

A STUDY ON HARVESTING MECHANIZATION OF SOYBEAN CROP

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ABSTRACT

The experiments were carried out during the agricultural season of 2003 to evaluate two different systems of harvesting soybean crop to choose the most efficient and economic system as well as to determine the optimum operating conditions for both systems. The first system was harvesting soybean crop by combine harvester (Yanmar-CA760) which was tested at four different forward and cylinder speeds under four various levels of grain and straw moisture contents. The second was harvested by hand sickle then threshed, winnowed by Turkish threshing machine that was tested at four feed rates and cylinder speeds under the same above mentioned moisture contents. All experiments were performed at the research farm of Rice Mechanization Center, Meet El-Deeba, Kafr El-Sheikh Governorate.

Results showed that combine harvester (Yanmar-CA760) is strongly recommended since it gave lower losses, damage, costs and higher performance efficiency compared to manual harvesting and gathering followed by mechanical threshing and winnowing using Turkish thresher. The optimum operating conditions for combine harvester (Yanmar-CA760) are at forward speed of 2.6 km/h, cylinder speed of 10.89 m/s and grain moisture content of 18.50%. However, the optimum operating conditions for manual harvesting and gathering followed by mechanical threshing and winnowing using Turkish thresher was at feed rate of 0.5 kg/s, cylinder speed of 11.99 m/s and grain moisture content of 18.50%.

INTRODUCTION

Soybean is considered as the most important oil crop in the world. In Egypt, soybean crop is not only an oil crop but also a ready source of protein for people diet, chickens and animals). It is well known that the lack of edible oil production is one of the greatest problems that Egypt has suffered from since the last decade. One of the major problems associated with the production of soybeans is field loss at harvest. In Egypt, harvesting and threshing soybean crop is still done manually which is tedious and time-consuming with high losses (Abd El-Motaleb *et al.*, 1999). The average soybean harvesting losses are generally more than 8 percent and that over 80 percent of these losses are caused by the combine header (Nave *et al.* (1973).

Mechanical damage of seeds during harvesting and handling processes is a major concern of the seed industries. Seed damage results in lower seed yield, storability problems, and reduced seed germination and seedling vigor (McDonald, 1985). Soybean seeds are particularly susceptible to mechanical damage because of their large size and mass, and because of the two cotyledons are easily split apart. Much of the damage is the result of seed impact with high velocity threshing and conveying mechanisms. The

great importance of this crop and the great loss and damage during harvesting make it necessary to have a study on harvesting soybean crop.

Mesquita (1994) stated that, losses during harvesting can be categorized as pre-harvest losses, threshing losses, separating losses and header losses. Pre-harvest losses can be minimized by harvesting soybean at the correct moisture content. Abd El-Motaleb *et al.* (1999) mentioned that increasing the forward speed from 1.7 to 4.9 km/h, increased the total losses of soybean crop by 55.43, 61.54 and 56.11% for seed moisture contents 13.56, 19.07 and 30.50%, respectively for combine harvester Case-International Model 1620.

Dunn *et al.* (1973) showed that under field conditions when soybean moisture was less than 13%, 81% of the harvesting loss resulted from the cutterbar when the crop was cut to leave a stubble height of 8.9 cm (3.5 in.). the auger was responsible for 13% of the loss and the reel for the remaining 6 %. They also added that the shatter loss was greater than either of the other loss categories. The total header loss, shatter and stalk losses accounted for 64.1 and 31.2% respectively. Tandon and Panwar (1989) found that header losses represent 80% of all soybean losses and consisted of 61% shatter loss, 22% lodging and stalk loss, and 17% stubble loss.

Vejasit and Salokhe (2004) showed the effect of drum speed, feed rate and moisture content on the threshing efficiency for soybean crop. They indicated that threshing efficiency was between 98.35 to 99.49%, these results were due to low pod cohesion at the range of soybean moisture content tested. Sharma and Devnani (1980) carried out threshing studies on soybean and cowpea, they found that the feed rate increased with the increase in cylinder tip speed at all concave clearances, which resulted in subsequently higher grain output. The threshing efficiency was affected by cylinder tip speed, concave clearance and the quantity of material passed through the thresher per hour (feed rate).

Baiomy *et al.* (1999) studied the performance of AMRI and Gabr threshers for soybean. The final results indicated that the best performance of AMRI and Gabr threshers were found at drum speed of 14 (400) and 12 (339) m/s (r.p.m) respectively. Fernando *et al.* (2004) developed and tested soybean threshing mechanism. They found that seed breakage and seed coat damage increased with increasing shaft rotational speeds of the threshing mechanism.

Jung (1988) reported that during harvesting soybean some beans may not be removed from the pods by the cylinder, due to high moisture content or incorrect cylinder-concave setting, 0.5% of the crop may be lost in this way but it is generally possible to eliminate the loss entirely, without the risk of over threshing which might damage some beans.

The objectives of the present study were to measure the total harvesting losses of soybean grain, to evaluate and choose the most efficient and economic system for harvesting and threshing soybean crop.

MATERIALS AND METHODS

Materials:

1) The combine (Yanmar – CA 760)

A Japanese made combine harvester model (Yanmar-CA 760) were used in the present study. Technical data and specifications are indicated in Table 1 and Fig. 1.

