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# A STUDY OF DIFFERENT HARVESTING METHODS FOR SUNFLOWER

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## ABSTRACT

Field experiments were carried out during seasons 2003 and 2004 at Nubaria region for harvesting sunflower (Euro-flower) in calcareous soil. Two mechanical harvesting methods (mower then thresher) and combine harvester were compared with traditional method (manual then thresher). The mechanical harvesting methods were done at five different field speeds 2.5, 3.1, 3.6 4.0 and 4.5 km/h for mower and combine. Three different drum speeds (450, 500 and 550 rpm) were also effected on grain losses and damaged grain for combine and thresher machines at three different moisture contents 8.78, 10.68 and 13.37 %. Field capacity, fuel consumption, power and energy requirements were calculated.

The experimental results showed that the highest losses for mower and combine header were 4.19 % and 3.03 % respectively at forward speed 4.5 km/h and moisture content 8.78 % besides sickle loss was 3.59% at the same moisture content. Increasing thresher drum speed from 450 to 550 rpm increase threshing losses about 0.46 % and damaged grain by 1.35 % at feed rate of 1 Mg/h. Total combine grain losses was 7.27 % at field speed 2.5 km/h, drum speed 450 rpm and moisture content 8.78 % (including grain damaged). The actual field capacity was low under sickle (one labor can harvest 0.025 fed/h) and mower. Actual field capacity increased about 2.6 times with combine than mower under the whole forward speeds. Combine consumed the lowest energy 33.96 kWh/fed compared with mechanical method 57.24 kW.h/fed at field speed 4.5 km/h and traditional methods, 34.62 kWh/fed (at thresher drum speed 550 rpm). The highest criterion cost with manual is 113.03 LE/fed at grain moisture content 8.78 %, in the mean time; the highest criterion cost with mower is 94.39 LE/fed at field speed 4.5 km/h, and grain moisture content 8.78 %. The highest criterion cost with thresher is 175.10 LE/fed at drum speed 550 rpm and grain moisture content 8.78 %. The highest criterion cost with combine harvester is 202.96 LE/fed at field speed 4.5 km/h; drum speed 550 rpm and grain moisture content 8.78 %.

## INTRODUCTION

Sunflower growing area in Egypt reach about 0.8 million feddans according to statistics of Control Agency for Public Mobilization and Statistics in 1995. The importance of sunflower as an oilseed crop has increased dramatically. Sunflower oil is now the second largest world source of vegetable oil (Dolton, 1970). Morghany (1995) evaluated some different retrieving systems (tractor-mounted mower, shredder, ensilage combine and self-propelled harvester) used in clearing land from residues of some different crops, namely: Cotton, corn and sunflower. The lowest field capacities were found with the used of tractor-mounted mower 75 % at forward speed 2.1 km/h for sunflower stalks. Thiestien (1990) investigated shatter losses when using several types of combine header (a small grain header, arrow crop header, a sunflower pan header) was examined for harvesting sunflowers. Losses were evaluated for 4 travel directions and 3 sunflower genotypes. Shatter losses were

highest when using the small grain platform and yields were significantly higher in rows planted east west compared to rows planted northeast. Ramakumar *et al.* (1991) evaluated the disc and rasp-bar threshers for sunflower, the results were compared to hand separation. Trials were conducted at 10.5, 13.4, 15.5 and 17.5 % molsture contents, threshing at 10.5 % moisture gave the highest threshing efficiency of 98 – 99 % and germination of 86.5 – 89 %, lowest breakage of 1.0 to 1.75 %. The rasp-bar thresher was more economical than the disc thresher or hand threshing for sunflower. Rizvi et al; (1993) made a study in order to determine a better threshing unit for a sunflower thresher. The performance of the threshing unit for output capacity, cleaning efficiency and percentage of broken were evaluated against rpm and concave clearances (2.54, 4.40, 6.35 cm). They observed that the lowest output was observed at 400 rpm for the peg cylinder, but the same was not true for the rasp-bar and rubber-strip cleaning efficiency was better at 600 rpm with the peg type. The peg cylinder has showed the highest cleaning efficiency and the least percentage broken at 400 rpm with 2.54 cm concave clearance.

