

DEVELOPMENT AND EVALUATION OF THE COMBINE HEADER TO SUIT HARVESTING SOYBEAN CROP

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ABSTRACT

Experiments were carried out by using a new modified header modification made on CLAAS Dominator 68™ harvesting combine. This work done to minimize header losses for soybean harvesting and to trace the effects of combine forward speeds of 1.92, 2.25, 2.41 and 3.11km/h; reel speeds of 0.94, 1.06, 1.30m/s (17, 20 and 24rpm) and crop moisture content of 18, 15 and 12% while, area of plates of seed collection was kept constant at 4.5m² during experiments on productivity of the machine, losses rate of combine header, percentage of seed damage due to threshing process, proportion of total losses of combine, power required, cost analysis and criterion function cost. Surveys before modification at experiment limit indicated that, the rate of header losses were ranged from 4.6 to 11.9%. However, the rate of total losses were ranged from 6.3 to 16.5%. While, results after modification indicated that, the machine productivity was 1.735ton/fed. Also, the minimum header losses, rate of threshing damage and total losses were 1.6, 1.3 and 3.1%, respectively. On the other hand, the minimum values of power consumed and energy required were 67.4kW and 31.45kW.h/fed, respectively. In addition to, the minimum operating cost required was 96.8LE/fed while, the minimum criterion function cost was 375.7LE/fed.

INTRODUCTION

The soybeans is considered a food crop and industrial important at the global level because its seeds contain about 20% oil free from cholesterol and about 40% protein nutritional value close to animal protein. The total cultivated area in Egypt is about 17055fed, produced 26399ton and average yield 1.548ton/fed (agricultural statistics, 2009). Egypt is ranked first globally in the level of productivity has increased by 30% higher than the global level. With that has been observed in the past decade decline in the acreage of soybeans in Egypt because of the high costs of production and productivity has increased stability and increases the proportion of crop loss at harvest and thus lowers the return on unit area. Therefore, the focus of research efforts in addressing those problems and come to the possibility of reducing costs by 30% through the use of mechanization in harvesting techniques with the development of machinery to reduce the loss rate by up to 25%. The analysis of earlier studies and researches conducted at mechanical soybean harvesting indicates that, James H. Herbek and Morris J. Bitzer, 1997; Ayres, 2006 and Subadh kulkarni, 2008, illustrate that, harvesting losses can be separated into several types of losses according to their location. Gathering losses occur at the front of the combine: 1)Loose beans and beans in pods that are shattered from the stalks by the cutter bar, reel, or cross auger. 2)Beans in pods attached to stalks that are cut off and dropped before entering the combine. 3)Beans in pods attached to lodged stalks that are not cut. 4)Beans in pods attached to the uncut stubble. Cylinder and separating

losses are found on the ground and in pods attached to the straw behind the combine. Charles *et al.* (1993) reported that, numerous tests of soybean combine losses show that up to 12 percent of the soybean crop is lost during harvest. Harvesting losses can't be reduced to zero, but they can be reduced to about 5 percent. Combines can be operated to reduce losses without affecting the harvesting rate. 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. indicated that increasing the forward speed from 1.7 to 4.9km/h, increased the total losses of soybean crop by 56.11% for seed moisture content of 30.50% by using combine harvester Case International Model 1620. Siemens (2002) make a study showed that, harvesting losses for conventionally equipped combines were approximately 26 percent of the harvesting crop. Utilizing double density guards reduced losses from 45 percent to 14 percent and utilizing an air reel in conjunction with the double density guards reduced losses to a more acceptable 10 percent level. Applying these findings to commercial field, losses could be reduced by approximately 153lb/ac with an increase gross revenue of \$22.95/ac, assuming a 1,000lb/ac yield and a price of \$0.15/lb. Utilization of such technology has the potential to make a marginally economically viable crop a profitable one and is currently commercially available. Beasley (2007) concluded that, harvested yields of soybeans in many NORTH CAROLINA fields can easily be increased by 5 to 10 percent just by leaving fewer beans in the field when combining. Studies have shown that field losses average about 10%, but run as high 15 to 20% in many cases. A machine harvesting loss of only 3 to 4% is practical to achieve with carefully operated modern equipment. Careful combining costs nothing extra, so the additional beans harvested go directly into the net profit column. Unless you know how much you are losing and from what part of the machine the loss is coming, you don't know how to make corrections. It is essential to measure losses and pinpoint their source to see where machine adjustments are needed. Always recheck losses after making adjustments to see if they had the desired effect. Once you learn the procedure, a loss check can be made in just a few minutes. Philbrook and Oplinger (1989) Carried out a study was conducted to determine the effects of delaying soybean harvesting on grain losses in the field. Field studies were conducted each year from 1983 to 1986 at Arlington, WI. Two cultivars from each maturity groups (MG) 0, I, and II, one more susceptible to lodging than the other, were used. Initial harvest for each maturity group began 3 to 7d beyond stage, R8. Three additional harvests were made for each maturity group at 14, 28 and 42d beyond their initial harvest. Average soybean field losses were 10% of the potential yield, but ranged from 5.5% in 1983 to 12.7% in 1984. Loss of potential yield increased linearly at a rate of 0.2% d⁻¹ from an average of 6.1% at the initial harvest to 13.9% 42d later. In 1984 and 1986 net yields were reduced 14 and 18kg.ha⁻¹.d⁻¹, respectively. Harvest delays of 42d resulted in plant deterioration and, in turn, lodging increased 20%, and pre-harvest, shatter, and stem losses increased 62, 95, and 70kg.ha⁻¹, respectively. Shatter losses were influenced by moisture conditions at