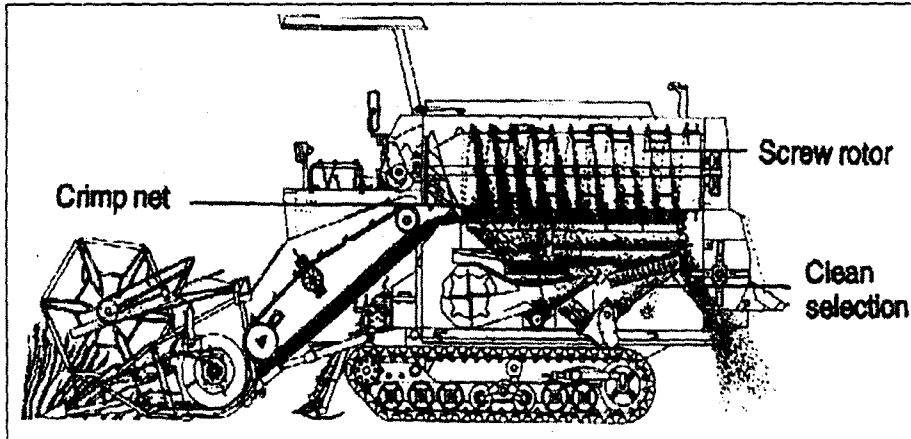


Fig. 1: Cross section view of combine harvester (Yanmar-CA760).

Table 1: Combine specifications

	Model	CA760-T	
Dimensions	Overall length, mm	5600	
	Overall width, mm	2430 (2180 at transport)	
	Overall height, mm	2650 (2265 at transport)	
Running weight, kg		3910	
Engine	Model	YANMAR 4TN100	
	Type	Water-cooled, 4-cycle, Vertical 4-cylinder diesel engine	
	Output, kW (r.p.m)	57 (2600)	
Traveling section	Type	Full crawler (rubber)	
	Crawler size (Width × ground contact length), mm	500 × 1710	
	Traveling speed	Forward, m/sec	0~2.3
		Reverse, m/sec	0~1.5
Header	Type	Platform and auger	
	Harvest width, mm	2060	
Threshing section	Type	Screw rotor	
	Rotor	Dia. × length, mm	650 × 2170
		Rotor speed, r.p.m	716 (rice, wheat, barley), 325 (soybean)
Separating section	Separating system	Suction air and shaking sieve	
	Chaff sieve area, m ²	1.24	
	Grain sieve area, m ²	0.22	
Grain handing system		Bagging type	
Straw disposal system		Straw spreader (option)	

2) Turkish threshing machine:

This machine essentially consists of two components fitted to a steel frame supported by two tire wheels and one vertical link. The two components are: threshing unit and winnowing unit (separating and cleaning) of grain. Technical data and specifications of Turkish threshing machine are indicated in Table 2 and Fig. 2. A2WD (Nassr DM 34) was used to operating the threshing machine. The tractor power used is 44.77 kW (60 hp). Diesel engine.

Table 2: Technical data and specifications of Turkish threshing machine

Manufacture	Turkey
Length	325 cm without hitch, 420 cm with hitch
Width	131 cm
Height	198 cm
Source of power	Transmit from tractor through pulley and belt
Threshing drum:	
Drum diameter	70 cm
Length	120 cm
Feed opening	118 x 50 cm
Concave:	
Number of concave holes	17 per (10 x 10 cm ²)
Hole diameter	1.8 cm
Concave clearance	3.5 cm
Grain-winnowing:	
Hole of vibrating screen, diameter	10 mm
Number of holes	40 per (10 x 10 cm ²)

3) Miscellaneous equipment:

- a) Electrical oven.
- b) Measuring tape
- c) Sickles for manual harvesting.
- d) Balance.
- f) Several square frames made from wood.
- e) Long sheet of canvas.
- g) Photo sensing tachometer:** was used for measuring the cylinder speed (Japanese make).

h) The Screen: The unthreshed grain were separated from the threshed grain by means of the hand operated screen.

4) Experimental procedure:

The experiments were carried out during the agricultural season of 2003 in order to evaluate two different systems of harvesting soybean crop and determine the optimum operating conditions for both harvesting systems. The first system was harvesting soybean crop by combine harvester (Yanmar-CA760) which was tested at four different forward speeds of 1.4, 1.9, 2.6 and 3.1 km/h, four cylinder speeds of 9.87 (290), 10.89 (320), 12.59 (370) and 13.95 (410) m/s (r.p.m) which obtained by using different pulleys and four moisture contents for both grain and straw of 22.41, 18.50, 14.96, 12.14 and 40.52, 31.34, 20.50, 14.82% respectively.

