DEVELOPMENT A MACHINE FOR PULLING FLAX CROP

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ABSTRACT

The laboratory experiments were carried out through the successive agricultural seasons of (2007-2008) at the center laboratory of Agricultural Engineering Research Institute (AEnRI) Dokki – Giza. Field experiments were conducted at the experimental farms of Gemmaiza Research Station, Gharbia Governorate, during the harvesting season of (2009), to develop the lentil pulling machine to be suitable for pulling flax crop using available locally materials to construct, modify and develop flax pulling machine. The developed machine consists of two vertical conveyor belts and power transmission. The developed machine evaluated by measuring and estimating pulling efficiency, harvester performance (Actual field capacity and Field efficiency), fuel consumption rate, energy requirement and criterion cost under the studied variables; machine forward speeds of 1.38, 2.00, 2.57 and 4.5 km/h, finger rotating speeds of 0.393, 0.524, 0.654 and 0.837 m/s and soil moisture contents of 29.24, 21.96, 18.35 and 15.75 % (w.b). The results could be concluded that the developed machine can be worked at the optimum operating parameters of 2.00 km/h forward speed, 0.654 m/s finger rotating speed (kinematic ratio of 1.18) and 21.96 % soil moisture content to obtain the suitable performance in pulling efficiency of 98.30%, actual field capacity of 0.46 fed/h, field efficiency of 80.00%, fuel consumption of 5.60 L/h, energy requirement of 38.7 kW.h/fed and criterion cost of 163.70 L.E/fed.

Keywords: Flax, pulling flax, pulling machine, uproot flax, pulling efficiency, pulling costs

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INTRODUCTION

Flax is one of the most important fiber crops in the world today. It plays an important role in Egyptian national economy due to export as well as local industry. It is grown in Egypt and some other countries as a dual purpose for seeds and fibers. In Egypt, flax is cultivated in total area of about 12784 fed. (new land 453 fed. and old land 12331 fed.), total productivity 55359 ton (new land 1662 ton and old land 53697 ton) (Economic affairs sector 2009). The Flax must be harvesting by pulling system to defend the crop economics. The shortage of hand labors in Egyptian agriculture has become a pressing problem in recent years. This shortage, has led to a continuous increase in the cost of agricultural production labors cost of 300 L.E and need of 8-10 labor. This problem has become an urgent one particularly in the pulling period of flax crop, which are presently pulling by hand. Hunt (1986) stated that the forward speed is probably the most important factor in optimizing the performance of a machine harvester. Several investigations have determined that total losses increase rapidly as forward speed increase, because of over loading, rack losses, particularly, rise with an increase in speed. The increase in rack loss appears to be directly proportional to speed and can amounted by 4% of the total yield as speed is increased from 3.2 to 5.6 km/h in heavy yielding grain. Ibrahim (1983) indicated that the pulling force required to uproot flax plant ranged from 8 to 34 N which is considered triple the pulling force value at Belarosia, the coefficient of friction ranged from 0.25 to 0.47 which was found less than its value at Belarosia. The force of uprooting (cutting), at the lowest third portion of the stalk ranged from 45 to 164N. The minimum value of pressure on stalks at which mechanical damage may occur was found to be 120 kPa. Klenin et al. (1985) reported that the flax pullers may be in the form (a) Straight belt conveyor and rollers consist of two endless puller belts running over the driven pulleys, the driven pulleys and the rollers which keep the two belts passed together. The dividers feed the stalks to the puller rolls, which grip them at the point of contact of the two belts. The stalks are held over the zone where the belts are in close contact. (b)Curvilinear belt conveyor and rollers: Consists of a puller belt, puller disks, clamping rollers, and a guide plate. The stalks are passed between the belt and the disk. Simultaneous with the pulling operation, the stalks are conveyed to the left (in the direction of motion of the machine). Between the disks, the stalks are transported by the pressure exerted on them by the guide plate. Rodjief et al. (1986) used the belt and disk puller (TLN) which was made in Russia for pulling flax plants an arranging the harvest stalks in windrows. The pulling device has to be mounted on the three point linkage of the tractor, which is a reversible motions tractor. So, the puller acts as a front mounted machine. The pulling device inclination angle to the horizontal, which depends on the flax stalks length and ranges from 150 to200 for long stalks 80 to 100 cm, and could be adjusted by changing the top link length. Abdel-Wahab (1987) designed a prototype of lentil walker puller to pull the lentil plants under manual and mechanical planting. Three types of cylindrical and conical shape for pulling fingers with clearance of 6.0, 20.6 and 22.8 mm were tested. Hamad et al. (1991) found that pulling efficiency reaches its maximum value of 92 % at speed ratio equal to 4.07 (between finger rotating speed and machine forward speed) and using the modified pulling flax machine, reduce the hourly operating costs for about 3.21 times compared with manual pulling. Abdel-Wahab (1994) reported that the pulling force increased by increasing the lentil stem diameter and decreasing moisture content of plant. The values of pulling forces were 68 and 42 N/plant, moisture content of 15 % and 32 %, respectively at lentil stem diameter of 6 mm. While the values were 15 and 7 N/plant with moisture content of 15 % and 32 % and stem diameter of 2 mm, respectively. El-Sharabasy (2003) developed and constructed a lentil pulling machine in (ATB), Germany. The developed machine was tested in Egyptian fields to determine the suitable conditions for lentil pulling. He mentioned that, the minimum fuel and energy required were 0.84 L/fed and 1.65 kW.h/fed recorded under seed drilling planting method 22 cm spacing between rows at finger rotating speed of 0.654 m/s and machine forward speed of 3.5 km/h (kinematics parameter, 0.71) and seed moisture content of 20%.