The rasp-bar cylinder performed satisfactorily throughout the test with the 6.35 cm concave sitting and 500 rpm of the drum, except for cleaning efficiency, which was better at 600 rpm. The rubber strip cylinder showed the best results for output and percent broken at 6.35 cm concave setting with 600 and 500 rpm respectively. However, the cleaning efficiency was relatively good at 2.54 cm with 600 rpm, and they recommended that the peg type cylinder with a speed range from 400 – 500 rpm and the concave clearance range from 2.54 – 3.00 cm may be used for developing a threshing unit for sunflower variety thresher. Naravani (1987) studied threshing of sunflower at heads moisture contents ranging from 34 to 7.5 %. The highest threshing capacity was 123 kg/h at 7.5 % moisture content. Threshing efficiency increased from 87.5 to 97.43 % and the moisture content decreased from 34 to 7.5 % the unthreshed grain/cwt. Also reduced from 14.0 to 2.6 kg/cwt. in this range. Threshing blow moisture content of 7.5 % created problems of cleaning (where cwt. = hundredweight = 112 pound = 50.7 kg.). Jadhav and Deshpande (1990) said that threshing of sunflower by such threshers necessitates drying of heads below 12 % moisture content which means 12 – 20 days sun-dried of the heads after maturity. The shape of the sunflower heads does not change appreciably after maturity (up to) 10 – 12 % seed moisture content. Below that they tend to take any irregular shape and found that the cleaning efficiency was between 96.4and 98.8. Economic commission for Europe FAO-UN (1986) indicated that head losses during harvesting sunflower plant depend largely on cutting height, as well as position of the heads, stem strength and uniformity of plant height. An essential condition for mechanized harvesting and one of the advantages of the hybrid varieties is precisely their even growth and the fact that they can be safely cut even growth and the fact that they can be safely cut even at a height of 75 – 80 cm. The research aims to evaluate and compare different harvesting methods of sunflower at different daily hours in sandy clay loam (calcareous) soil. For the importance of sunflower as a oilseed crop and it's large growing area, the mechanical harvesting with low cost and less seeds

damage showed be carried for increasing the crop importance. The research aims to evaluate and compare different harvesting systems of sunflower at different daily hours in sandy clay loam (calcareous) soil.

## MATERIALS AND METHODS

The experiments were conducted during seasons 2003 and 2004 at Nubaria region for harvesting sunflower crop (Euro-flower) in sandy clay loam (calcareous) soil. Treatments were investigated and replicated three times. Statistical analysis was made by ( Costat) program.

**Treatments of harvesting:**

Three different harvesting systems have been considered in this study, namely:

-Manual harvesting by sickle then threshing by thresher (traditional system),
-Semi mechanical harvesting system (mounted mower + thresher)
-Full mechanical system (combine harvester).

Combine harvester was prepared for harvesting sunflower by fixing fingers on combine header to help for reducing grain loss as shown in Fig. 1. Besides, the other specifications in table 1.

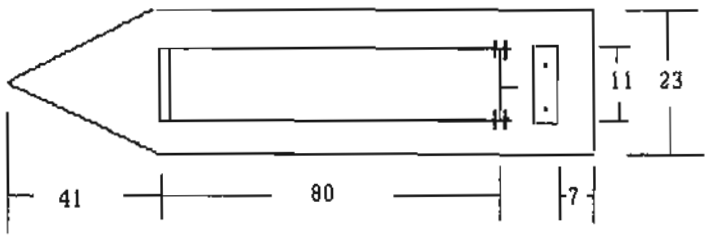


Fig.1. Sketch drawing fingers of the combine for harvesting sunflower.

**Table 1. Some specifications of the implement**

| Implement | Specifications |
|---|---|
| Tractor | Nasr- 48.51 kW – distance between tires 180 cm |
| Mower | Bozatis-(power take off) source of power- single knife – cutting width160 cm. |
| Thresher | Shams- drum diameter 73 cm- drum length 120cm. Concave has round holes 18 mm. The eccentric stroke of the screen is 3.5 cm |
| Combine: | Class |
| Engine power | 85 kW |
| Cutting width | 4.2 m |
| Drum width | 1.08 m |
| Concave Clearance | Front 3 cm - Rear 2 cm |
| Air fan speed | 300 – 1000 rpm |
| Total sieves area | 3.57 $m^2$ |

**Test procedure of harvesting:**

**1 - Forward speed:**

Forward speed was determined by measuring the time consumed for traveling distance of ten revolutions of rear tractor wheels.

S = d/t

S = forward speed, m/s t = traveling time, s d = traveling distance, m

The specifications of all implements used in this study were summarized in Table 1.