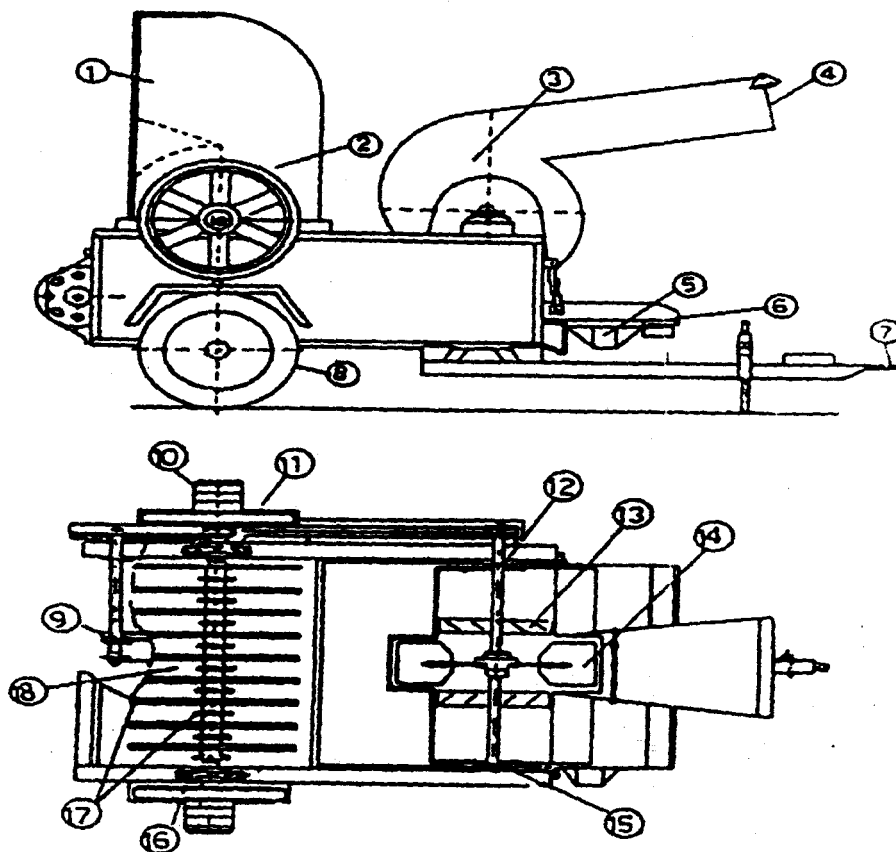


Fig. 2: Main components of Turkish threshing machine.

- | | | |
|--------------------------|---------------------|-----------------------------|
| 1. Feeding opening. | 7. Latch point. | 13. Separator wing. |
| 2. Threshing unit. | 8. Tire wheel. | 14. Paddle wheel. |
| 3. Centrifugal fan. | 9. Crank mechanism. | 15. Bearing of fan shaft. |
| 4. Output straw opening. | 10. Pulley drum. | 16. Bearing of drum shaft. |
| 5. Output grain opening. | 11. Flywheel. | 17. Beater fingers of drum. |
| 6. Vibrating screen. | 12. Fan shaft | 18. Concave grate. |

The second system was harvested by hand sickle then threshed, winnowed by Turkish threshing machine. The Turkish threshing machine was tested at four feed rates of 0.2, 0.3, 0.4 and 0.5 kg/s, four cylinder speeds of 11.99 (327), 14.84 (405), 17.96 (490) and 20.89 (570) m/s (r.p.m) and the same above mentioned moisture contents. All experiments were performed at the research farm of Rice Mechanization Center, Meet El-Deeba, Kafr El-Sheikh Governorate. The characteristics of Giza-21 soybean crop are shown in Table 3.

Table 3: Some physical properties of soybean variety (Giza-21) at grain and straw moisture content of 18.50% and 31.34%

No. of sample	Plant height, cm	Height of the first pod, cm	Grain dimensions, mm			Mass of 1000 seed, g	Grain/straw ratio
			Length	Width	Thickness		
1	115	3	6.51	5.60	4.21	181	1:1.26
2	92	5	6.54	5.66	4.33	180	1:1.41
3	117	4	6.60	5.57	4.18	183	1:1.30
4	90	7	6.54	5.61	4.33	182	1:1.37
5	105	4	6.62	5.68	4.34	183	1:1.33
6	92	8	6.60	5.54	4.21	183	1:1.41
7	95	6	6.62	5.68	4.20	182	1:1.31
8	120	4	6.50	5.60	4.35	181	1:1.40
9	99	6	6.61	5.61	4.30	182	1:1.30
10	105	5	6.50	5.68	4.33	183	1:1.29
Total	1030	52	65.64	56.23	42.78	1820	1:13.38
Mean	103	5.2	6.56	5.62	4.28	182	1:1.338

a) **Total grain losses:** The total losses of combine harvester were those occurred in front and behind the combine during harvesting operations and it includes the following main sources:

i) Total header loss (sum of shatter, lodged, stalk and stubble loss).

$$\text{Total header loss, \%} = \frac{\text{Total header loss, kg/fed.}}{\text{Total yield, kg/fed.}} \times 100 \text{ ----- (1)}$$

ii) Unthreshed grain loss measurement (when using combine Yanmar-CA760):

$$\text{Unthreshed grain loss, \%} = \frac{\text{Unthreshed grain loss, kg/fed.}}{\text{Total yield, kg/fed.}} \times 100 \text{ -----(2)}$$

iii) Threshed grain loss measurement (when using combine Yanmar-CA760):

$$\text{Threshed grain loss, \%} = \frac{\text{Threshed grain loss, kg/fed.}}{\text{Total yield, kg/fed.}} \times 100 \text{ ----- (3)}$$

$$\text{Total losses, \%} = \frac{H_L + U_L + T_{SL}}{H_L + U_L + T_{gL} + T_Y} \times 100 \text{ ----- (4)}$$

Where:

- H_L = Total header loss, kg/fed.,
- U_L = Unthreshed grain loss, kg/fed.,
- T_{gL} = Threshed grain loss, kg/fed.,
- T_Y = Total grain yield, kg/fed.

b) **Mechanical grain damage (visible and invisible):**

i) Visible grain damage: It was determined by separating the damage grain by hand from a mass of 100 grams the samples were taken randomly from the threshed grain. The percentage of seed damage was calculated as follows:

$$\text{Visible grain damage, \%} = \frac{\text{Mass of broken grains in sample, g}}{\text{Total mass of grains in sample, g}} \times 100 \text{ ---- (5)}$$

ii) Invisible grain damage: A germination test was carried out using Petri dishes. The samples of these tests were taken randomly after separating the damage grain (visible damage). One hundred grains were put in Petri dish on a filter paper, covered with water and incubated at 25° C for 24h. the germinated grains were collected from each dish and expressed as a percentage of the original number of seed.