harvest, but plant deterioration also increased shattering beyond that accounted for by moisture. Berglund and Helms (2003) told that, timely, careful harvesting means extra bushels of soybean. Soybean is easy to thresh, but the challenge is to get all the soybean seed into the combine. Straight combining is the most satisfactory and commonly used method of harvest. Swathing soybean can result in excessive field losses (up to 25%) due to shattering. Use of equipment like floating headers, pick up reels, love bars and row crop headers are helpful in reducing harvest losses. Keep the combine in good repair- a cutter bar in poor condition will increase gathering losses. Be sure knife sections and ledger plates are sharp, and that wear plates, hold-down clips and guards are properly adjusted. Proper reel speed in relation to ground speed will reduce gathering losses. Use a reel speed about 25 percent faster than ground speed. Operate the cutter bar as close to the ground as possible at all times. Keep forward speeds at or below 3 miles per hour. Slow down if stubble is high and ragged, or if separating losses are high. Approximately four beans or one to two pods per square feet represent a yield loss of "one bushel" per acre. Jiang *et al.* (1991) evaluated 216 soybean varieties and observed that shattering percentage increased with decreasing pod moisture content. The purpose of the sample study was to examine a new modification for header at harvesting soybean crop. The information obtained is to be used to decrease damage and header losses and increase net returns to producers. Schnug and Beuerlein (1987) report that average soybean harvest losses remain greater than 10% of the harvestable seeds remaining on the plants at harvest, but with proper machine operation and adjustment, losses can be reduced from 1 to 3%. The authors recommended too that soybean harvest begin when the crop reaches 170 to 190g.kg⁻¹ grain moisture, with most efficient harvest occurring between 130 to 160g.kg⁻¹ grain moisture. Gomaa *et al.* (2009) carried out a study on harvesting mechanization of soybean by using two different systems (harvesting soybean crop by using combine harvester yanmar-CA760 and harvesting by hand sickle then threshed, winnowed by Turkish threshing machine). results showed that the optimum operating condition for combine harvester are at forward speed of 2.km/h, cylinder speed of 10.89m/s and grain moisture content of 18.50%. However, the optimum operating condition for manual harvesting and gathering using Turkish thresher was at feed rate of 0.5kg/s, cylinder speed of 11.99m/s and grain moisture content of 18.50%. Therefore, the objective of the present study is to develop and evaluate the combine header to suit harvesting soybean crop.

MATERIALS AND METHODS

Experimental used combine harvester before modification:

Field trials have made by using a classic Combine Harvesting Deutsch-made brand CLAAS Dominator 68™ by using soybean variety Crawford in West Nubaria during the harvest season of 2010. The engineering drawing of the combine header is shown in Fig. 1 and the general specifications of used grain combine harvester indicated in Table 1.

Operating process of the machine:

Getting all of the soybeans into the header is challenging. However, bean pods may set low on the stalk—close to the ground. Dry soybeans, especially those that are dry, tend to shatter. Research shows that beans lost at the header account for more than 90 percent of the total loss. Gathering loss is the sum of shatter, stubble, lodged and stalks loss. The full process of combined operation of cutting, transportation, threshing, separating, sieving and packing is completed. Thus, when operating in fields, the stalk separators will separate crop inside and outside of the cutting area. The reel will move crop entering into left and right stalk separators to the cutter, and then cut the stalk of crop. Crop cut down will fall to the harvester under dead weight, the effect of combine forward speed and the assistance by the reel. But, observed at harvest soybeans, this act is conducive to causing the loss of a large quantity of seeds and by previous studies found to be up to 30%.

Table 1: Specifications of used grain combine harvester.

No.	Item	Value
1	Model	CLAAS Dominator 68™
2	Made	Germany
3	Cutting width, mm	5600
4	L XW XH, mm	6560x6000x4650
5	Capacity of grain tank, kg	3000
6	Engine power, kW	117.65
7	Total weight, kg	2280
8	Reel diameter, mm	1150
9	Cutter stroke, mm	76.2
10	Reel type	Eccentric teeth platform- type
11	Reel rod number	5
12	Harvester auger diameter, mm	490

Suggested modification:

The header is the part of combine for cutting of crops. It is suspended on the front ferrule of the combine. The header mainly consists of header screw conveyer, header transmission mechanism, cutter-bar, dividers, left and right stalk separators and reel. Some major changes in combine header were undertaken as shown in Fig. 2 to reach the result of reducing the proportion of seed losses and were as follows:

- 1) Installation of a twenty slide frames were having length of 125cm and a width of 20cm and the top of the triangle base 20cm with a height of 25cm. Mounted on the holder knife mowing left with spacing of 5cm between each to allow harvest of these distances to the knife cutting interval to fill the space that can occur by scattering seeds and therefore when a scattering of seeds can fall into these frames and return into the combine header.
- 2) Replace the forks reel crossbeam's by rubber mounted on the base metal to prove the symptoms of reel to draw the yield and horns gently so as not easily scattered.

- 3) Installation of metal plates to fill spaces drums threshing centuries to prevent the entry into the drum to reduce damage to seed.
- 4) Manufacture of both sides of the dividers on the right and left, up to 80cm of separation between the sticks in the field and harvest the inside of the combine, and also to collect the seeds scattered in terms of the sides during the harvest.
- 5) Adjust the speeds and clearances of all parts of the machine to fit the harvesting and threshing soybean and removing the combine floats.