**2 - Grain losses:**

**Pre-harvesting loss:**

Pre-harvest losses were determined by locating wooden frame (1 x 1 m) in different random places to determine grain losses. Five replicates have been taken for each moisture content during the daily hours of harvesting. The percentage of pre-harvest losses was calculated by using the following equation:

$$Pre-harvest\ losses, \% = \frac{Pre-harvest\ loss}{Total\ yield} \times 100$$

Sickle, mower and combine header losses:

Sickle, mower and combine header losses have been measured by using two wooden frames 0.5 x 0.5 m to determine grain losses after harvesting. Three replicates were done for each test.

$$Harvesting\ losses, \% = \frac{H}{T} \times 100$$

**Where:**

H= Sickle, mower or combine header losses mass, kg/m²

T= Total grain yield, kg/m²

**Thresher losses:**

Thresher losses included damaged and un-threshed grains. They were calculated as follows:

$$Threshing\ losses, \% = \frac{DG + U_n G}{TG} \times 100$$

**Where:**

DG: mass of damaged grains collected at all outlets per unit time, kg.

$U_n$ G: mass of un-threshed grain, kg.

TG: mass of total grain, kg.

**Drum, straw walker and cleaning losses for combine harvester:**

Collecting grain dropped behind combine on plastic sheet and weighed, replications were done for the test. Drum, Straw walker and cleaning losses were calculated using the following equation:

$$D, Sw, C. losses, \% = \frac{D + Sw + C}{T} \times 100$$

**Where:**

D = drum losses, kg/m² Sw = straw walker losses, kg/m²

C = cleaning losses, kg/m² T = total grain yield, kg/m²

**3 – Germination:**

Germination percent was calculated after harvesting to calculate grain damage by the following equation:

$$G = \frac{P}{d} \times 100$$

**Where:**
P = Number of germinated seeds
d = Total number of seeds

**4 - Fuel consumption:**

Fuel consumption per unit time was determined by measuring the volume of fuel consumed during operation.

**5 - Determination of the power requirement:**

The following formula was used to estimate Power (P) (Embaby, 1985):

$P = (Fc/3600) \times \rho \times L.c.v \times 427 \times \eta_{th} \times \eta_m \times (1/75) \times (1/1.36)$, kW

**Where:**

Fc = Fuel consumption, L/h
ρ = Density of fuel, kg/L (0.85 kg/L for diesel fuel)
L.c.v = Lower calorific value, kCal/kg (10000 for diesel fuel)
427 = thermo-mechanical equivalent, kg.m/kCal.
$\eta_{th}$ = Thermal efficiency of the engine (40 % for diesel engine)
$\eta_m$ = Mechanical efficiency of the engine (80 % for diesel engine)

**6 - Field capacity and field efficiency:**

Field capacity was measured for each case by recording the operating time for mower and combine, ignoring transportation time.

$$Actual\ field\ apacity = \frac{1}{Total\ time\ in\ hours\ required\ per\ fed.}, (fed./h)$$

$$Field\ efficiency = \frac{Actual\ field\ capacity}{Theoretical\ field\ capacity} \times 100$$

**7 - Energy requirements:**

The following formula was used to calculate the energy requirements:

$$Energy\ requirements = \frac{Power\ (kW)}{Actual\ field\ capacity\ (fed./h)}, \quad kW.h/fed.$$

$$\text{Energy requirements} = \frac{\text{Power (kW)}}{\text{Actual field capacity (fed./h)}}, \quad \text{kW.h/fed.}$$

The human energy expenditure involved in the field operations can be estimated as a normal and healthy human labor supplies 0.1 hp (Chancellor, 1981).

Human energy (kW) = 0.1 x 0.746 x number of laborers

**8 – Harvesting cost:**

The cost of performing the different operations was estimated considering the conventional way of estimating both fixed and variable costs: The value of grain losses has been considered at the different field speed, moisture content and drum speed; besides, the operating cost.

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

The criterion cost (operating cost + value of losses)

## RESULTS AND DISCUSSION

**Plant characteristics:**

The mean values reflecting crop conditions at the time of harvesting. Some plant characteristics were measured and tabulated in table 2.

**Table 2: The values of some crop characteristics of sunflower variety Euro-flower**

| Function | Mean | C.V |
|---|---|---|
| Plant length, cm | 116.6 | 3.7 |
| Stem diameter, mm | 1.914 | 9.5 |
| No. of plants / $m^2$ | 7.6 | 7.2 |
| Weight of 100 seeds, g | 6.572 | 5.9 |

**Harvesting operational losses:**

**Pre-harvesting loss:**

Pre-harvesting loss decreased by increasing moisture contents (w.b) and the daily hours. The moisture content of grain and straw were also affected by daily hours.

