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DEVELOPMENT AND EVALUATION OF SMALL REAPER TO SUIT PULLING FLAX CROP .

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ABSTRACT

Field experiments were carried out to evaluate a new developed reaper(Japanese harvesting reaper model KUBOUTA - AR 120) on pulling flax crop. The effect of four pulling rollers speeds of 0.39 , 0.52 , 0.65 ,and 0.78 m/s , three machine forward speeds of 1.2 , 1.5 , and 1.8 km/h ,and three stalk moisture contents of 17.30 , 14.81, and 11.56 % . On actual field capacity, field efficiency, yield output, stalk damage and total stalk losses were undertaken. And also, an estimation of energy requirements and operating cost were determined. Results indicated that, the maximum value of actual field capacity, field efficiency and stalk yield output were 0.53 fed./h, 93% and 2.656 ton/h , respectively at pulling speed of 0.78 m/s , machine forward speed of 1.8 km/h and stalk moisture content of 11.56 %. However the lowest value of energy requirement of 1.97 kW.h/ton was recorded under the same mentioned above conditions. Meanwhile, the minimum values of stalk damage and stalk losses were 1.41% and 0.62 % , respectively at machine forward speed of 1.2 km/h , pulling speed of 0.78 m/s and stalk moisture content of 17.30 % .

INTRODUCTION

Flax crop is regarded as strategically crop in Egypt, where, it is considered as a double advantage (oil and fiber). The total cultivated area is *20820* fed./ year with an annual production of *0.721* ton/fed. for seeds (equal *15031* ton/year) and *4.422* ton/fed. for stalks (equal *92072* ton/ year) (Agricultural Statistics, 2007). On the other hand, Egyptian farmers still harvested flax crop manually by hand pulling (conventional system) especially in small holdings, consuming time ,more cost and moreover high percentage of both seed and stalk losses. So, using mechanical machine in pulling flax will be the best method. The present study is intend to manufacture a newly development machine for pulling flax stalks depends upon drag and draw using part of reflected motion pulleys. Many investigators were carried out to evaluate the parameters affecting on flax pulling such as: *kanafojski (1976)* reported that the length of flax stalks containing the most valuable part of plant-fiber is relatively small. Flax harvesting by mowing increased the percentage of fiber losses. In order to avoid such losses, flax is harvested by pulling stalks out of the soil together with the roots. This is permitted by the considerable tenacity of the lower plant section which is four times higher than the required to pull the root out of the soil. *Ibrahim (1983)* found that the rupturing (cutting) force at the lowest third portion of flax stalk equal to five times the pulling force. *Hamam (1991)* modified machine for pulling flax crop, he indicated that, machine forward speed and puller belt speed had a highly significant effect on pulling efficiency, capsule losses and stalk damage. Where, pulling efficiency decreases as increasing forward speed and belt speed, while, capsule losses increases as increasing forward speed and belt speed, and stalk damage percentage decrease while increasing belt speed and reducing forward speed. He added too that, the maximum pulling efficiency of 95.667% was obtained using the speed ratio of 3.16 at 40 kg/fed. seeding rate (Broad casting method) and pull inclination angle equal to 0.2617 red (15°deg.) While the minimum pulling efficiency of 91.87% was obtained using the speed ratio of 4.01 at 50 kg/fed. Seeding rate (drilling method) and pull inclination angle 0.2617 red (15° deg.).*Hamed et al*. *(1991)* develop a pulling device suitable for flax crop. He reported that, the optimum values of forward speed , puller belt speed and puller inclination angle were 0.7 m/s ,2m/s and 0.2617 red(15°deg.), respectively. Comparison between manual and developed machine showed that manual harvesting of flax costs of a bout 3.21 times that mechanical harvesting*. abou - shieshaa et al.(1998)* carried out a study at flax pulling to evaluate the effect of moisture content(for capsule , stalk and soil), machine forward and roller speeds on field capacity and efficiency . they noticed that, increasing forward speed from 1.52 to 3.54 km/h tends to increase the effective field capacity from 0.367 to 0.576 fed/h. while , the field efficiency decreased from 84.56 to 56.68%. Also, they mentioned that, there is no need to increase the forward and roller speeds, more than 2.73 km/h and 940 r.p.m. where, they led to decrease the pulling efficiency. However, there is a direct proportion with soil moisture content and lifting efficiency. *Habib et al. (2002)* reported that the cutting energy consumed in harvesting process is much lower than the energy consumed in crushing process due to effect of moisture content. *Srivastava et al. (1994)* indicated that the machinery costs include costs of ownership and operation, ownership costs included depreciation of machine, interest on investment and cost of taxes, insurance, and housing of the machine .operating cost are costs associated with use of a machine including the cost of labor, fuel, oil and repair and maintenance. *Mostafa et al. (1999)* reported that harvesting cost for one feddan equal 110 L.E/fed. at using the modified rotor. While, it was equal 190 L.E/fed. at using original rotor. They warranted the cost reduction with using the modified rotor could be attributed to height actual field capacity, decreasing specific fuel consumption and decreasing machine losses .

MATERIALS AND METHODS

Field experiments were carried out at sakha agricultural research station during the growing season of 2007 to examine new development reaper to suit pulling flax crop (variety of sakha 3). Studying the effect of engineering parameters of machine on flax stalks, to estimate the optimum conditions for operation, also, to estimate energy requirements and operating cost essential for operation.

Harvesting reaper before development:

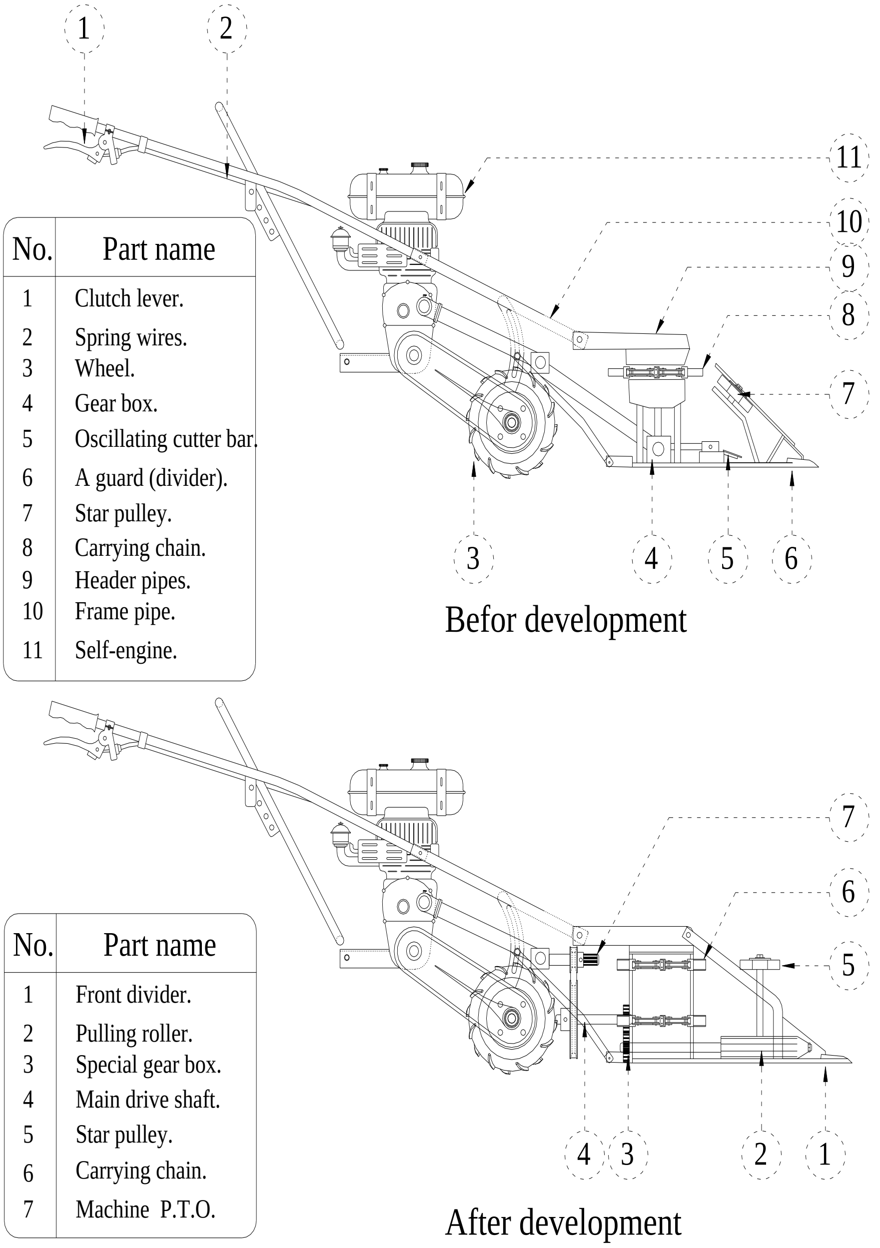
Japanese harvesting reaper model (KUBOUTA - AR 120) was used in this study. The general specifications are presented in Table 1 and components parts are shown in Fig.1,it consists of : frame pipe , wheels , self-engine , oscillating cutter bar , star wheels , carrying chain , gear belts , clutch lever , spring wires , header pipes and a guard .

Harvesting reaper after development:

In many Egyptian farms, the majority of flax producers up till now are still used manually harvesting method with flax crop (by hands only).This consumed more time, labor and then more cost requirements and subsequently affected the field production for the next crop. Using harvesting reaper may solve these problems, which harvest the crop with lower time and labor require . But from the defects of this method is the machine can be leaved great parts from plants stalk on the field surface. Wherever, this amount of stalk consider as a losses, that is to say equal financial losses for farmers. So, the present work aims to modify and improve some parts of the harvesting reaper to suit pulling flax crop and evaluate the machine performance under different operation conditions to decrease stalk losses and cost require for operation. Also, to increase their working performance and yield output.

The general modification parts carried out on the developed machine are presented in Table 1 and sketched in Figs 1 and 2. They were consisting of the following parts:

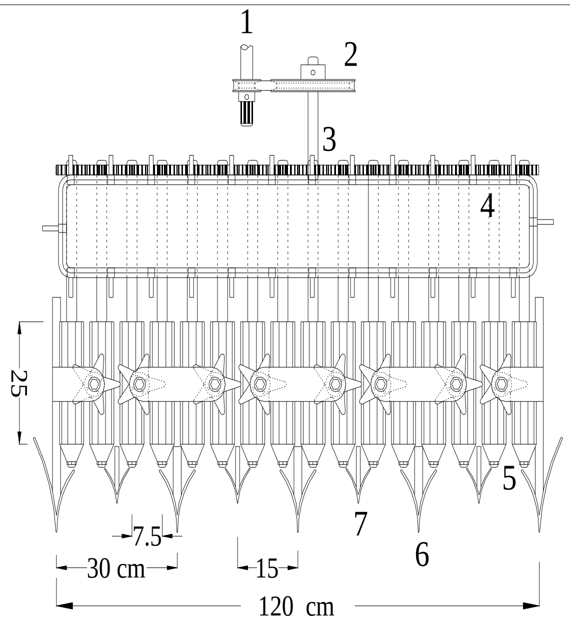
1- Modify main front dividers and lateral dividers to suit spaces between flax cultivate raw, by decreasing its volume and uniformity distribution.
2- Constitution internal secondary dividers distribute between every couple from main front dividers in order to systematize entering of stalks over pulling units.
3- Replacement the oscillating cutter bar by eight of pulling units, where, these units were distributed similarity over machine width operation. Every pulling unit consists of pair of horizontal rollers reversed motion in order to pull and draw the stalks as shown in Fig . 2.
4- Replacement all of inclined star pulley (before development) by pair of horizontal star pulleys to serve place between two of main dividers as shown in Fig. 4 -a.
5- Move transport from engine main drive shaft to pulling units with pulley and belt and group of overlap from gears used for move distribution on all pulling units as shown in Fig. 3.
6- Move transport to star pulleys groups by using special gear box.



No.	Part name
1	Clutch lever.
2	Spring wires.
3	Wheel.
4	Gear box.
5	Oscillating cutter bar.
6	A guard (divider).
7	Star pulley.
8	Carrying chain.
9	Header pipes.
10	Frame pipe.
11	Self-engine.

No.	Part name
1	Front divider.
2	Pulling roller.
3	Special gear box.
4	Main drive shaft.
5	Star pulley.
6	Carrying chain.
7	Machine P.T.O.

Fig. 1 : Elevation view of the experimental reaper before and after development.