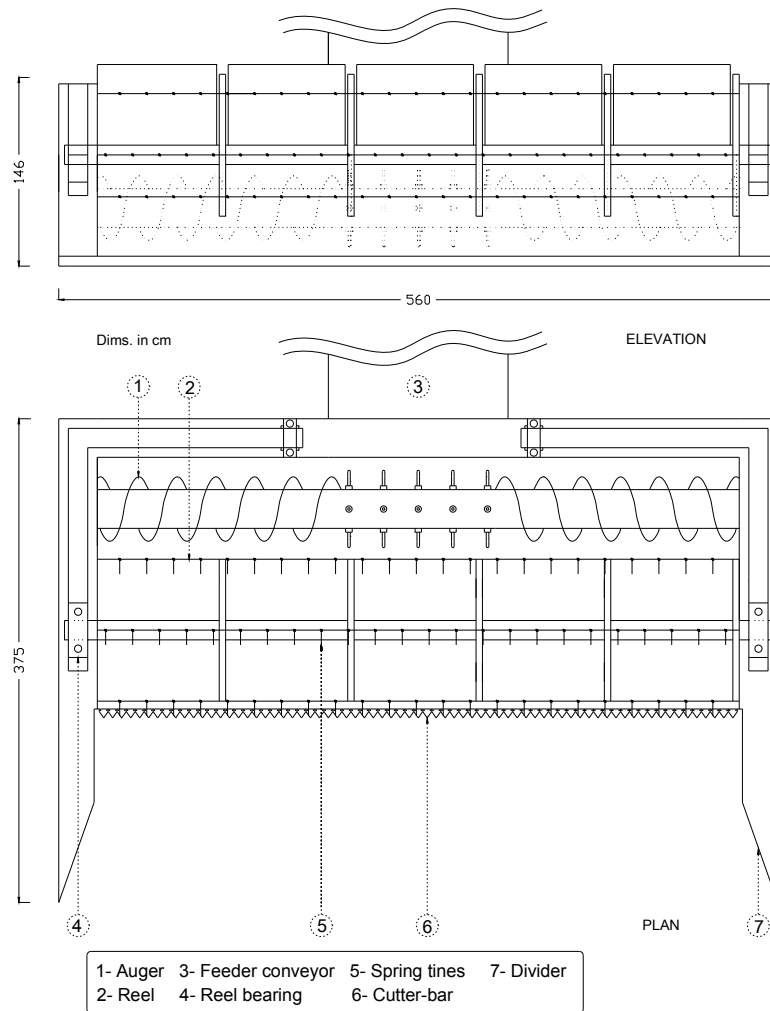


Fig. 1: An elevation and plan for the combine header before modification.

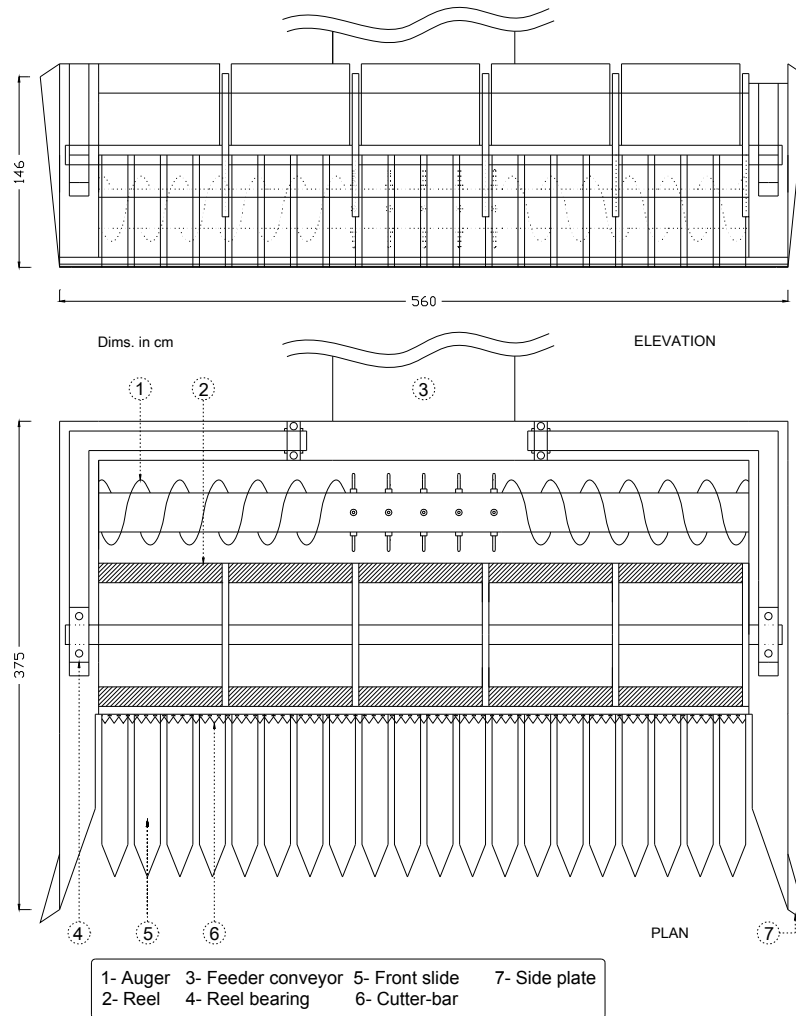


Fig. 2: An elevation and plan for the modified combine header.

Investigated variables:

The present study was carried out in about three feddans to evaluate the effect of forward speed, reel speed, covering plate area and crop moisture content on productivity of the machine, rate of combine header losses, percentage of grain damage, total losses of combine, power required and cost analysis.

Measurements:

- 1) Productivity of the machine: It was determined by collecting yield output from the experimental area.

- 2) Total grain losses: It 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:

$$\text{Total header losses, \%} = \frac{\text{Total header losses, kg / fed}}{\text{Total yield, kg / fed}} \times 100 \dots\dots\dots 1$$

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

$$\text{Unthreshed grain losses, \%} = \frac{\text{Unthreshed grain losses, kg / fed}}{\text{Total yield, kg / fed}} \times 100 \dots\dots 2$$

$$\text{Threshed grain losses, \%} = \frac{\text{Threshed grain losses, kg / fed}}{\text{Total yield, kg / fed}} \times 100 \dots\dots\dots 3$$

$$\text{Total losses, \%} = \frac{H_L + U_L + T_L}{H_L + U_L + T_L + T_Y} \times 100 \dots\dots\dots 4$$

Where:

- H_L Total header losses, kg/fed;
- U_L Unthreshed grain losses, kg/fed;
- T_L Threshed grain losses, kg/fed and
- T_Y Total grain yield, kg/fed.