**Table 3: Pre-harvesting loss as affected by daily time and moisture content (Mc).**

| Daily time | Grains Mc, % | Heads and stalks Mc,% | Pre-harvesting loss, % |
|---|---|---|---|
| $9^{AM}$ | 8.78 | 44.1 | 0.48 |
| $12^{PM}$ | 10.68 | 50.6 | 0.94 |
| $4^{PM}$ | 13.37 | 56.8 | 0.71 |

**Manual, mower and combine header loss:**

Traditional method of harvesting and threshing requires four important operations: harvesting, transporting, threshing and winnowing the grain. The results of grain harvesting losses for the tested mower and combine were recorded and compared with traditional harvesting method using (manual + thresher). Grain loss using traditional system was measured and tabulated in table 4. The highest manual harvesting loss is 3.59 % at moisture content 8.78 %, while the lowest manual loss is 2.89 % at moisture content 13.37 %.

**Table 4: Grain loss for traditional harvesting system at different daily moisture contents**

| Moisture content, % | Manual loss, % | Transportation loss, % | Threshing loss, % | Damaged seeds, % | Total loss, % |
|---|---|---|---|---|---|
| 8.78 | 3.59 | 6.21 | 1.81 | 7.83 | 19.44 |
| 10.68 | 3.21 | 5.8 | 1.7 | 7.32 | 17.52 |
| 13.37 | 2.89 | 5.49 | 1.78 | 6.85 | 16.32 |

Figs (2 and 3) indicated that mower and combine header losses increased with the increases of harvesting speed. The highest loss for mower and combine header were 4.19 % and 3.03 %, respectively at forward speed 4.5 km/h and moisture content 8.78 %, this may be due to the system of gathering and cutting which is considered more effective for combine. Besides, the lowest loss for mower and combine header were 2.19 and 1.37 % respectively at forward speed 2.5 km/h and moisture content 13.37 %. In general, header; drum and cleaning grain losses tend to increase with the increase of harvesting speed and decrease moisture content.

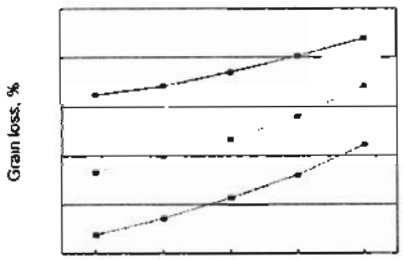


Fig (2): Effect of field speed on mower grain loss at different grains moisture contents

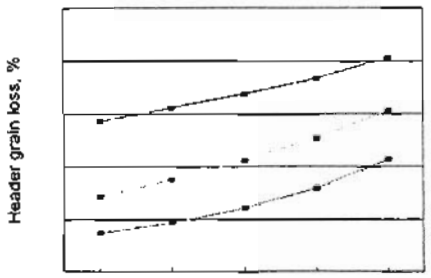


Fig (3): Effect of field speed on header grain loss at different grains moisture contents

**Effect of drum speed and moisture content on threshing losses for thresher:**

Table 5. Illustrated that increasing drum speed from 450 to 550 rpm increase threshing losses about 0.46 % and damaged grain by 1.35 % at feed rate of 1 Mg/h; in the mean time, increase grain moisture content from 8.78 to 13.37 % decrease total grain losses about 1.2 %

**Table 5. Grain loss, damaged seeds as affected by drum speed, moisture content at feed rate one Mg/h.**

| Grain M.c., % | Drum speed, rpm | Grain loss, % | Damaged grain, % | Total grain loss, % |
|---|---|---|---|---|
| 8.78 | 450 | 1.81 | 7.83 | 9.64 |
| | 500 | 2.12 | 8.51 | 10.63 |
| | 550 | 2.36 | 9.45 | 11.81 |
| 10.68 | 450 | 1.7 | 7.32 | 9.02 |
| | 500 | 1.91 | 7.81 | 9.72 |
| | 550 | 2.16 | 8.67 | 10.83 |
| 13.37 | 450 | 1.78 | 6.85 | 8.63 |
| | 500 | 1.97 | 7.39 | 9.36 |
| | 550 | 2.22 | 8.23 | 10.45 |

Drum, straw walker and cleaning losses:

The performance parameters of drum, straw walker and cleaning units are the percentage of detached and the percent of damaged seeds from threshing unit and separate the threshed grains (straw walker effectiveness) then to separate seeds from other plant residues that have passed through the openings. Table 6. shows that increasing field speed and drum speed increased grain losses; however, it decreased by increasing moisture content. The highest grain losses was 2.81 % at field speed 4.5 km/h, moisture content 8.78 % and drum speed 550 rpm, while the lowest grain losses was 1.86 % at forward speed 2.5 km/h, grains moisture content 10.68 % and drum speed 450 rpm.