No.	Part name
1	Machine P.T.O..
2	Pulley and belt.
3	Special gear box.
4	Shaft.
5	Pulling roller.
6	Front divider.
7	Lateral divider.

Fig. 2 : Header plan view of the experimental developed reaper.

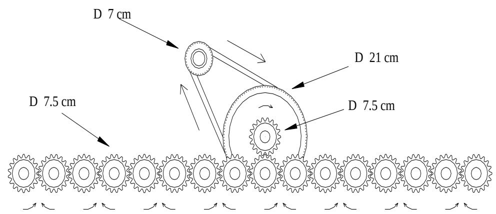
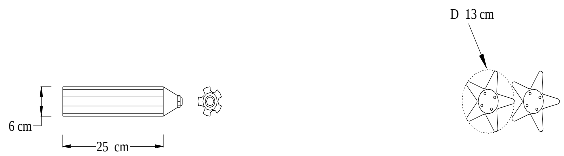


Fig. 3 : Special gear boxused in operating pulling pulleys.



a) pulling roller. b) star pulley

Fig. 4 : side view and elevation of pulling roller and star pulley.

Table 1: Description of harvesting reaper before and after development.

No.	Item	Harvesting reaper before development	Harvesting reaper after development
1	Overall length, m	2.39	2.39
2	Overall width, m	1.47	1.47
3	Overall height, m	0.90	0.90
4	Weight, kg	116	125
5	Working capacity, h/fed.	2.25 – 2.75	2.25 – 2.75
6	Direction of crop released	Right side of machine (viewed from rear)	Right side of machine (viewed from rear)
7	Fuel engine type	gasoline	gasoline
8	Fuel tank volume	3.0 liter	3.0 liter
9	Cutting device	Reciprocating knife bar	Pairs of reflex pulling rollers
10	Cutting height, cm	10 – 30	0 – 3
11	Cutting width, m	1.20	1.20
12	Upper delivery device	Revolving chain with lug plates	Revolving chain with lug plates
13	Lower delivery device	Revolving chain	Revolving chain
14	Total stalk damage,%	2.13 – 7.73	1.41 – 5.61
15	Total stalk losses ,%	12 – 22.9	0.62 – 2.11

Investigated variables:

The experimental studies were achieved to determine the effect of three different variables were as follow:

1- Pulling rollers speed: four pulling rollers speed were used in this study, namely: 0.39 m/s (150rpm), 0.52 m/s (200rpm), 0.65m/s (250rpm), and 0.78m/s (300rpm).

2-Machine forward speed: three forward speeds of 1.2 km/h, 1.5 km/h, and 1.8 km/h were used in the present study.

3- Stalks moisture content: experiments were carried out at three different levels of moisture content, namely: 17.30 %, 14.81 % and 11.56 %. Its were determined with using the oven method according to *(Ashrae, 1999)* the following formula was used for determination:

$$\text{Moisture content} = \frac{M1 - M2}{M2} \times 100 \quad , \quad \% \qquad ....(1)$$

Where: M1 = moist mass, g ; and

M2 = dry mass, g.

Experimental procedure:

At first , experimental field divided into equal three parts of area and stalks were pulled for each alone part on three different times in order to obtain three various stalk moisture contents ,three various machine forward speeds and four pulling rollers speed were undertaken during the experiments, the digital tachometer was used for measuring speeds. Also, fuel consumption was determined by using the graduated glass tumbler then energy consumption was calculated. Over and above a stopwatch was used for accounted time consumed to estimate the machine output. Eventually, after every experiment we had be estimated damage and losses.

Physical properties of flax :

Table 2 presented average of physical properties and characteristics for flax crop (sakha3 variety) was used in this experimentation.

Table 2 : physical properties of flax crop (sakha 3 variety)

physical properties	Min. value	Max. value	Mean value
Total plant height,cm	94	134	114
Technical length,cm	90.8	107	98.9
Length of flowering zone,cm	12.6	18.2	15.4
Stalk diameter,mm	0.99	3.11	2.05
Number of capsules /plant	5	13	9
Number of seed /plant	59	91	75
Mass of 1000seed,g	3.736	6.31	5.023
Seed yield/plant	0.223	0.501	0.362

Measurements:

1- Actual field capacity: the actual pulling time was the actual average time consumed during pulling operation (lost time + pulling time). The actual field capacity can be determined from the following equation:

$$FC\ act = \frac{60}{T\ u + Ti} \quad ,fed./h \ldots\ldots\ldots\ldots(2)$$

Where:

FC act = actual field capacity of the pulling machine;

T u = utilization time per feddan in minutes; and

Ti = sum. of lost time per feddan in minutes.

2- Field efficiency: it was calculated by using the values of the theoretical field capacity and actual field capacity rates as follows:

$$\eta f = \frac{FC\ act}{FC\ th} \times 100 \quad , \% \ldots\ldots\ldots\ldots(3)$$

Where:

ηf = field efficiency, %

FC act = actual field capacity, fed./h ;and

FC th = theoretical field capacity, fed./h, as,

$$FC\ th = \frac{S\ X\ W}{4.2} \quad ,fed./h \ldots\ldots\ldots\ldots(4)$$

Where:

S = the operating speed, km/h; and

W = the operating width, m.

3- Yield output: yield output was estimated for all treatments under test by measuring the time used in operation and mass of output stalks.

4- Stalk damage: stalk damage were calculated according to the following formula:

M sd

$$\text{Stalk damage} = \frac{M\,sd}{M\,d} \times 100 \quad ,\%............(5)$$

Where,

M sd = mass of stalk damage in yield output during pulling process, g; and

M d = total mass of stalks rather than capsules, g.

5- Total stalk losses: stalk losses were calculated as follow :

$$\text{Stalk losses} = \frac{M\,sl}{M\,d} \times 100 \quad ,\%...................(6)$$

Where,

M sl = mass of split portion of stalk losses in ground after pulling operation, g.

6- Energy requirements: estimation of the required power was calculated using the following formula (**Hunt, 1984)**:

Pr = [FC (1/3600) ρE X L.C.V.X 427 X ηthb Xηm X 1/75 X1/1.36], kW……(7)

Where:

FC = the fuel consumption, l/h;

ρE = the density of fuel, kg/l (for gasoline = 0.72);

L.C.V= the lower calorific value of fuel, 11000k.cal/kg;

ηThb = thermal efficiency of the engine, (for Otto engine = 25%);

427 = thermo- mechanical equivalent, kg.m/k.cal ;and

ηm = mechanical efficiency of the engine (for Otto engine = 85%).