- 3) Grain damage (visible and invisible):

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

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

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.

$$\text{Total grain damage, \%} = (\text{Visible grain damage, \%} + \text{Invisible grain damage, \%}) \dots\dots\dots 6$$

- 4) Power consumption: The fuel consumption was measured by using an especial device consists of 3 liter graduated cylinder was connected to the fuel pump. The amount of fuel in tube after executing each treatment was recorded. Then Power consumption was calculated according the principles and assumption of Hunt (1983):

$$EP = \frac{FC \times \rho_f \times LCV \times 427 \times \eta_m \times \eta_{th}}{3600 \times 75 \times 1.36}, kW \dots\dots\dots 7$$

Where:

- EP* Power requirements consumption during the cutting operation, kW;
- FC* Fuel consumption, l/h;
- ρ_f Density of the fuel, 850 kg/m³;
- LCV* Lower calorific value of fuel, 10000 kcal/kg;
- 427* Thermo mechanical equivalent, kg.m/kcal;
- η_m Mechanical efficiency of engine, 80% and
- η_{th} Thermal efficiency of the engine, (considered to be about 35 for diesel engine).

5) Operating cost: The total cost needed for operation was estimated by the following formula:

$$Operating\ cost, LE / h = \frac{Machine\ cost, LE / ton}{Yield\ output, ton / h} \dots\dots\dots 8$$

Where,

machine cost was determined by the following formula (Awady, 1978):

$$C = p / h[(1/a) + (i/2) + t + r] + (0.9wsf) + m / 144 \dots\dots\dots 9$$

Where:

- | | |
|---|---|
| <i>C</i> Hourly cost, L.E/h; | <i>w</i> Engine power, hp; |
| <i>p</i> Price of machine, LE; | <i>s</i> Specific fuel consumption, l/hp.h; |
| <i>h</i> Yearly working hours, h/year; | <i>f</i> Fuel price, LE/L; |
| <i>a</i> Life expectancy of the machine, h; | <i>0.9</i> Factor accounting for lubrication; |
| <i>i</i> Interest rate/year; | <i>m</i> Monthly average wage, LE; and |
| <i>t</i> Taxes ratio; | <i>144</i> Reasonable estimation of monthly working hours |
| <i>r</i> Repairs and maintenance ratio; | |

6) Criterion function cost : it was estimated according to the following formula:

$$C_f = U_c + L_c \dots\dots\dots 10$$

Where:

- C_f* Criterion function cost, LE/ton;
- U_c* Operating cost, LE/ton and
- L_c* The losses cost, LE/ton

RESULTS AND DISCUSSION

a) Preliminary trial:

Initial experiment was carried out during the season of 2010 for harvesting soybean crop by using CLAAS Dominator 68™ combine harvester to determine the effect of some independent variables such as forward speed, reel speed and crop moisture content on header and total harvesting losses. Results show that, header and total harvesting losses were increased with increasing both of forward speed and reel speeds. Also, it was increased with decreasing crop moisture content as shown in Table 2. Whereas, header and total harvesting losses were increased from 4.6 to 11.9%(+158.7%) and from 6.3 to 16.5%(+161.9%) with increasing forward speed from 1.92 to 3.11km/h and reel speed from 0.94 to 1.30m/s and decreasing crop moisture content from 18 to 12%.

Table 2: Rate of header and total losses before modification.

MC, %	Reel speed, m/s	Rate of header losses before modification, %				Rate of total losses before modification, %			
		Forward speed, km/h				Forward speed, km/h			
		1.92	2.25	2.41	3.11	1.92	2.25	2.41	3.11
18	0.94	4.6	5.9	6.4	7.0	6.3	7.9	8.7	9.5
	1.06	6.0	7.1	7.5	8.0	7.8	9.5	10.3	10.8
	1.30	6.5	7.5	8.0	8.6	8.5	9.9	10.8	11.5
15	0.94	6.1	6.5	7.0	7.4	8.1	8.9	9.7	10.4
	1.06	6.7	6.9	7.5	8.5	9.0	9.6	10.5	11.4
	1.30	7.5	7.9	8.5	9.1	10.1	10.9	11.6	12.4
12	0.94	8.3	8.8	9.0	9.6	10.8	11.6	12.5	13.7
	1.06	9.4	9.9	10.3	10.7	11.9	12.6	13.5	14.8
	1.30	10.5	10.9	11.4	11.9	12.7	13.9	15.7	16.5

b) Combine performance after header modification: productivity:

Fig 3 shows the effect of forward speed, reel speed and crop moisture content on combine harvester productivity, it is clear that, the combine productivity was decreased with increasing both of forward speed and reel speed. It was decreased also with decreasing crop moisture content this was due to the high proportion of grain losses has increased with forward speed and increase the speed of reel and also the high proportion of loss at low moisture content. Whereas, increasing forward speed from 1.92 to 3.11 km/h at reel speed of 0.94 m/s and crop moisture content of 18% , productivity decreased from 1.735 to 1.683 ton/fed. Increasing reel speed from 0.94 to 1.30 m/s at forward speed of 1.92 km/h and crop moisture content of 18%, productivity decreased from 1.735 to 1.713 ton/fed . Meanwhile, decreasing crop moisture content from 18% to 12%, at forward speed of 1.92 km/h and reel speed of 0.94 m/s, productivity decreased from 1.735 to 1.631. And, since the increase the forward speed of the combine or the increase in reel speed and also down the moisture content of the crop, increases the amount of seed lost during harvest and as a result less overall productivity of feddan.