**Table 6. Drum, straw walker and cleaning losses as affected by drum speed, field speeds and moisture contents**

| Field speed,km/h | Drum speed, 450 rpm Moisture contents,% | | | Drum speed, 500 rpm Moisture contents,% | | | Drum speed, 550 rpm Moisture contents,% | | |
|---|---|---|---|---|---|---|---|---|---|
| | 8.78 | 10.68 | 13.37 | 8.78 | 10.68 | 13.37 | 8.78 | 10.68 | 13.37 |
| 2.5 | 2.02 | 1.86 | 1.93 | 2.12 | 1.89 | 1.98 | 2.28 | 2.1 | 2.18 |
| 3.1 | 2.11 | 1.9 | 2.01 | 2.21 | 1.96 | 2.09 | 2.38 | 2.21 | 2.29 |
| 3.6 | 2.26 | 1.98 | 2.12 | 2.33 | 2.09 | 2.22 | 2.49 | 2.33 | 2.42 |
| 4.0 | 2.41 | 2.12 | 2.29 | 2.48 | 2.24 | 2.35 | 2.63 | 2.44 | 2.55 |
| 4.5 | 2.6 | 2.29 | 2.46 | 2.71 | 2.41 | 2.54 | 2.81 | 2.59 | 2.69 |

**Damaged seeds for combine harvester:**

Table 7. shows that increasing field speed and drum speed increased grain damage; however, it decreased by increasing moisture content. The highest grain damage was 3.88 % at forward speed 4.5 km/h, moisture content 8.78,% and drum speed 550 rpm, while the lowest grain losses was 1.96 % at forward speed 2.5 km/h, moisture content 13.37 % and drum speed 450 rpm.

**Table 7. Damaged grains as affected by drum speed, field speeds and moisture contents**

| Harvesting speed, km/h | Drum speed, 450 rpm | | | Drum speed, 500 rpm | | | Drum speed, 550 rpm | | |
|---|---|---|---|---|---|---|---|---|---|
| | 8.78 | 10.68 | 13.37 | 8.78 | 10.68 | 13.37 | 8.78 | 10.68 | 13.37 |
| 2.5 | 2.82 | 2.19 | 1.96 | 3.11 | 2.41 | 2.27 | 3.27 | 2.59 | 2.41 |
| 3.1 | 2.96 | 2.32 | 2.08 | 3.21 | 2.5 | 2.32 | 3.38 | 2.70 | 2.50 |
| 3.6 | 3.11 | 2.47 | 2.20 | 3.33 | 2.62 | 2.42 | 3.52 | 2.83 | 2.62 |
| 4.0 | 3.31 | 2.62 | 2.34 | 3.50 | 2.78 | 2.56 | 3.70 | 3.0 | 2.77 |
| 4.5 | 3.49 | 2.79 | 2.53 | 3.71 | 2.97 | 2.77 | 3.88 | 3.2 | 2.93 |

**Field capacity and efficiency:**

Although the field capacity increased, the field efficiency decreased with the increase of harvesting speed. The actual field capacity was low under manual harvesting (one labor can harvest 0.025 fed./h) and mower that due to low human energy and a few width of mower cutter-bar. Actual field capacity increased about 2.6 times with combine than mower under the

whole forward speeds that may due to the excess of cutting width with combine than mower. Although, field efficiency decrease about 23.5 % with combine than mower under the whole forward speeds Fig. (4 A and B).

**Fuel consumption:**

Fuel consumed was measured for all harvesting systems. Tables (8 and 9) show that combine consumed the highest value of fuel consumption 18.1 L/h compared with semi mechanical system (mower + thresher) 14.47 L/h at field speed 4.5 km/h However, the lowest value of fuel consumption was 10.12 L/h with combine compared with semi mechanical system 11.4 L/h at field speed 2.5 km/h and traditional system (manual + thresher), 6.6 L/h for threshing operation.

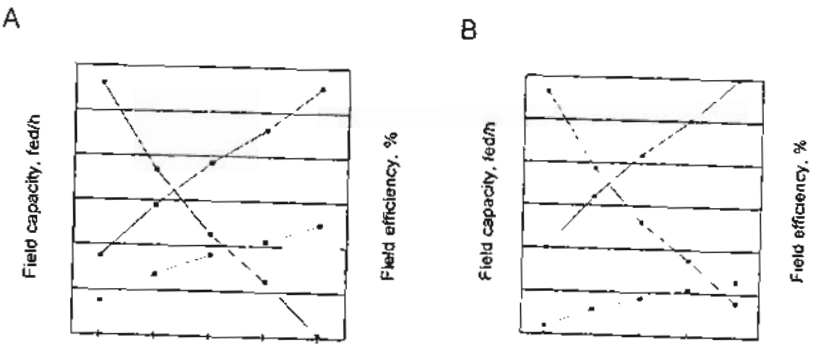


**Fig. (4): Field capacity and efficiency vs harvesting speed for mower and combine (A,B)**

**Energy requirements:**

Energy was calculated for all harvesting systems. From table (8), it is clear that combine consumed the lowest energy 33.96 kW.h/fed compared with semi harvesting system (mower + transportation + threshing) 64.85 kW.h/fed and traditional system, 39.1 kW.h/fed (manual cutting + transportation and threshing).