Hence, the energy requirements can be calculated as follows:

$$\text{Energy requirements} = \frac{\text{Power required kw)}}{\text{Yield output (ton/h)}} , \quad \text{kW.h/ton……..(8)}$$

7-Total cost requirements: The total cost need for operation was estimated by the following formula **(Awady et al.1982**):

$$\textbf{Operating cost} = \frac{\text{Machine cost ,L.E/h}}{\text{Yield output , ton/h}} , \quad \text{L.E/ton……….(9)}$$

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

C= p/h (1/a + i/2 + t + r) + (0.9 w.s.f) + m/144…………………………..(10)

Where:

c	=	hourly cost , L.E/h.	0.9	=	factor accounting for lubrication
p	=	price of machine , L.E.	w	=	engine power,hp
a	=	life expectancy of the machine ,h.	s	=	specific fuel consumption, l/hp.h.
h	=	yearly working hours, h/year.	144	=	reasonable estimation of monthly working hours.
i	=	interest rate/year.	m	=	monthly average wage ,L.E.
t	=	taxes ratio	f	=	fuel price , L.E/l
r	=	repairs and maintenance ratio			

Also, criterion function cost, L.E/ton= operating cost, L.E/ton + losses cost, L.E/ton…..(11)

RESULTS AND DISCUSSION

I- Primordial test:

Primary experiment was carried out during harvesting season 2007, to determine stalks losses and stalks damage with harvesting flax crop by KUBOUTA AR-120 harvester which used oscillating cutter bar. The effect of cutter bar speed, forward speed and stalks moisture content on stalks losses and damage were determined. Results show also that, rate of losses and damage were very high because this machine (used oscillating cutter bar) having great cutting height ranged from 10 to 30 cm above ground surface. Whereas, the medium of length is 90 cm, so about from 11 to 33 % from stump leaved in the ground, in addition to losses caused by machine operation. The maximum rate of stalks losses was 22.9% and maximum rate of stalks damage was 7.73 % recorded at cutting speed of 14.3 m./s ,forward speed of 1.8 km/h and stalks moisture content of 11.33%, respectively. So, using harvesting reaper before development was unsuitable for harvesting flax crop.

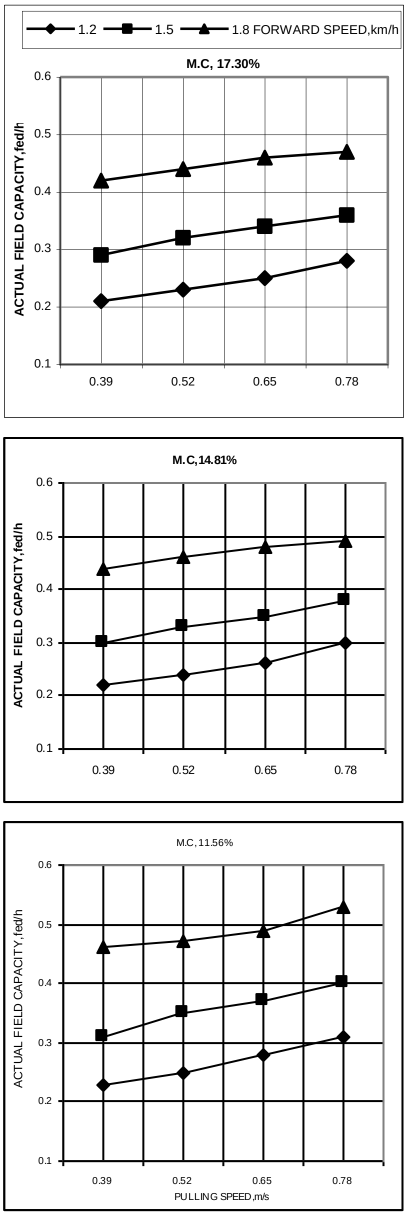
Π- Development reaper performance

1- Actual field capacity:

Data in Fig. 5 Shows the effect of pulling rollers speed and forward speed with different stalks moisture content on actual field capacity. The results indicated that actual field capacity was increased with increasing pulling rollers speed when the other variables were kept constant. At stalks moisture content of 17.3 %, d.b., and forward speed of 1.2 km/h, by increasing pulling rollers from0.39 to 0.78 m/s, actual field capacity was increased from0.21 to 0.28 fed./h (+33.33%).However at increase of forward speed from 1.2 to 1.8 km/h with constant pulling rollers speed at 0.39m/s and stalks moisture content at 17.3%, d.b., actual field capacity was increased from 0.21to 0.42 fed./h (+100%).On the other hand, decreasing stalks moisture content from 17.3 to 11.56%, d.b., under the same forward speed and pulling rollers, actual field capacity was increased from 0.21 to 0.23 fed./h(+9.52%) . This may be due to the ability of plants to leave the ground by the assistant of facility under rollers pulling influence. Whereas, the machine performance was improved with increasing both pulling roller speed and forward speed .Also, with decreasing stalks moisture contents.

2- Field efficiency:

Field efficiency is determined as a percentage between actual field capacity and theoretical field capacity. The theoretical field capacity at forward speed 1.2, 1.5, 1.8 km/h were equals 0.34, 0.43, and 0.57 fed./h, respectively. Data in Fig. 6 shows the effects of pulling rollers speed and forward speed with different stalks moisture contents on field efficiency.



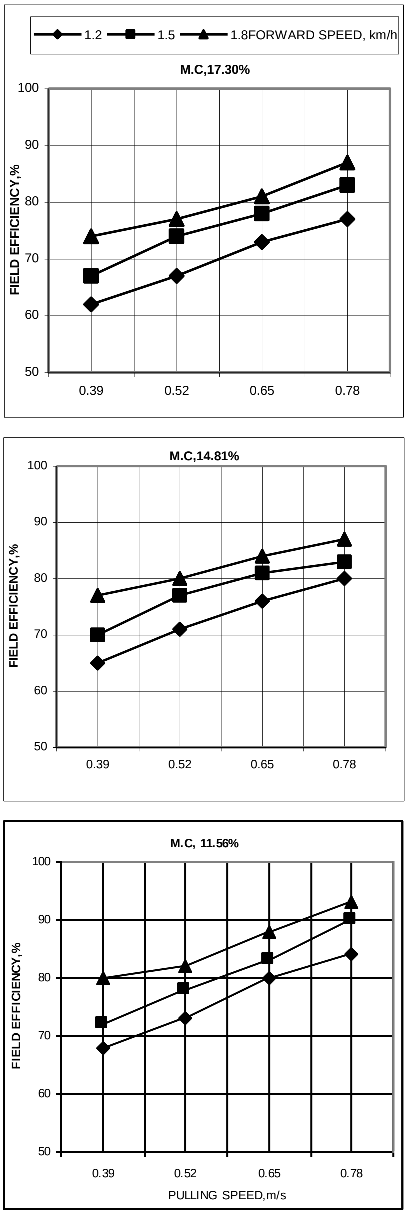


Fig 5: Effects of pulling speeds, forward speed and stalk moisture contents on actual field capacity, fed/h.	Fig 6 : Effects of pulling speeds, forward speed and stalk moisture contents on field efficiency,%