Harvesting losses:

As shown in Figs. 4 and 5, it is clear that the average of header losses and total losses increased gradually when forward speed increased at all reel speeds and crop moisture content levels. Therefore, header losses increased from 1.6 to 3.0% and total losses increased from 3.1 to 4.9% by increasing forward speed from 1.92 to 3.11km/h with reel speed of 0.94m/s and crop moisture content of 18%. Also, increasing reel speed tends to increase both of header losses and total losses at all forward speed under difference moisture content levels. So, increasing reel speed from 0.94 to 1.30m/s at forward speed of 1.92km/h and crop moisture content of 18%, header losses increased from 1.6 to 2.2% and total losses increased from 3.1 to 4.2%. On the other hand, decreasing moisture content tends to increase header losses and total losses at all forward speeds and reel speeds. When moisture content decreased from 18 to 12%, with forward speed of 1.92km/h and reel speed of 0.94m/s, header losses increased from 1.6 to 2.7% and total losses increased from 3.1 to 4.7%. From the results it became clear that the impact of forward speed of the most influential factor was the loss rate, chest, due to a collision aspects of crop and placidly machine parts and also due to the collision with the rig assembly of the crop. Also it was found that the amendment to the header leading to decrease header loss rate, maximum 11.9% of the issued prior to the amendment to 4.6% after the modification (- 61.3%), and low total loss rate, the maximum total machine from 16.5% before the amendment to 7.3% after the amendment (- 55.7%).

Threshing damage:

Laboratory studies on the grain resulting from the harvest at different levels of experience showed that the percentage of damaged grains as in the form of Fig. 5 was inversely proportional to the increase of the forward speed, reel speed and crop moisture content. From the results it is clear to us that forward speed is the most influential factor on the percentage of damage in the crop as they select the feed rate of the combine . Minimum amount of threshing damage was 1.3% recorded with forward speed of 0.94m/s and crop moisture content of 18%. While, maximum amount of threshing damage was 4.1% recorded with forward speed of 3.11km/h, reel speed of 1.30m/s and crop moisture content of 12%.

Power consumption and energy requirements:

Fig. 6 illustrates the effect of forward speed, reel speed and crop moisture content on and power consumption. They were directly proportional with forward and reel speeds, meanwhile they had inversely proportional with crop moisture content. The maximum amount of power consumption was 107.4kW recorded with forward speed of 3.11km/h, reel speed of 1.30m/s and crop moisture content of 18%. However, the minimum amount of power consumption was 67.4kW recorded with forward speed of 1.92km/h, reel speed of 0.94m/s and crop moisture content of 12%. On the other hand, data in Fig. 7 shows that the energy requirements decreased with increasing either forward speed or reel speed and with decreasing crop moisture content.

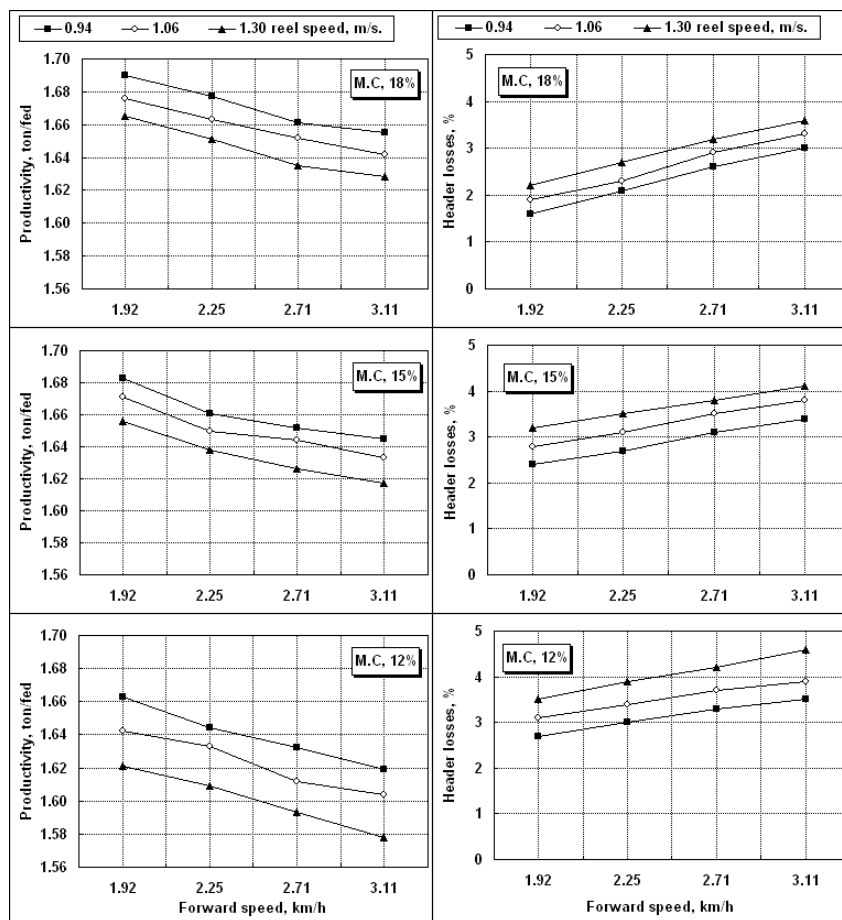


Fig. 3: Relationship between forward speed and productivity at different reel speeds and crop moisture contents.

Fig. 4: Relationship between forward speed and header losses at different reel speeds and crop moisture contents.