**Table 8. Fuel consumption was determined at drum speed 550 rpm**

| Machines | Speed, km/h | Fuel, L/h | Power, kW | Energy, kW.h/fed. |
|---|---|---|---|---|
| Mower | 2.5 | 4.8 | 19.28 | 25.71 |
| | 3.1 | 5.12 | 20.56 | 23.61 |
| | 3.6 | 5.48 | 22.01 | 22.95 |
| | 4.0 | 6.34 | 24.37 | 23.89 |
| | 4.5 | 7.87 | 31.6 | 28.73 |
| Combine | 2.5 | 10.12 | 40.64 | 25.4 |
| | 3.1 | 11.6 | 46.58 | 25.95 |
| | 3.6 | 13.04 | 52.36 | 27.13 |
| | 4.0 | 15.2 | 61.04 | 30.07 |
| | 4.5 | 18.1 | 72.68 | 33.96 |
| Manual | - | - | 0.373 | 2.98 |

Table 9. Fuel consumption as affected by drum speed with thresher

| | Drum speed, rpm | Fuel cons., L/h | Power, kW | Energy, kW.h/Mg |
|---|---|---|---|---|
| Thresher | 450 | 6.6 | 28.51 | 28.51 |
| | 500 | 7.91 | 31.76 | 31 76 |
| | 550 | 8 62 | 34.62 | 34.62 |

Harvesting cost:

The total harvesting cost is calculated as the sum of the operation cost and the cost of grain loss per feddan. Thus the total harvesting cost is affected by the harvesting speed. Total grain losses cost increased by increasing forward speeds in case of using mower and combine.

Table 10. Operating and losses costs for combine

| Field speed, km/h. | Drum speed, rpm | Mc.8.78, % | | | Mc.10.68, % | | | Mc.13.37, % | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criteri oncost, LE/fed | Total losses kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. |
| 2.5 | 450 | 64.18 | 77.02 | 177.02 | 50.93 | 61.12 | 161.12 | 46.43 | 55.72 | 155.72 |
| | 500 | 67.62 | 81.14 | 181.14 | 53.14 | 63.77 | 163.77 | 49.61 | 59.53 | 159.53 |
| | 550 | 70.44 | 84.53 | 184.53 | 56.58 | 67.90 | 167.90 | 52.61 | 63.13 | 163.13 |
| 3.1 | 450 | 67.35 | 80.82 | 180.82 | 53.85 | 64.62 | 164.62 | 49.08 | 58.90 | 158.90 |
| | 500 | 70.44 | 84.53 | 184.53 | 55.97 | 67.16 | 167.16 | 51.91 | 62.29 | 162.29 |
| | 550 | 73.44 | 88.13 | 188.13 | 59.94 | 71.93 | 171.93 | 55.26 | 66.31 | 166.31 |
| 3.6 | 450 | 71.15 | 85.38 | 185.38 | 57.47 | 68.96 | 168.96 | 52.35 | 62.82 | 162.82 |
| | 500 | 73.71 | 88.45 | 188.45 | 59.76 | 71.71 | 171.71 | 55.17 | 66.20 | 166.20 |
| | 550 | 76.80 | 92.16 | 192.16 | 63.73 | 76.48 | 176.48 | 58.70 | 70.44 | 170.44 |
| 4.0 | 450 | 75.56 | 90.67 | 190.67 | 61.88 | 74.26 | 174.26 | 56.76 | 68.11 | 168.11 |
| | 500 | 77.86 | 93.43 | 193.43 | 64.35 | 77.22 | 177.22 | 59.23 | 71.08 | 171.08 |
| | 550 | 80.95 | 97.14 | 197.14 | 68.06 | 81.67 | 181.67 | 62.85 | 75.42 | 175.42 |
| 4.5 | 450 | 80.51 | 96.61 | 196.61 | 7.18 | 0.62 | 180.62 | 62.32 | 74.78 | 174.78 |
| | 500 | 83.42 | 100.10 | 200.10 | 9.82 | 3.78 | 183.78 | 65.15 | 78.18 | 178.18 |
| | 550 | 85.80 | 102.96 | 202.96 | 3.44 | 8.13 | 188.13 | 67.88 | 81.46 | 181.46 |

Table 10. The highest criterion cost with combine harvester is 202.96LE/fed at field speed 4.5 km/h, drum speed 550 rpm and grain moisture content 8.78 % while the lowest criterion cost with combine harvester is 155.72 LE/fed at field speed 2.5 km/h, drum speed 450 rpm and grain moisture content 13.37 %.