It is clear also that field efficiency was increased with increasing pulling rollers speed, forward speed and with decreasing stalks moisture content. Considering, increasing pulling rollers speed from 0.39 to 0.78m/s at constant forward speed of 1.2km/h and stalks moisture content at 17.3%,d.b., field efficiency was increased from 62 to 82% (+32%) ,and so on . Also, increasing the forward speed from1.2 to 1.8km/h with constant pulling rollers speed at 0.39m/s and stalks moisture content at 17.3%, d.b., field efficiency was increased from 62 to 74% (+19%). While, decreasing stalks moisture content from 17.3 to 11.56%, d.b., at constant pulling rollers speed at 0.39m/s and forward speed at 1.2 km/h field efficiency was increased from 62 to 68% (+9.6%) . Field efficiency was increased due to the increase of actual field capacity. Results showed also that pulling rollers speed was very most effective parameter in increasing field efficiency.

3- Yield output:

Data presented in Fig. 7 illustrated that, the yield out put was increased with increasing of pulling rollers speed, forward speed and with decreasing stalks moisture content. Where as , yield output was increased from 1.029 to 1.371 ton/h(+33.23%) by increasing pulling rollers speed from 0.39 to 0.78m/s at constant of forward speed of 1.2 km/h and stalks moisture content of 17.3%, d.b. Also, it was increased from 1.029 to 2.058 ton/h(+100%) by increasing forward speed from 1.2 to 1.8 km/h at constant pulling rollers speed of 0.39m/s and stalks moisture content of 17.3%,d.b. While, it was increased from 1.029 to 1.126 ton/h(+9.42%) by decreasing stalks moisture content from 17.3 to 11.56%,d.b., with constant of pulling rollers speed of 0.39m/s and forward speed of 1.2 km/h, respectively. Whereas increasing forward speed tends to increase the feed rate and subsequently increases the yield output. Also, pulling speed and decreasing stalks moisture content increases the yield output.

4- Stalks damage:

The obtained results showed in Fig. 8 indicated the relation between stalks damage and pulling rollers speed, forward speed and stalks moisture content. Results in Fig 8 shows that, increasing pulling rollers speed from 0.39 to 0.78 m/s at constancy forward speed of 1.2 km/h and stalks moisture content 17.3 %, d.b. stalks damage increased from 1.41 to 2.11% (+49.6%) .Also, increasing forward speed from 1.2 to 1.8 km/h at constancy pulling rollers speed of 0.39m/s and stalks moisture content of 17.3%, d.b., stalks damage increased from 1.41 to 3.61% (+156%). On the other hand, stalks damage was increased from 1.41 to 2.51% (+78%) by decreasing stalks moisture content from 17.3 to 11.56%, d.b., with constant pulling rollers speed of 0.39m/s and forward speed of 1.2 km/h. Generally, this increase of stalks damage was occurred because of excessive effective force on stalks due to the increase of pulling speed and forward speed and decreasing moisture content.

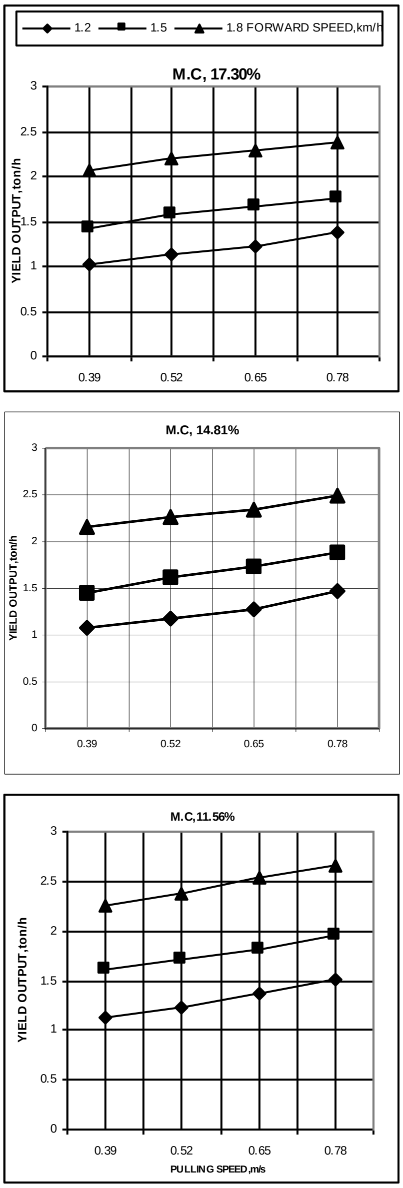


Fig 7: Effects of pulling speeds, forward speed and stalk moisture contents on yield output, ton/h.

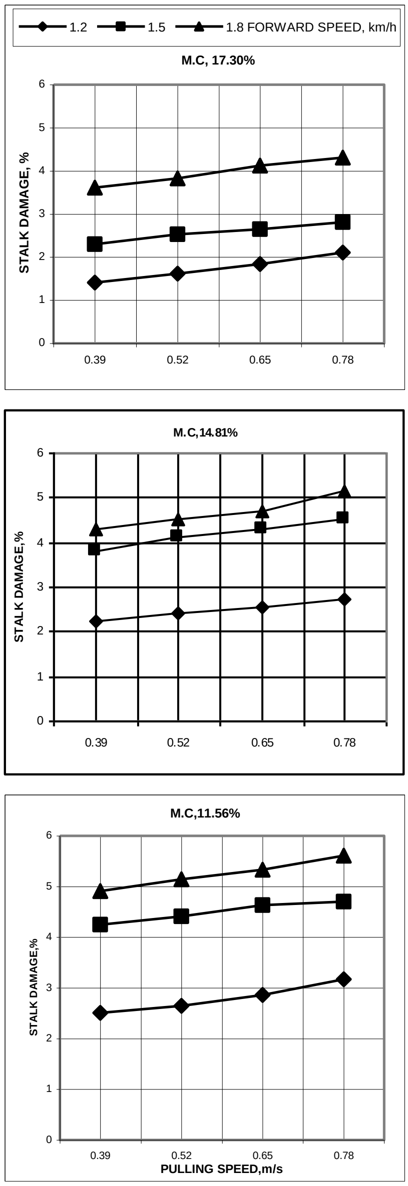


Fig 8: Effects of pulling speeds, forward speed and stalk moisture contents on stalk damage, %.