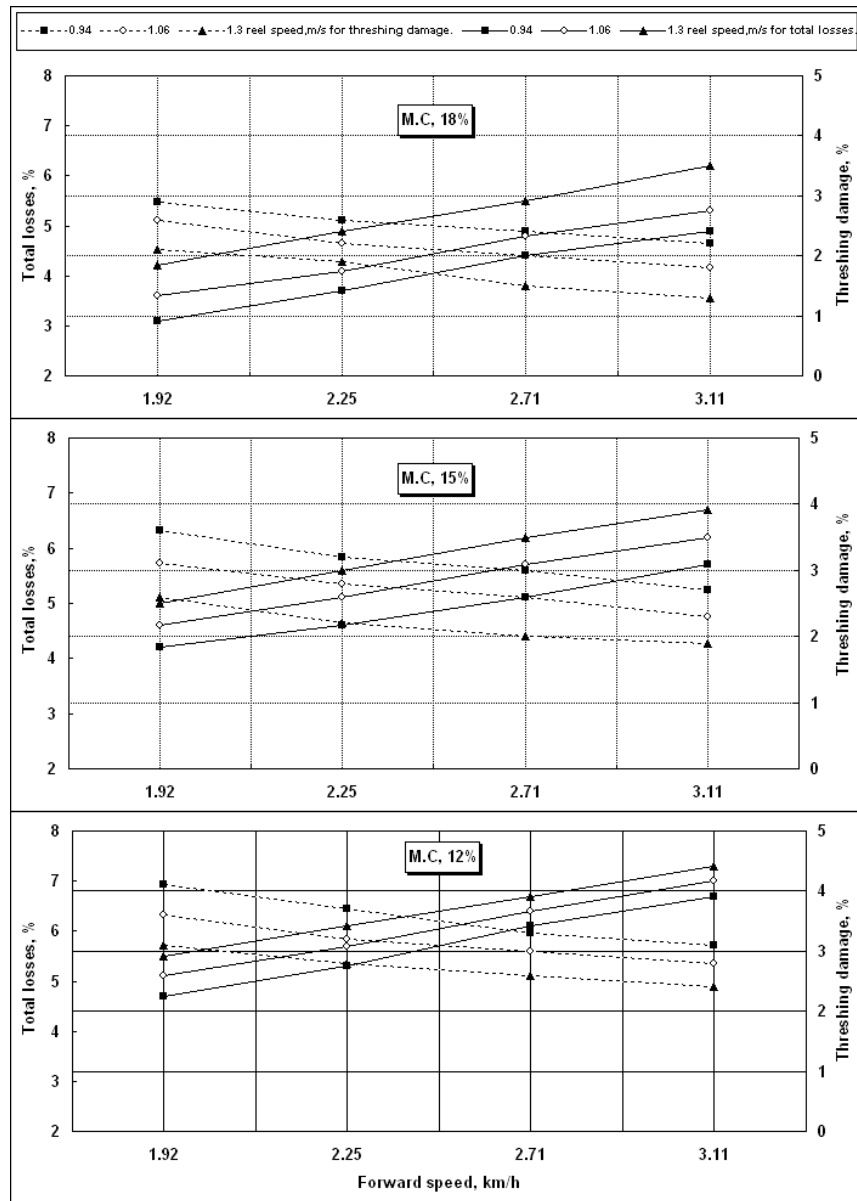


Fig. 5: Relationship between forward speed and total losses with threshing damage at different reel speeds and crop moisture contents.

Moreover, the maximum amount of energy requirements was 75.63kW.h/fed recorded with forward speed of 1.92km/h, reel speed of 0.94m/s and crop moisture content of 18%. Meanwhile, the minimum amount of energy requirements was 31.45kW.h/fed recorded with forward speed of 3.11km/h, reel speed of 1.30m/s and crop moisture content of 12%. This may be due to increasing both forward and reel speeds, lead to increase the feeding rate of the machine, which otherwise requires much more power, while at low moisture content of the crop yield, the crop are easily passed through the machine which requires less quantity of power consumption.

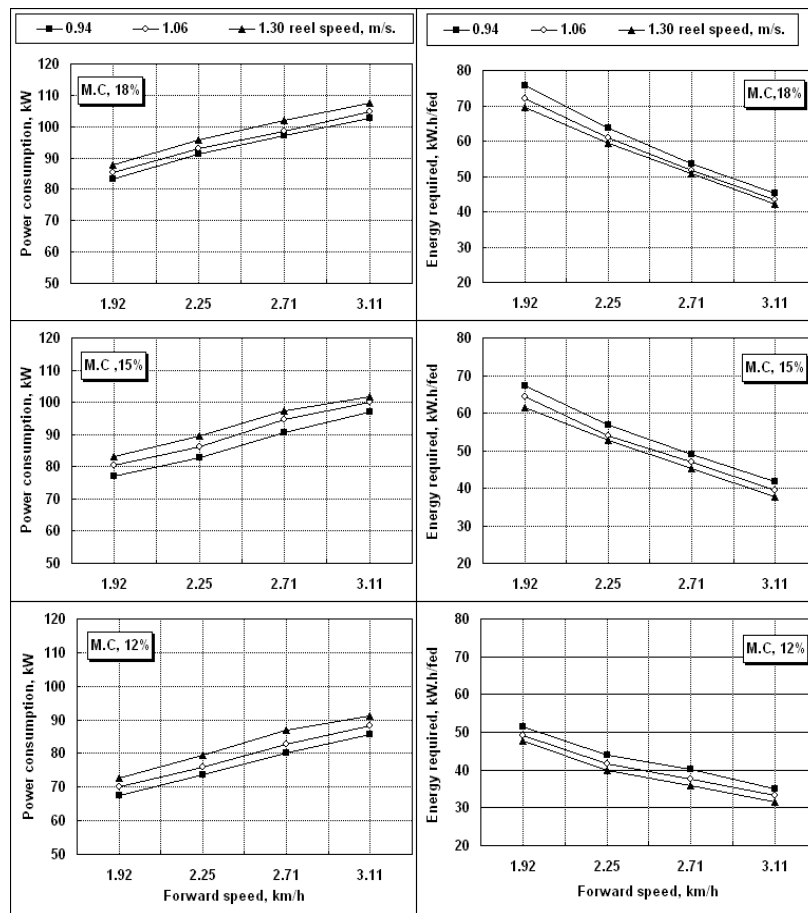


Fig. 6: Relationship between forward speed and power consumption at different reel speeds and crop moisture contents.