The highest criterion cost with mower is 94.39 LE/fed; at field speed 4.5 km/h, and grain moisture content 8.78 % while the lowest criterion cost is 73.20 LE/fed; at field speed 2.5 km/h and grain moisture content 13.37 %. Table 11.

Table 11. Operating and losses costs for mower

| Field peed,km/h | Mc.8.78, % | | | Mc.10.68, % | | | Mc.13.37, % | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. | Total grain loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. |
| 5 | 31.96 | 38.35 | 88.35 | 24.98 | 29.98 | 79.98 | 19.33 | 23.20 | 73.20 |
| 1 | 32.75 | 39.3 | 89.3 | 26.48 | 31.78 | 81.78 | 20.83 | 25.00 | 75.00 |
| 3.6 | 33.99 | 40.79 | 90.79 | 27.98 | 33.58 | 83.58 | 22.69 | 27.22 | 77.22 |
| 4 | 35.40 | 42.48 | 92.48 | 30.01 | 36.02 | 86.02 | 24.72 | 29.66 | 79.66 |
| 4.5 | 36.99 | 44.39 | 94.39 | 32.75 | 39.3 | 89.3 | 27.45 | 32.94 | 82.94 |

The highest criterion cost with thresher is 175.10 LE/fed; at drum speed 550 rpm and grain moisture content 8.78 % while the lowest criterion cost is 141.42 LE/fed; at drum speed 450 rpm and grain moisture content 13.37 %.Table 12.

**Table 12. Operating and losses costs for thresher**

| Drum speed, rpm | Mc.8.78, % | | | Mc.10.68, % | | | Mc.13.37, % | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. |
| 50 | 85.10 | 102.12 | 152.12 | 79.62 | 95.55 | 145.55 | 76.18 | 91.42 | 141.42 |
| 00 | 93.84 | 112.6 | 162.6 | 85.80 | 102.96 | 152.96 | 82.62 | 99.15 | 149.15 |
| 50 | 104.25 | 125.10 | 175.10 | 95.60 | 114.72 | 164.72 | 92.25 | 110.7 | 160.70 |

The highest criterion cost with manual is 113.03 LE/fed at grain moisture content 8.78 % while the lowest criterion cost is 105.61 LE/fed at moisture content 13.37 %. see Table 13. Combine reduced the criterion cost of harvesting about 32 and 36 % compared with semi mechanical system (mower + transportation + thresher) and traditional system (manual + transportation + thresher) respectively.

**Table 13. Operating and losses costs for manual**

| Field speed, km/h | Mc.8.78, % | | | Mc.10.68, % | | | Mc.13.37, % | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total loss, kg/fed | Grain loss cost, LE/fed. | Criterion cost, LE/fed. | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. | Total loss, kg/fed. | Grain loss cost, LE/fed. | Criterion cost, LE/fed. |
| manual | 31.69 | 38.03 | 113.03 | 27.54 | 33.05 | 108.05 | 25.51 | 30.61 | 105.61 |

## CONCLUSION

Pre-harvesting loss was measured during the daily hours $9^{AM}$, $12^{PM}$ and $4^{PM}$ at the different moisture contents of 8.78, 10.68 and 13.37 % respectively.

The highest grain losses with manual, mower and combine header were 3.59, 4.19 and 3.03 % respectively at field speed 4.5 km/h. Mower loss was more than manual that may due to dropping heads on the floor could cause impacting for grains. The lowest grain losses with sickle, mower and combine header were 2.89, 2.19 and 1.37 % respectively at mower and combine field speed 2.5 km/h.

- The highest total grain loss for thresher was 11.81 % at drum speed 550 rpm, moisture content 8.78 % and feed rate 1 Mg/h while, the lowest total grain loss for thresher was 8.63 % at drum speed 450 rpm, moisture content 13.37 %.