5- Total stalk losses:

Total stalk losses is considered the efficacious indication, which investigate the evaluation of the developed machine .Results in Fig. 9 show that, stalk losses were increased by increasing forward speed and decreasing stalks moisture content, meanwhile they were decreased with increasing pulling speed . Considering, by increasing forward speed from 1.2 to 1.8 km/h at constant pulling speed of 0.39 m/s and stalks moisture content of 17.30 %, d.b, total stalk losses increased from 1.08 to 1.33 % (+23%). also, by decreasing stalks moisture content from 17.30%to 11.56%, d.b, with constant pulling speed of 0.39m/s and forward speed of 1.2 km/h, total stalk losses increased from 1.08 to 1.61 % (+49%). Otherwise, increasing pulling speed from 0.39 to 0.78 m/s with constant forward speed of 1.2 km/h and stalks moisture content of 17.30%, d.b., total stalk losses decreased from 1.08 to 0.62 % (-42%). And so on with other experimental variables.

6- Energy requirement:

Data in Fig. 10 represented the effect of pulling speed, forward speed and stalk moisture contents on energy requirement. Values of energy requirement decreased with decreasing pulling speed, forward speed and with decreasing stalk moisture contents. For instance, increasing pulling speed from 0.39 to 0.78 m/s with constant forward speed of 1.2 km/h and stalk moisture content of 17.30%,d.b, energy required decreased from 4.85 to 4.37 kW.h/ton(-9.9%). Besides additional, increase in forward speed from 1.2 to 1.8 km/h with constant pulling speed of 0.39 m/s and stalk moisture content at 17.30%., d.b, energy required decreased from 4.85 to 2.85 kW.h /ton (- 41%).While, decreasing stalk moisture content from 17.30% to 11.56%, d.b, at constant pulling speed of 0.39 m/s and forward speed of 1.2 km/h, energy required decreased from 4.85 to 3.53 kW.h/ton (-27.2%). There were also indications that the lowest energy requirement was 1.97 kW.h/ton obtained with pulling speed of 0.78 m/s, forward speed of 1.8 km/h and stalks moisture content of 11.56%d.b. This as a result of increasing stresses inside the developed machine at increasing all of forward speed , pulling speed and stalk moisture content.

7- Operating cost and criterion function cost:

According to Fig.11 results indicated that, the increased of both pulling speed from 0.39 to 0.78 m/s and forward speed from 1.2 to 1.8 km/h tended to decrease operating cost, L.E/ton. Also, decreasing stalk moisture contents from 17.30 to 11.56%, d.b., led to decrease operating cost. The minimum operating cost was 9.79 L.E/ton recorded at pulling speed of 0.78m/s, forward speed 1.8 km/h and stalks moisture content of 11.56%, d.b., while the maximum operating cost was 25.28 L.E/ton recorded at pulling speed of 0.39m/s, forward speed of 1.2 km/h and stalk moisture content of 17.30%, d.b. Besides, Table 3 illustrated the variables influences on criterion function cost.

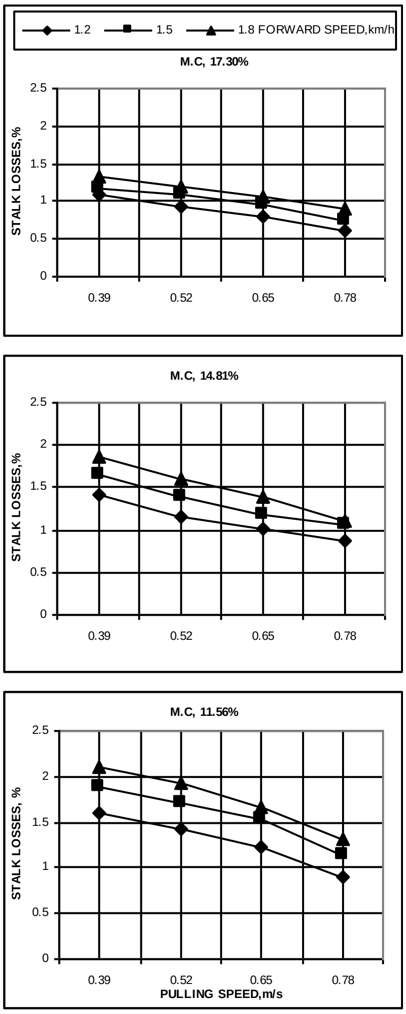


Fig 9: Effects of pulling speeds, forward speed and stalk moisture contents on Total stalk losses, %.