Fig. 7: Relationship between forward speed and energy required at different reel speeds and crop moisture contents.

Operation and criterion function cost:

Data in Fig. 8 explain that, operation cost was decreased with increasing both combine forward and reel speed. While, it was decreased with decreasing crop moisture content. whereas, increasing forward speed from 1.92 to 3.11km/h, at reel speed of 0.94m/s and crop moisture content of 18%, decreased operation cost from 125.8 to 104.2LE/fed (-17.2%). Increasing reel speed from 0.94 to 1.30m/s at forward speed of 1.92km/h, and crop moisture content of 18% , operation cost increased from 125.8 to 137.4LE/fed (+8.4%). Whilst, the decrease of crop moisture content from 18 to 12%, at forward speed of 1.92km/h and reel speed of 0.94m/s, operation cost decreased from 125.8 to 114.2LE/fed (-9.2%). From the above it is clear that , forward speed has been more influential factor on the costs of operating . On the other hand, Fig. 9 illustrates the effect of combine forward and reel speed and crop moisture content on criterion function cost, where, it was increased by increasing of forward and reel speed. Also, it was increased by decreasing crop moisture content. Whereas, it was increased from 375.7 to 477.7LE/fed (+27.15%) by increasing forward speed from 1.92 to 3.11km/h with reel speed of 0.94m/s and crop moisture content of 18%. Also, at forward speed of 1.92km/h and crop moisture content of 18%, by increasing reel speed from 0.94 to 1.30m/s, criterion function cost increased from 375.7 to 456LE/fed(+ 21.37%). While, at forward speed of 1.92km/h and reel speed of 0.94m/s decreasing crop moisture content from 18 to 12% criterion function cost increased from 375.7 to 466.4LE/fed (-24.14). From the above it is clear that the combine forward speeds were more influential factor on criterion function cost as it was the most influential factor on the rate of loss after the impact of any of moisture content of the crop and reel speed. Minimum amount of operation cost was 96.8LE/fed recorded with forward speed of 3.11km/h, reel speed of 1.30m/s and crop moisture content of 12%, while, minimum amount of criterion function cost was 375.7LE/fed recorded with forward speed of 1.92km/h, reel speed of 0.94m/s and crop moisture content of 18%, And where the criterion function cost is the ultimate indicator of the operation costs and the value of the lost quantity of the crop, the operating mode, which gives the lowest value for the criterion function cost is the optimal situation to operate. Therefore, the development of the former is less a criterion function cost is the optimal situation to run.

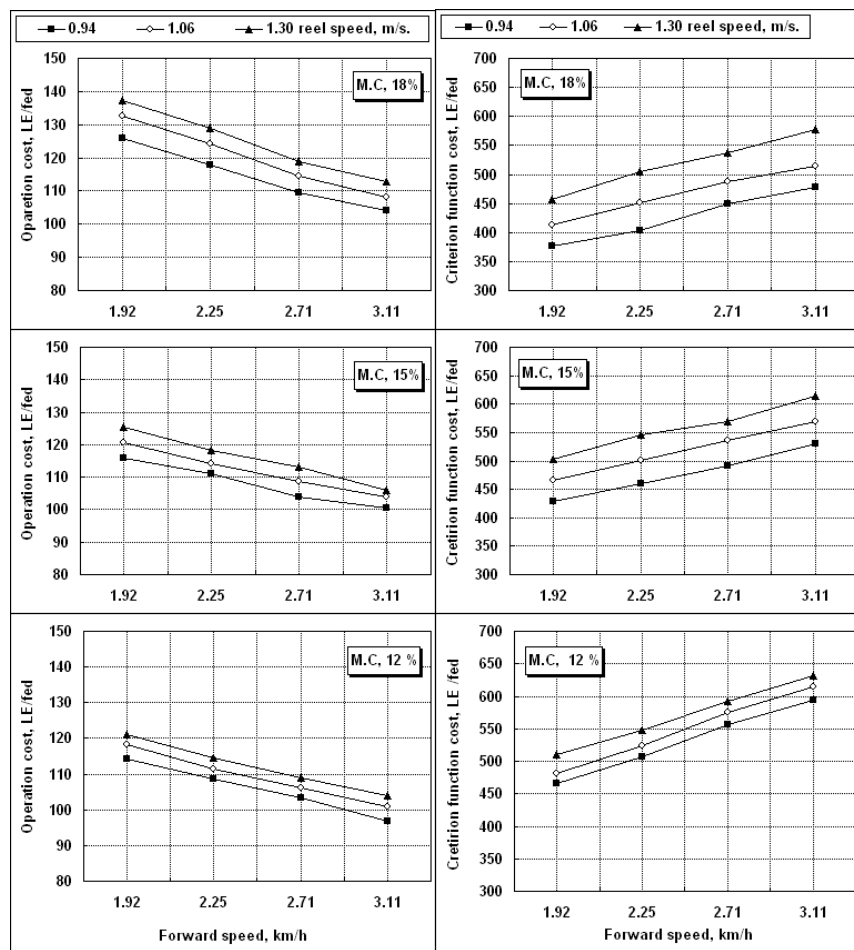


Fig. 8: Relationship between forward speeds and operation cost at different reel speeds and crop moisture contents.

Fig. 9: Relationship between forward speeds and criterion function cost at different reel speeds and crop moisture contents.