Total grain damage, % = (Visible grain damage, % + Invisible grain damage, %) --- (6)

c) Fuel consumption: The fuel consumption per unit time is determined by measuring the volume of fuel consumed during harvesting or threshing time. The fuel consumption was experimentally determined by using a fuel consumption apparatus. Its capacity is about 750 ml. It has a reading scale divided into 15 sections with accuracy of 50 ml.

d) Consumed power: It was calculated by accurately measuring the decrease in fuel level in fuel tank immediately after carrying out each treatment. The following formula was used to determine consumed power (Barger *et al.* 1963).

$$E_r = \left[F_c \times \frac{1}{3600} \right] \times \rho_f \times \text{L.C.V} \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times \frac{1}{1.36} \text{---kW} \text{----- (7)}$$

Where:

E_r = Power requirements, kW;

F_c = Fuel consumption rate, l/h;

ρ_f = Density of the fuel, kg/l (for solar fuel)= 0.85 kg/l;

L.C.V= Lower calorific value of solar fuel (average, 10.000 kcal/kg);

427= Thermo-mechanical equivalent, kg.m/kcal;

η_{th} = Thermal efficiency of the engine, (considered to be about 35% for diesel engine), and

η_m = Mechanical efficiency of engine, 80% (considered to be about 80% for diesel engine).

e) Cost analysis

The cost of machine work was calculated by using the following formula (Awady, 1978):

$$C = P/h (1/a + i/2 + t + r) + (1.2 W.S.F) + m/144 \text{----- (8)}$$

Where:

C = Hourly cost, L.E/h;

P = Price of machine, L.E;

h = Yearly working hours, h;

a = Life expecting of the machine, year;

i = Interest rate /year ratio;

t = Taxes, overheads ratio;

r = Repairs and maintenance ratio,

W = Power, hp;

S = Specific fuel consumption (l/hp.h);

F = Fuel price, L.E;

m = Operator monthly salary L.E./h;

1.2 = A factor to take lubrication and greasing into account, and

144 = The monthly average working hours.

Criterion cost:

The criterion cost was estimated by using the following equation (Awady et al., 1982):

$$\text{Operating cost} = \frac{\text{Machine cost, L.E/h}}{\text{Effective field capacity, fed./h}}, \text{L.E/fed.} \text{----- (9)}$$

Comparative value: The comparative value was calculated by using the following equation:

$$\text{Comparative value} = \text{Operating cost (L.E/fed.)} + \text{Grain losses cost (L.E/fed.)} + \text{The difference in price between the whole grain and damage grain (L.E/fed.)} \text{----- (10)}$$

RESULTS AND DISCUSSION

Total losses, %:

Fig. 3 indicate the effect of forward speed, cylinder speed and grain moisture content on the total grain losses. It can be noticed that the mean values of total losses reached 3.570, 4.182, 4.874 and 5.748% at combine forward speeds of 1.4, 1.9, 2.6 and 3.1 km/h, respectively by using cylinder speed of 9.87 m/s and grain moisture content of 12.14%. The other cylinder speeds and grain moisture contents gave the same above mentioned trend. It is remarkable that increasing combine forward speed tends to increase the total grain losses at all cylinder speeds and grain moisture contents. The reason is due to the exponential increase of all losses of different combine parts with increasing combine forward speed. Similar results obtained by (Abd El-Motaleb et al., 1999). The cylinder speeds of 9.87, 10.89, 12.59 and 13.95 m/s gave the following values of total losses: 3.465, 3.271, 3.046 and 2.815%, respectively at forward speed of 1.9 km/h and grain moisture content of 18.50%. It is evident that the total losses decreased by 18.76% when the cylinder speed increased from 9.87 to 13.95 m/s at the previous above mentioned factors. Otherwise, for all forward speed and grain moisture contents increasing the cylinder speeds leads to a decrease in the total losses. This attributed to the decrease of unthreshed and threshed grain losses by increasing cylinder speed.

Fig. 4 shows the effect of feed rate, cylinder speed and grain moisture content on total grain losses by using manual harvesting (traditional method) followed by mechanical threshing (Turkish thresher). It is clear that both cylinder speed and feed rate had small effect on total grain losses. On the other hand, an increase of total grain losses was observed by decreasing the grain moisture content from 22.41% to 12.14% where it increases by 39.32% at feed rate of 0.5 kg/s and cylinder speed of 2.89 m/s. These increase in total losses may be attributed to the increase of manual harvesting and gathering at the lower moisture content (late of the season).