- The total grain losses with the (traditional system) including grain damage are 19.44, with the semi mechanical system are 19.47, with the full mechanical system are 7.27 at moisture content 8.78 % and thresher's drum speed 450 rpm.
- The highest actual field capacity with sickle, mower and combine were 0.025, 1.1 and 2.14 fed/h respectively at forward speed 4.5 km/h.
- The highest energy requirement with manual, mower and combine (at drum speed 450 rpm) were 0.373, 28.73 and 33.96 kW.h/fed. respectively at forward speed 4.5 km/h.
- The highest energy requirement with thresher at drum speed 550 rpm was 34.62 kW.h/fed.
- The highest criterion cost with combine is 202.96 LE/fed, the highest criterion cost with manual is 113.03 LE/fed, with mower is 94.39LE/fed, and with thresher is 175.10LE/fed respectively at grain moisture content 8.78 %, field speed 4.5 km/h, drum speed 550 rpm and grain moisture content 8.78 %

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**دراسة مقارنة للطرق المختلفة لحصاد محصول عباد الشمس في الأراضي الجديدة**

**على إبراهيم موسى ومحمد عبد المعتمد إسماعيل**
**معهد بحوث الهندسة الزراعية – وزارة الزراعة.**

أجريت هذه الدراسة بمنطقة النوبارية خلال الموسمين الصيفيين ٢٠٠٣ – ٢٠٠٤ لمحصول عباد الشمس صنف Euro-flower في أرض جيرية بغرض مقارنة تأثير بعض الطرق المختلفة للحصاد على إنتاجية محصول عباد الشمس وهى: فواقد الحبوب ,تلفها ,السعة الحقلية ,استهلاك الوقود,الطاقة المستهلكة,التكاليف.

- تم مقارنة طريقة الحصاد التقليدية ( استخدام المنجل في الحصاد ونقل النباتات بالعمالة والدراس والتذرية باستخدام آلة الدراس) بالطريقة الميكانيكية ( الحصاد بالمحشة ونقل النباتات بالعمالة والدراس باستخدام آلة الدراس وكذا الكومباين للحصاد والدراس والتذرية في عملية واحدة).
- تم دراسة الطرق الميكانيكية للحصاد على خمس سرعات مختلفة ٢،٥ & ٣،١ & ٣،٦ & ٤،٠ &٤،٥ كم/ساعة للمحشة و الكومباين تحت تأثير ثلاث محتويات رطوبة مختلفة للحبوب وهى ٨،٧٨& ١٠،٦٨ & ١٣،٣٧ وثلاث سرعات لدرفيل آلة الدراس ودرفيل الكومباين ٤٥٠& ٥٠٠ & ٥٥٠ لفة/دقيقة.

تم دراسة فواقد الحبوب والحبوب المكسورة الناتجة عن آلة الدراس ودرفيل الكومباين .تحت تأثير ثلاث سرعات مختلفة لدرفيل الدراس ومعدل تغذية ١ طن/ساعة لآلة الدراس عند نفس المحتويات الرطوبة السابقة.

تم حساب السعة الحقلية الفعلية واستهلاك الوقود والقدرة والطاقة المستهلكة والتكاليف.

**وقد أوضحت النتائج مايلى:**

- أعلى فاقد للمحشة وجهاز الحصاد الأمامي في الكومباين ٤،١٩ & ٣،٠٣ % على التوالى عند سرعة أمامية ٤،٥ كم/ساعة ومحتوى رطوبى ٨،٧٨ % مقارنة بفاقد الحصاد اليدوي ٣،٥٩ %.
- بزيادة سرعة درفيل آلة الدراس من ٤٥٠ إلى ٥٥٠ لفة/دقيقة يزداد فاقد الدراس حوالي ٠،٤٦ % وحبوب مكسورة ١،٣٥ % عند معدل تغذية ١ طن/ساعة.
- الفاقد الكلى للكومباين ٧،٢٧ % عند سرعة حقلية ٢،٥ كم/ساعة وسرعة درفيل ٤٥٠ لفة/دقيقة ومحتوى رطوبى ٨،٧٨ % (مضافا إليها الحبوب المكسورة)

السعة الحقلية الفعلية للحصاد اليدوي (٠،٠٢٥ فدان/ساعة) بينما زادت السعة الحقلية الفعلية للكومباين حوالي ٢،٦ ضعف عن المحشة وذلك عند جميع السرعات الأمامية السابقة.

أعلى طاقة مستهلكة فى الحصاد بأستخدام الطريقة الميكانيكية ( الحصاد بالمجشة والدراس والتذرية بآلة الدراس تليها الطريقة التقليدية ثم الكومباين وهى (٥٧،٤-٣٤،٦٢-٣٣،٩٦ كيلووات ساعة/فدان) على التوالى.

أعلى تكلفة للحصاد بالجنية كانت كالآتى بالنسبة (لليدوى+ الدراس)-(المحشة+الدراس) ثم الكومباين هى ٢٨٨،١٣-٢٦٩،٤٩ ثم ٢٠٢،٩٦على التوالى عند محتوى رطوبى ٨،٧٨% والسرعات قرين كل منها.