Conclusion:

From preliminary trial on combine before modification it can be concluded that header losses ranged from 4.6 to 11.9% also total harvesting losses ranged from 6.3 to 16.5% during experiment levels. while, combine performance after header modification were:

- 1) Combine produced maximum productivity of 1.735ton/fed by using forward speed of 1.92km/h, reel speed of 0.94m/s and crop moisture content of 18%.
- 2) Header and total losses increased with increasing combine forward speed at all levels of reel speed and crop moisture content.

- 3) Minimum amount of threshing damage was 1.3% recorded with forward speed of 3.11km/h, reel speed of 1.30m/s at crop moisture content of 18%.
- 4) Minimum amount of power consumption was 67.4kW respectively, recorded with forward speed of 1.92km/h, reel speed of 0.94m/s and crop moisture content of 12%.
- 5) Minimum amount of energy requirement was 31.45kW.h/fed recorded with forward speed of 3.11km/h, reel speed of 1.3m/s and crop moisture content of 12%.
- 6) At the optimum operation conditions , the minimum value of criterion function cost was 375.7LE/fed.

REFERENCES

- Abd El-Motaleb, I. A.; M. M. Ibrahim and I. S. Yousef (1999). A study on harvesting of soybean and sunflower crops. *Misr J. Ag. Eng.*, 16(2):337-351.
- Agricultural statistics (2009). Area, yield and production of summer soybeans crop. Ministry of Agriculture, Cairo, Egypt, 110.
- Awady, M. N. (1978). Engineering of tractors and agricultural machinery. In Arabic text. Col. of Ag., Ain Shams Univ., 164-167.
- Ayres, G. E. (2006). Profitable soybean harvesting. <http://www.extension.iastate.edu>.
- Beasley, E. O. (2007). Reduce soybean harvest losses. <http://www.lpm.ncsu.edu/soybeans>.
- Berglund, D. R. and T. C. Helms (2003). Soybean production. <http://www.ag.ndsu>.
- Charles W. S.; L. Ellis and W. Hires (1993). Measuring and reducing soybean harvesting losses. <http://www.extension.missouri.edu/publications>.
- Gomaa, S. M.; R. R. Abou-Shieshaa; F. I. Hindy and M. A. Hassan (2009). A study on harvesting mechanization of soybean. *J. Ag. Sci. Mansoura Univ.*, 34(3): 2381-2395.
- James H. Herbek and Morris J. Bitzer (1997). Soybean production in Kentucky Part V: Harvesting, Drying, Storage, and Marketing. The University of Kentucky Cooperative Extension Service. Part five of a five-part series. AGR 132.
- Jiang, J. L.; Thseng F. S. and Yeh M. S. (1991). Studies on the pod shattering in soybean. *J. of the Ag. Association of China new series*. 56: 15-23.
- Philbrook, B. D. And E. S. Oplinger (1989). Soybean field losses as Influenced by harvest delays. *Agrono. J.*, 81(2): 251-258.
- Schnug, B. and J. Beuerlein. (1987). Harvesting, drying, handling, and storage. pp. 96-100 In J. Beuerlein (Ed.). *The soybean in Ohio*. Ohio Coop. Ext. Serv. The Ohio State Univ. Ext. Bull., 741.
- Siemens, M. (2002). Effects of header modifications on garbanzo bean harvesting losses. [http:// www.ars.usda.gov](http://www.ars.usda.gov).

Subadh kulkarni (2008). Importance of minimizing field losses during soybean harvest. Ph. D. Program Associate Machinery. University of Arkansas, United States Dep. of Ag., and County Governments Cooperating. <http://www.uaex.edu>.

نشرة وزارة الزراعة (٢٠٠٣). خدمة وزراعة محصول فول الصويا في الأراضي القديمة والجديدة، البرنامج القومي للمحاصيل البقولية، مركز البحوث الزراعية.

تعديل وتقييم صدر آلة جامعة لتناسب حصاد محصول فول الصويا عاطف عزت اليماني ، رفاعي أبو شعيشع و محمد عبد الحميد بسيوني معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية - الجيزة – مصر

يعتبر محصول فول الصويا من أهم المحاصيل الغذائية والصناعية الهامة على المستوى العالمي نظرا لاحتواء بذوره على زيت خالي من الكولسترول وحوالي ٤٠% بروتين ذو قيمة غذائية تقارب قيمة البروتين الحيواني (نشرة وزارة الزراعة، ٢٠٠٣). وتعاني مصر من نقص إنتاج زيت الطعام منذ فترة طويلة حيث تنتج سنويا ٢٥% من اجمالي الاستهلاك المحلي 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. ومحصول الفول الصويا يكون ذات طبيعة خاصة عند حصاده ميكانيكيا حيث تزداد نسبة الفاقد نتيجة لتكسير سيقانه وقرونه بسهولة ومن خلال الدراسات السابقة فان نسبة الفاقد تصل إلى حوالي ٢٥% ويكون الجزء الأكبر منها راجع إلى فاقد صدر الآلة لذلك فأنه يكون في حاجة إلى تطوير خاص ليناسب حصاد الفول الصويا. لذا كان الهدف من الدراسة هو تصنيع وتطوير مقدمة صدر الكومباين ليناسب حصاد الفول الصويا بغرض تقليل نسبة الفاقد قدر الإمكان وزيادة كفاءة الآلة. وكانت أهم النتائج المتحصل عليها هي انخفاض الفاقد الكلي للآلة وفاقد الصدر بعد التعديل بنسبة ٢٨% ، ٣٨,٧% على الترتيب عنده قبل التعديل. وتلف الدارس كان يتراوح بين ٤,١% ، ١,٣% خلال حدود التجربة. اقل طاقة مستهلكة كانت ٤٥, ٣١ كيلو وات. ساعة/فدان وأيضا فان اقل تكاليف عند الظروف المثلي للتشغيل كانت ٩٦.٨١ جنيه/فدان بينما اقل دالة معيارية للآلة كانت ٣٧٥.٧ جنيه/فدان.

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