Results also showed a remarkable increase in total grain losses for manual and mechanical harvesting followed by mechanical threshing comparing with the combine harvester. However the maximum value of total grain losses reached 8.191 and 5.091 for manual harvesting followed by mechanical threshing and combine harvester, respectively under the same grain moisture content.

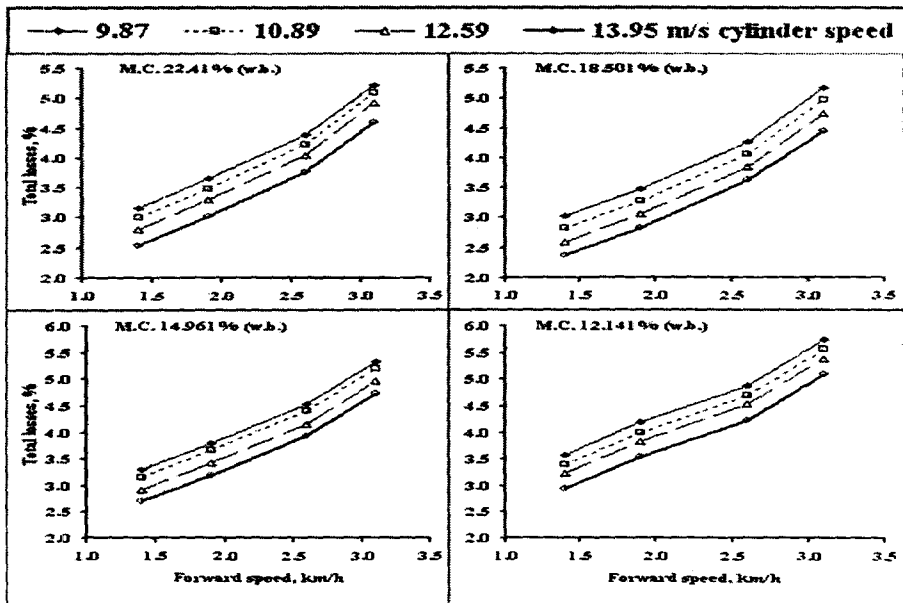


Fig. 3: Effect of forward speed, cylinder speed and grain moisture content on the total losses for combine harvester.

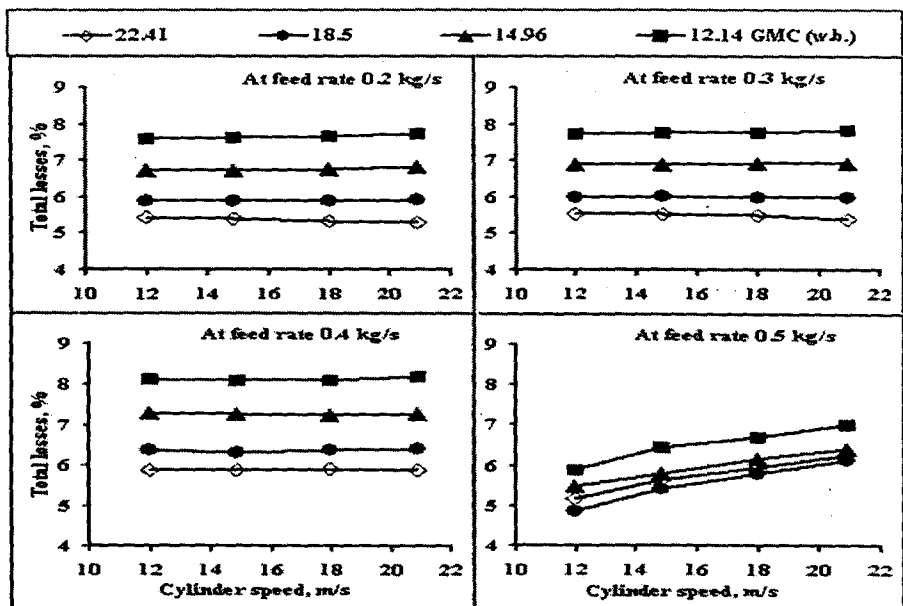


Fig. 4 : Effect of Feed rate, cylinder speed and grain moisture content on the total losses for Turkish threshing machine.

Total grain damage:

Fig. 5 illustrates the effect of combine forward speed, cylinder speed and grain moisture content on total grain damage. It can be mentioned that total grain damage decreases by the increase of combine forward speed where it decreases by 43% when the combine forward speed increased from 1.4 to 3.1 km/h at grain moisture content 18.5% and cylinder speed of 9.87 m/s. This may be due to the greater density of layer of material passing between the cylinder and the concave bars at high feed rate apparently provides more protection of the seeds. Thereby reducing the probability of repeated impacts by cylinder bars. This result agreed with that reported by (Nyborg, 1964). Results also, showed that if grain moisture content above or below 18,5% the total grain damage will be increased at all operation conditions of combine harvester. In regard to total grain damage, the increase of cylinder speed from 9,87 to 13,95 m/s leads to increase the total grain damage by 266% at grain moisture content of 18,5% and combine forward speed of 1,4 km/h. Fig. 6 illustrates the effect of cylinder speed, feed rate and grain moisture content on total grain damage for Turkish threshing machine. The obtained values of total grain damage showed that the grain moisture content above or below 18,5% increases the total grain damage. The highest value was 7,003% which obtained from grain moisture content of 12,14%, cylinder speed of 20,89 m/s and feed rate of 0,2 kg/s. Dealing with the increase of cylinder speeds from 11,99 to 20,89 m/s the total grain damage increased by 26%. This may be due to the probability of repeated impacts by cylinder bars.