So, this research aimed to develop the pulling bar of lentil-harvesting machine to suite the harvesting operation of flax with traditional tractor, evaluate the developed machine performance and determine the optimum studied parameters.

MATERIALS AND METHODS

Materials

Flax plants

Physical and mechanical properties of flax plants are presented in Table 1.

Machine

- **The pulling machine before development**

The lentil pulling machine consists of four main parts follows:

Pulling device (pulling finger, steel case and dividers), Crop reel, Conveyor belt and Power transmission (Fig. 1)

- **The pulling machine after development**

The lentil pulling machine was developed to be suitable for pulling flax crop. The developed pulling machine (Fig. 2 and3) consists of four main parts.

Pulling device

The pulling device consists of 20 pulling fingers (10 pulling units). Each finger is conical in shape and its diameter was 54.5 mm at the rear end and 18 mm at the front end. The finger length was 200 mm. (El-sharabasy, 2003).

Dividers

The dividers were fixed in the front of pulling device to separate and guide the flax stalks into the pulling unit. The numbers of dividers were 11, each one have a specifically shaped and tapered front section. (El-sharabasy, 2003).

Conveyor belt

A two vertical conveyor belts were fixed on a special frame directly over the steel case to carry and move the pulled flax plants slightly aside the machine.

The conveyor belt consists of twins vertical rubber belt which has dimensions of 1315mm for length, 60 mm for width and 10 mm for thickness. Each belt contains 22 L-shape plugs, each one has 60 mm in length, 50 mm in width, and 3 mm in thickness. (Fig. 4).

The conveyor belt is powered by means of two pulleys. The first

Table 1. Physical and mechanical properties of flax plants (Giza 4)

plants characteristics	Average Value
Plant height	937.8 mm
Technical length (from the soil layer to the flowering zone)	761.4 mm
Flower zone length	202.3 mm
Stem diameter at 10 cm distance from ground surface	2.014 mm
Number of plants / m^2	1247
Mass of 1000 seed / gm	7.43 g
Biological yield (seed and straw yields)	4.60 Mg/fed
Straw yield/ fed	3.92 Mg/fed
Shear force of plant	160.07 N
Compression force for damage capsule	3.14 N
Tensile strength of capsule	6.62 N
Average pulling force	60.64 N

pulley has diameter of 90 mm at rotation speed of 232 rpm fixed on the gear box, and the second pulley diameter of 130 mm was fixed on the main shaft. These two pulleys keep constant relation between drive shaft rotating speed and finger rotating speed of (1:1.73) to give constant relation between conveyor belt and machine forward speed of (1:1.4). Bosoi et al. (1991).

Power transmission:

The power is transmitted for the tractor PTO shaft to the pulling fingers through pulleys, gear box, universal joint, and power shaft as shown in Fig. 5.

A 540 rpm at PTO pulley which has diameter of 85 mm can be transmitted to pulley diameter of 165 mm using V-belt between the two.

pulleys to be equal 278 rpm, with reduction ratio of 1.94:1.The rotating speed transported from the pulley to the power shaft length of 2300 mm.

The rotating speed transported from the power shaft to case shaft through universal joint length of 250 mm .Another advantage of universal joint, making easy the pulling device up during machine transport from field to another down during pulling operation in the field.

