كم/س ونسبة الرطوبة العالية٢٥,٩١ . بينما في نظام الميكنة الكلي أقل فواقد للحبوب كانت 1.84 % عند السرعة الأمامية المنخفضة 1.6 كم/س ونسبة الرطوبة 21.85 %. مقارنة بالنظام التقليدي الذي أعطى أقل فواقد للحبوب 3.35 % عند نسبة الرطوبة المنخفضة 19.64 %.
- في نظام الميكنة الجزئي، أقل طاقة مستهلكة كانت 44.91 كيلووات.س/ف عند السرعة الأمامية العالية للمحشة الذاتية 3.1 كم/س ونسبة الرطوبة المنخفضة للحبوب١٩,٦٤ % ، وأعلى طاقة مستهلكة كانت 60.25 كيلووات.س/ف عند السرعة الأمامية المنخفضة للمحشة الذاتية 2.1 كم/س ونسبة الرطوبة العالية للحبوب٢٥,٩١ %.
- في نظام الميكنة الكلي، أقل طاقة مستهلكة كانت 40.62 كيلووات.س/ف عند السرعة الأمامية العالية للكومباين 2.8 كم/س ونسبة الرطوبة المنخفضة للحبوب 19.64 % . في حين أن أعلى طاقة مستهلكة كانت٧٩,٥٦ كيلووات.س/ف عند السرعة الأمامية المنخفضة للكومباين 1.6 كم/س ونسبة الرطوبة العالية للحبوب 25.91 %. مقارنة بالنظام التقليدي والذي استهلك طاقة 43.30 كيلووات.س/ف عند الرطوبة العالية للحبوب 25.91 %.
- أقل تكاليف كلية لحصاد ودراس محصول الأرز كانت 227.83 و 140.91 جنيه/ف عند السرعة الأمامية العالية 3.1 و 2.8 كم/س ونسبة الرطوبة المنخفضة للحبوب 19.64 % في نظامي الميكنة الجزئي والكلي على الترتيب. بينما كانت أعلى تكاليف كلية لحصاد ودراس محصول الأرز هي ٢٥٥,٠٤ و ٢٨١,٨٢ جنيه/ف عند السرعة الأمامية المنخفضة2.1 و١,٦ كم/س ونسبة الرطوبة العالية للحبوب 25.91 % في نظامي الميكنة الجزئي والكلي على الترتيب. مقارنة بالنظام التقليدي والذي تكلف حصاد ودراس محصول الأرز به حوالي 327.21 جنيه/ف عند الرطوبة المنخفضة للحبوب 19.64 %.