Specific fuel consumption, l/kW.h:

Table 4 summarizes the effect of combine forward speed, cylinder speed and grain moisture content on specific fuel consumption. It can be noticed that, the increase of combine forward speed, drum speed and grain moisture content increase the specific fuel consumption. The highest value of 0.235 l/kW.h was recorded at combine forward speed of 3.1 km/h, cylinder speed of 13.95 and grain moisture content of 22.41%. Results also, showed that Turkish thresher gave the lowest values of specific fuel consumption comparing with the combine harvester.

In the same manner the same trend was observed in case of using Turkish thresher whereas, the increase in both cylinder speed and grain moisture content tend to increase the specific fuel consumption. Also, results showed that the increase of feed rate increases the specific fuel consumption and the highest value of specific fuel consumption was 0.131 l/kW.h at cylinder speed 20.89 m/s, feed rate of 0.5 kg/s and grain moisture content of 22.41%. it can be noticed that combine harvester gave the highest values of specific fuel consumption in all cases.

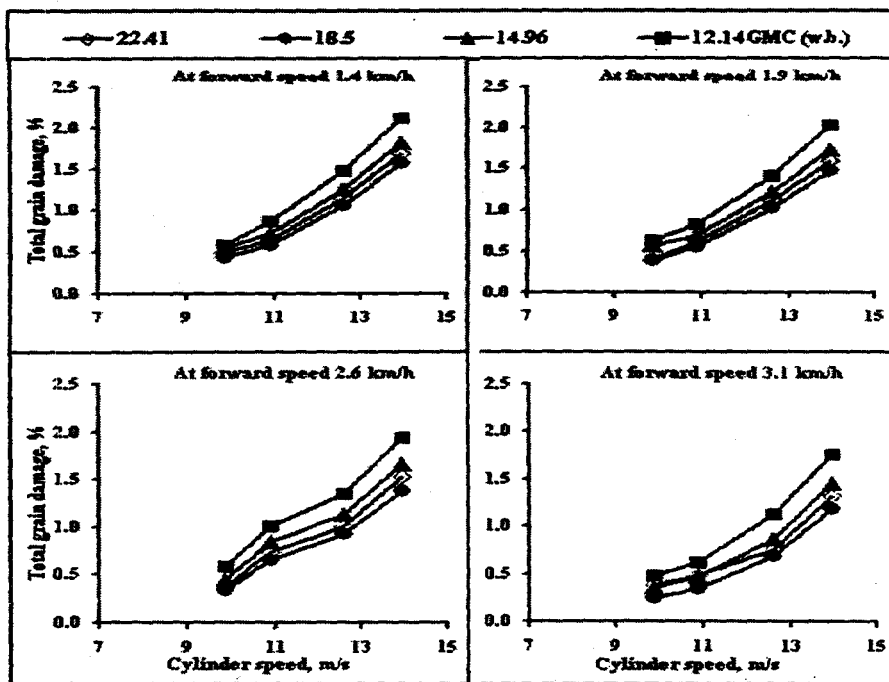


Fig. 5 : Effect of combine forward speed, cylinder speed and grain moisture content on total grain damage of soybean crop.

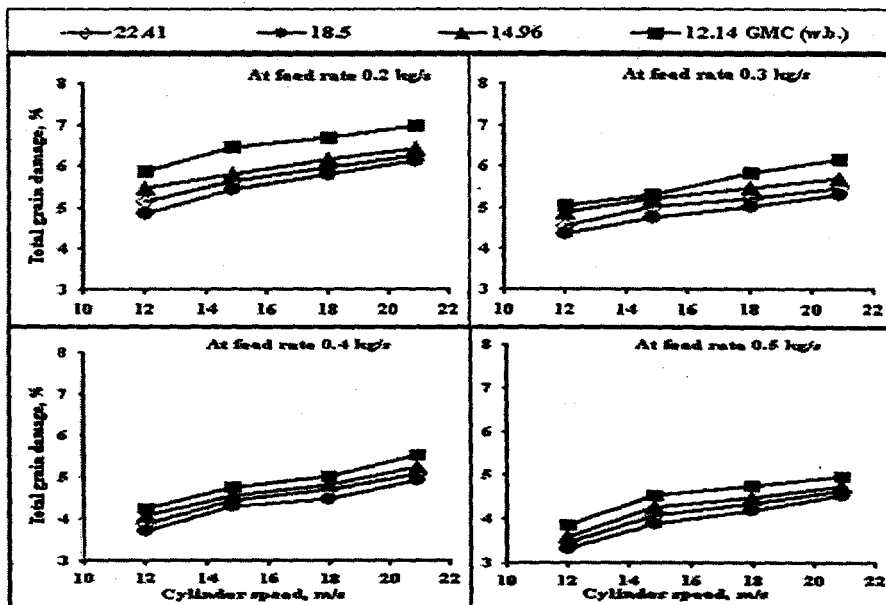


Fig. 6 : Effect of Feed rate, cylinder speed and grain moisture content on the total grain damage for Turkish threshing machine.