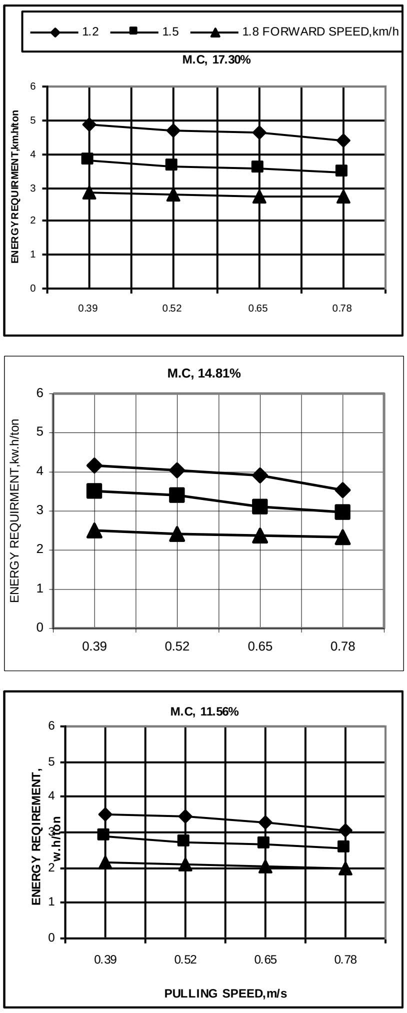
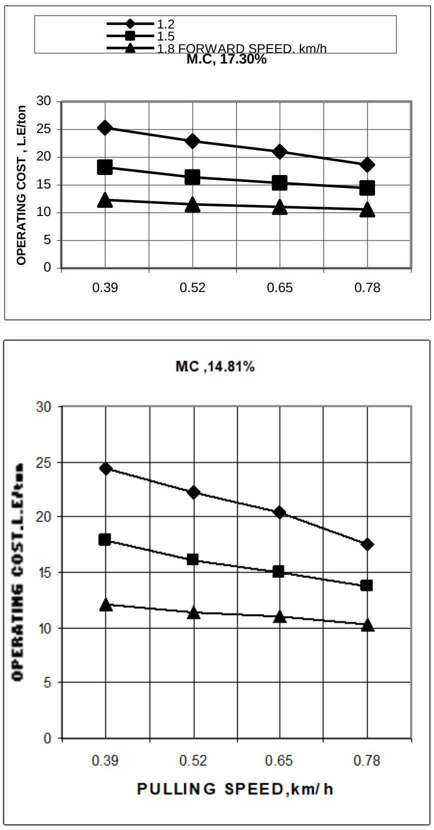


Fig 10: Effects of pulling speeds, forward speed and stalk moisture contents on Energy requirement, kW.h/ton.

values of criterion function cost was decreased with increasing pulling speed , while it was increased with increasing forward speed and with decreasing stalk moisture content. For instance, with increasing pulling speed from 0.39 to 0.78 m/s at constant forward speed on 1.2 km/h and stalk moisture content on 17.30%,d.b, criterion function cost decreased from 31.56 to 29.79 L.E/ton (-5.6%) . while , increasing forward speed from 1.2 to 1.8 km/h at constant pulling speed on 0.39 m/s and stalk moisture content on 17.30%,d.b, criterion function cost increased from 31.56 to 38.97 L.E/ton (+23.5%), also decreasing stalk moisture content from 17.30 to 11.56%,d.b, with constant pulling speed on 0.39 m/s and forward speed on 1.2 km/h, criterion Function cost increased from 31.56 to 35.48 L.E /ton (+12.4%). Data show also that, the minimum value of criterion function cost was 29.79 L.E /ton recorded at pulling speed of 0.78 m/s, forward speed of 1.2 km/h and stalk moisture content of 17.30 %, d.b, while the maximum value of criterion function cost was 50.04 L.E /ton recorded at pulling speed of 0.39 m/s, forward speed of 1.8 km/h and stalk moisture content of 11.56%, d.b.



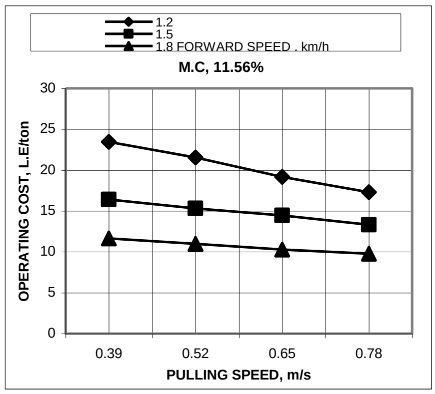


Fig11: Effects of pulling speeds, forward speed and stalk moisture contents on operating cost, L.E/ton.

Table 3: Effect of pulling speed, forward speed and stalk moisture content on criterion function cost, L.E /ton for developing reaper.

Moisture content ,% d.b	Forward speed, km/h	Pulling speed , m/s			
		0.39	**0.52**	**0.65**	**0.78**
17.30	**1.2**	31.56	31.o6	30.63	29.79
	1.5	35.03	34.17	33.58	32.09
	1.8	38.97	38.29	37.34	35.83
14.81	**1.2**	33.80	32.92	32.47	31.89
	1.5	38.07	37.24	36.01	35.64
	1.8	46.09	44.07	41.95	39.63
11.56	**1.2**	35.48	35.12	34.65	33.19
	1.5	42.52	40.92	39.16	37.39
	1.8	50.04	49.13	47.19	43.39

CONCLUSION

The significant effects could be condensed as the following :

1- At primordial test for harvesting reaper before developed was made high value of stalk losses and stalk damage at all experimental levels. Results showed that the maximum rate of stalk losses was 22.9% and the maximum value of stalk damage was 7.73% recorded at a combination of cutting speed high forward speed and low stalk moisture contents.

2- After developing, reaper gave the highest values of actual field capacity, field efficiency and yield output. Whereas the previous parameters were increased with increasing both pulling speed and forward speed. On the other hand, they were increased with decreasing stalk moisture contents.

3- Stalk losses and stalk damage were decreased by high extent with developing reaper. The maximum rate of stalk damage was 5.61% recorded at pulling speed of 0.78m/s, forward speed of 1.8 km/h and stalk moisture content of 11.56%. While, the maximum rate of stalk losses was 2.11% recorded at pulling speed of 0.39m/s, forward speed of 1.8 km/h and stalk moisture content of 11.56%.

4- Energy requirement was decreased with increasing both of pulling speed and forward speed, also with stalk moisture contents decreasing. The lowest value was 1.97 kw.h/ton registered at pulling speed of 0.78 m/s, forward speed of 1.8 km/h and stalk moisture content of 11.56% .

5- Operating cost was decreased from 25.28 to 9.79 L.E/ton by increasing pulling speed from 0.39 to 0.78 m/s, increasing forward speed from 1.2 to 1.8 km/h and decreasing stalk moisture contents from 17.30 to 11.56 %. On the other hand, lowest value of criterion function cost was 29.79 L.E/ton registered at pulling speed of 0.78 m/s, forward speed of 1.2 km/h and a stalk moisture content of 17.30 %.

From previous results, developed machine indicated remark superiority whereas, decreasing stalk damage and stalk losses. Also, decreasing operation cost compared with machine before development. Whereof, suggesting that, this machine considered as suitable for Egyptian farmers in pulling flax crop.