Table 4: Effect of combine forward speed, cylinder speed and grain moisture content on specific fuel consumption, l/kW.h

M.C.	Forward speed, km/h	Cylinder speed, m/s			
		9.87	10.89	12.59	13.95
12.14	1.4	0.121	0.134	0.142	0.153
	1.9	0.128	0.139	0.150	0.161
	2.6	0.135	0.147	0.158	0.170
	3.1	0.143	0.155	0.167	0.179
14.96	1.4	0.142	0.153	0.165	0.177
	1.9	0.149	0.158	0.173	0.185
	2.6	0.158	0.169	0.180	0.191
	3.1	0.165	0.177	0.189	0.202
18.5	1.4	0.161	0.172	0.184	0.195
	1.9	0.169	0.180	0.193	0.207
	2.6	0.178	0.188	0.20	0.215
	3.1	0.187	0.196	0.208	0.224
22.41	1.4	0.183	0.190	0.198	0.206
	1.9	0.186	0.198	0.207	0.215
	2.6	0.195	0.205	0.215	0.224
	3.1	0.207	0.214	0.225	0.235

Comparative value for combine harvester, (L.E/fed.):

Data listed in Table 5 shows the effect of combine forward speed, cylinder speed and grain moisture content on comparative value.

Table 5 : Effect of combine forward speed, cylinder speed and grain moisture content on the comparative value for combine harvester

Forward speed, km/h	Cylinder speed, m/s	Mean values of comparative value, L.E/fed.			
		Grain moisture content (w.b.), %			
		22.41	18.50	14.96	12.14
1.4	9.870	307.921	293.640	295.075	296.021
	10.89	306.223	290.815	293.928	294.950
	12.59	308.150	291.404	295.309	298.099
	13.95	309.091	292.980	297.721	299.625
1.9	9.870	287.187	271.972	274.939	279.450
	10.89	285.220	269.229	274.233	277.463
	12.59	287.249	269.736	275.163	280.835
	13.95	286.604	270.220	276.251	281.628
2.6	9.870	282.721	268.843	270.293	272.729
	10.89	281.290	265.901	269.524	270.829
	12.59	282.501	266.152	269.879	274.166
	13.95	282.579	266.878	271.339	274.413
3.1	9.870	301.729	287.596	284.361	288.453
	10.89	299.533	283.571	282.697	285.584
	12.59	300.488	282.272	281.707	287.883
	13.95	299.549	281.347	283.840	288.908

It can be stated that, increasing the forward speed from 1.4 to 2.6 km/h tends to decrease the comparative value from 290.815 to 265.901 L.E/fed., at cylinder speed of 10.89 m/s and grain moisture content of 18.50%. Meanwhile, it was increased from 265.901 to 283.571 L.E/fed., by increasing the combine forward speed from 2.6 to 3.1 km/h at the above mentioned cylinder speed and grain moisture content. The other cylinder speeds and grain moisture contents had the same above mentioned trend.

Comparative value for traditional method, L.E/fed.:

Table 6 shows the effect of feed rate, cylinder speed and grain moisture content on the comparative value for traditional method. It can be stated that, increasing the feed rate from 0.2 to 0.5 kg/s leads to decrease the comparative value from 500.212 to 398.307, 486.411 to 394.295, 499.101 to 409.702 and from 510.002 to 421.554 L.E/fed. at cylinder speed of 11.99 m/s and grain moisture contents of 22.41, 18.50, 14.96 and 12.14%, respectively. The other cylinder speeds gave the same above mentioned trend. Results showed a positive relationship between the comparative value and cylinder speed at all feed rates and grain moisture content. The obtained comparative values were: 510.002, 514.228, 516.603 and 520.244 L.E/fed. at cylinder speeds of 11.99, 14.84, 17.96 and 20.89 m/s, respectively, with the feed rate of 0.2 kg/s and grain moisture content of 12.14%.

Table 6: Effect of feed rate, cylinder speed and grain moisture content on the comparative value for traditional method

Feed rate, kg/s	Cylinder speed, m/s	Mean values of comparative value for traditional method, L.E/fed.			
		Grain moisture content (w.b.), %			
		22.41	18.50	14.96	12.14
0.2	11.99	500.212	486.411	499.101	510.002
	14.84	502.522	490.183	499.711	514.228
	17.96	503.493	493.170	501.850	516.603
	20.89	504.460	497.458	505.523	520.244
0.3	11.99	443.846	435.824	451.450	460.897
	14.84	448.447	439.587	454.675	465.586
	17.96	449.655	441.840	457.345	468.834
	20.89	450.323	445.488	459.979	473.996
0.4	11.99	415.240	408.217	424.180	434.019
	14.84	422.024	415.600	429.621	439.586
	17.96	424.976	416.355	432.264	443.329
	20.89	427.092	422.314	437.754	451.109
0.5	11.99	398.307	394.295	409.702	421.554
	14.84	407.140	400.509	417.430	429.316
	17.96	411.391	405.915	419.432	432.136
	20.89	414.898	411.191	423.338	436.608

Conclusion

Form the above results the following conclusions are driven:

1. Combine harvester (Yanmar-CA760) is strongly recommended since it gives lower losses, damage and costs, and higher performance efficiency

- compared to manual harvesting and gathering following by mechanical threshing and winnowing using Turkish thresher.
2. The optimum operating conditions for the combine harvest or (Yanmar-CA760) are at forward speed of 2.6 km/h, cylinder speed of 10.89 m/s and grain moisture content of 18.50%.
 3. The optimum operating conditions for manual harvesting and gathering followed by mechanical threshing and winnowing using Turkish thresher at the same time was at feed rate of 0.5 kg/s, cylinder speed of 11.99 m/s and grain moisture content of 18.50%.
 4. The lowest comparative value for combine harvester (265.901 L.E/fed.,) was obtained at cylinder speed of 10.89 m/s, forward speed 2.6 km/h and grain moisture content of 18.50%. Meanwhile, it was reached (394.295 L.E/fed.,) at cylinder speed of 11.99 m/s, feed rate of 0.5 kg/s and grain moisture content 18.50% for traditional method.