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طوير ريبر صغير ليناسب تقليع محصول الكتان

عــاطف عــزت اليمــــاني ، رفــاعي أبــو شعيشــع ، رفعــت محمــد المرحــومى و عبد الفتاح القويعى

معهد بحوث الهندسة الزراعية – الدقى – الجيزة

محصول الكتان من محاصيل الألياف الهامة و يزرع سنويا في مصر بغرض الحصول على البذور لإنتاج الزيت و الألياف لإنتاج المنسوجات. و قد بلغت المساحة المزروعة منة 20820فدان و كانت الإنتاجية الكلية من القش 92072طن بمتوسط 422 ,4 طن/للفدان و كانت الإنتاجية الكلية من البذور 2 ¸15031 طن بمتوسط 721¸. طن /للفدان (إحصائيات وزارة الزراعة 2007). و تعتبر عملية تقليع أعواد الكتان من

ارض الحقل من العمليات الزراعية الصعبة و الشديدة الإرهاق للمزارع و بصفة عامة لا توجد إلة زراعية تقوم بهذه العملية سوى المحشات الترددية والتي لا يفضلها المزارع نظرا لأنها تترك قدر من الأعواد بالأرض (ارتفاع القطع). وهذا المقدار من الأعواد يعتبره المزارع فقد في العائد نظرا لارتفاع أسعار ألياف الكتان لذلك كانت فكرة هذه الدراسة هي تطوير ريبر الحصاد ذات ا لسكينة الترددية بتحويله إلى آلة تقليع لأعواد الكتان عن طريق استبدال سكينة القطع بعدد من بكرات التقليع الدوارة المتجاورة حيث تدور كل بكرتين في اتجاهين متضادين إلى أعلى فتعمل على تقليع الأعواد من جذورها دون ترك اى جزء بالأرض و رفعها إلى جنزير تجميع و خروج المحصول عن طريق بكرات نجمية أفقية الوضع حيث يتم خروج المحصول في الجانب الأيمن من الآلة.

العوامل تحت الدراسة:

1- سرعة دوران بكرات التقليع: تم استخدام أربعة سرعات كانت 39¸. , 52 ¸. , 65¸., 78 ¸. م/ث.

2- سرعة تقدم الآلة:تم استخدام ثلاث سرعات أمامية كانت 2 ¸1, 5 ¸1, 8 ¸1 كم/ساعة.

3- المحتوى الرطوبى: تم إجراء التجارب عند ثلاثة محتويات رطوبة للأعواد كانت 30¸ 17 %, 81¸14 %, 56¸ 11 % على أساس جاف.

و قد تم تقييم أداء الآلة المعدلة من خلال دراسة المؤشرات الآتية:

1- السعة الحقلية الفعلية ¸ .Fed/h	2- الكفاءة الحقلية ¸ %.
3- الإنتاجية ¸ ton/h	4- نسبة التلف بالأعواد ¸%.
5- الفاقد الكلى للمحصول ¸%.	6- الطاقة اللازمة ¸ .kw.h/ton
7- اجمالى تكلفة التشغيل ¸ .L.E/ton	8- الدالة المعيارية للتكاليف¸ .L.E/ton

أهم النتائج:

1- أن استخدام الريبر في تقليع الكتان قبل التعديل قد سبب فاقد في الأعواد وصلت إلى 9¸22 % بينما سبب تلف في الأعواد بلغ 3 7¸7%.

2- السعة الحقلية الفعلية و الكفاءة الحقلية كانتا تتناسب طرديا مع سرعة بكرات التقليع وسرعة التقدم بينما كانت تتناسب عكسيا مع المحتوى الرطوبى.

3- الإنتاجية (طن/ساعة): كانت تزداد بزيادة سرعة بكرات التقليع وبزيادة سرعة التقدم أو بانخفاض المحتوى الرطوبى و كانت أعلى قيمة لها 656¸ 2طن/ساعة سجلت عند سرعة الملخ 78¸.م/ث و سرعة التقدم للآلة 8 ¸1كم/ساعة والمحتوى الرطوبى 56¸11%.

4- نسبة تلف الأعواد (%): كانت تتناسب طرديا مع سرعة بكرات التقليع وسرعة التقدم وعكسيا مع المحتوى الرطوبى و كانت اقل نسبة تلف بالأعواد هي 41¸1% سجلت عند سرعة بكرات التقليع 39 ¸. م/ث وسرعة التقدم للآلة 2 ¸1 كم/ساعة والمحتوى الرطوبى 30¸ 17 %.

5- نسبة الفقد في الأعواد (%): كانت تتناسب عكسيا مع سرعة بكرات التقليع و المحتوى الرطوبى وطرديا مع سرعة التقدم و كانت اقل نسبة تلف بالأعواد هي 62¸% سجلت عند سرعة بكرات التقليع 78 ¸. م/ث وسرعة التقدم للآلة 2 ¸1 كم/ساعة والمحتوى الرطوبى 30¸ 17 %.

6- احتياجات الطاقة اللازمة (ك وات. ساعة/طن): كانت تتناسب عكسيا مع سرعة بكرات التقليع و سرعة التقدم وطرديا مع المحتوى الرطوبى و كانت اقل طاقة لازمة للتشغيل هي 97¸1 ك وات. ساعة/طن سجلت عند سرعة بكرات التقليع 78 ¸. م/ث وسرعة التقدم للآلة 8 ¸1 كم/ساعة والمحتوى الرطوبى 56¸ 11 %.

7- التكاليف الكلية لعملية التقليع (جنيها /طن): وجد أن اقل قيمة للتكاليف الكلية للآلة كانت79¸ 9 جنيها/طن سجلت عند سرعة بكرات التقليع 78 ¸. م/ث وسرعة التقدم للآلة 8 ¸1 كم/ساعة والمحتوى الرطوبى 56¸ 11 %. بينما كانت اقل قيمة للدالة المعيارية 79¸ 29 جنيها/طن و سجلت عند سرعة بكرات التقليع 78 ¸. م/ث وسرعة التقدم للآلة 2 ¸1 كم/ساعة ومحتوى ر طوبى 30¸ 17 % على التوالي.

وقد أظهرت النتائج السابقة تفوق الآلة المعدلة من حيث انخفاض نسب التلف و نسب فقد الأعواد وانخفاض التكاليف الكلية للتشغيل عنها قبل التعديل مما يعنى أن هذه الآلة تعتبر ذات مواصفات تشغيل جيدة وتناسب المزارع المصري في تقليع محصول الكتان.