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دراسة على ميكنة حصاد محصول فول الصويا
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يعتبر محصول فول الصويا من أهم المحاصيل الغذائية والصناعية الهامة على المستوى العالمى نظرا لاحتواء بنوره على نحو ٢٠٪ زيت خالى من الكوليسترول وحوالى ٤٠٪ بروتين ذو قيمة غذائية تقارب قيمة البروتين الحيوانى (نشرة وزارة الزراعة، ٢٠٠٣). وتعانى مصر من نقص إنتاج الزيت منذ فترة طويلة حيث ينتج سنويا ٢٥٪ من إجمالي الاستهلاك المحلى خاصة من بذرة القطن، والنسبة الباقية يتم استيرادها من الخارج. لذلك أدخلت وزارة الزراعة العديد من المحاصيل التقليدية الخاصة بإنتاج الزيت ومنها محصول فول الصويا لحل هذه المشكلة. ونظرا للتغلب على زيادة نسبة الفاقد والتلف الناتج أثناء عملية الحصاد فقد تم دراسة تأثير نظامين مختلفين لحصاد محصول فول الصويا (جيزة ٢١) من خلال إجراء تجربة حقلية أقيمت فى المزرعة البحثية بمركز ميكنة الأرز بميت الديبة - محافظة كفر الشيخ باستخدام آلة الحصاد الجامعة (Yanmar-CA760) وآلة الدراس التركيبية الصنع لمساحة فدانين خلال الموسم الزراعي ٢٠٠٣م. وذلك بهدف اختيار النظام الأمثل لحصاد فول الصويا عند أقل فاقد وتلف وتكاليف تحت ظروف التشغيل المختلفة.

وقد تم تقييم آلتى الحصاد والدراس من خلال المعاملات التالية:

- ١- آلة الحصاد الجامعة: السرعة الأمامية لآلة الحصاد الجامعة (١،٤، ١،٩، ٢،٦، ٣،١ كم/ساعة)، وسرعة درفيل الدراس (٩،٨٧، ١٠،٨٩، ١٢،٥٩، ١٣،٩٥ م/ث)، والمحتوى الرطوبى (١٨،٥٠، ١٤،٩٦، ١٢،١٤ ٪ للحبوب) و (٤٠،٥٢، ٣١،٣٤، ٢٠،٥٠، ١٤،٨٢ ٪ للقص) على أساس رطب.
- ٢- آلة الدراس الثابتة (التركيبية): معدل التغذية (٠،٢، ٠،٣، ٠،٤، ٠،٥ كجم/ث)، وسرعة درفيل الدراس (١١،٩٩، ١٤،٨٤، ١٧،٩٦، ٢٠،٨٩ م/ث)، والمحتوى الرطوبى (١٨،٥٠، ١٤،٩٦، ١٢،١٤ ٪ للحبوب) و (٤٠،٥٢، ٣١،٣٤، ٢٠،٥٠، ١٤،٨٢ ٪ للقص) على أساس رطب.

يمكن تلخيص النتائج المتحصل عليها كما يلى:

- (١) يفضل استخدام طريقة الحصاد بآلة الحصاد الجامعة (Yanmar-CA760) تحت الظروف المصرية حيث أنها أقل فى الفاقد والتلف والتكاليف وأعلى كفاءة مقارنة بطريقة الحصاد والتجميع اليدوى ثم الدراس والتذرية بآلة الدراس التركيبية.
- (٢) أنسب ظروف تشغيل للحصاد بآلة الحصاد الجامعة (Yanmar-CA760) تم الوصول إليها عند سرعة أمامية ٢،٦ كم/ساعة وسرعة درفيل الدراس ١٠،٨٩ م/ث ومحتوى رطوبى للحبوب ١٨،٥٠٪.
- (٣) أنسب ظروف تشغيل لطريقة الحصاد والتجميع اليدوى ثم الدراس والتذرية بآلة الدراس التركيبية فى نفس الوقت تم الوصول إليها عند معدل تلقى ٠،٥ كجم/ث وسرعة درفيل ١١،٩٩ م/ث ومحتوى رطوبى للحبوب ١٨،٥٠٪.
- (٤) وكانت أقل قيمة للقيمة المقارنة لآلة الحصاد الجامعة هي ٢٦٥،٩٠١ جنية/فدان عند سرعة أمامية ٢،٦ كم/ساعة وسرعة درفيل ١٠،٨٩ م/ث ومحتوى رطوبى للحبوب ١٨،٥٠٪. بينما كانت أقل قيمة للقيمة المقارنة للطريقة التقليدية هي ٣٩٤،١٢٩ جنية/فدان عند معدل تلقى ٠،٥ كجم/ث وسرعة درفيل ١١،٩٩ م/ث عند نفس المحتوى الرطوبى.