No.	Part Name	No. of parts	No.	Part Name	No. of parts
1	Pulling finger	20	9	Drive wheel	1
2	Divider	11	10	Seat	1
3	Crop reel	1	11	Engine	1
4	Conveyor belt	1	12	Machine frame	1
5	V-Belt	1	13	Conveyor pulley	2
6	O-Belt	1	14	Gear box (1:3)	1
7	Front wheel	2	15	Spring	1
8	Rear wheel	2	16	Lifter	1

All dimensions in mm

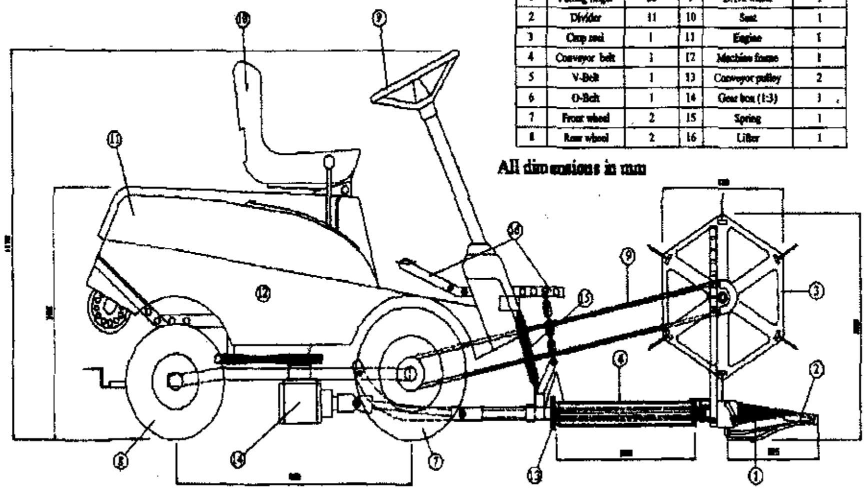


Fig.1. The side view of lentil pulling machine before development

No.	Part Name	No. of parts	No.	Part Name	No. of parts
1	Flax pulling machine	1	4	Tractor PTO	1
2	Hitching point	2	5	Front wheel	2
3	Tractor engine	1	6	Rear wheel	2

All dimensions in mm

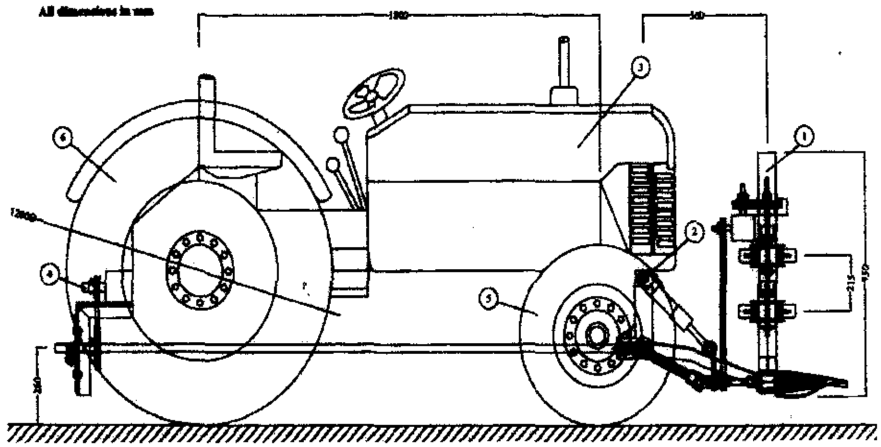


Fig.2. The side view of the developed pulling flax machine

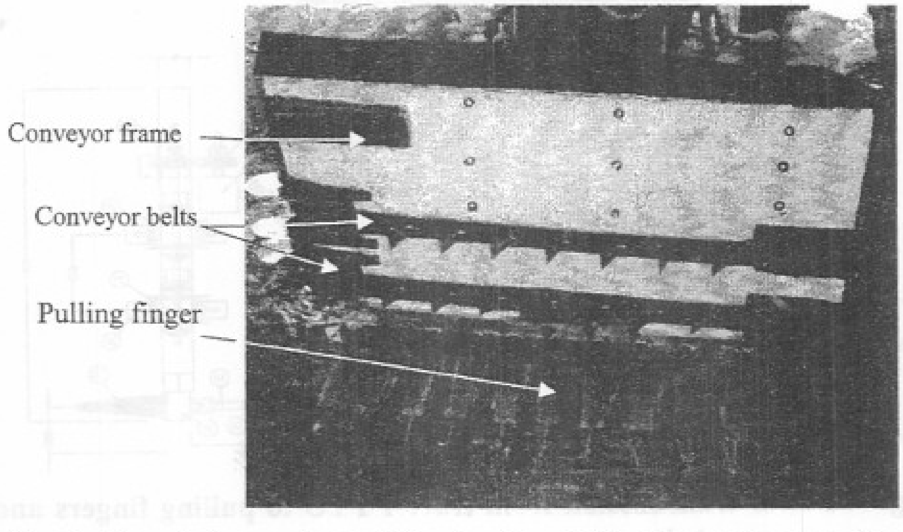
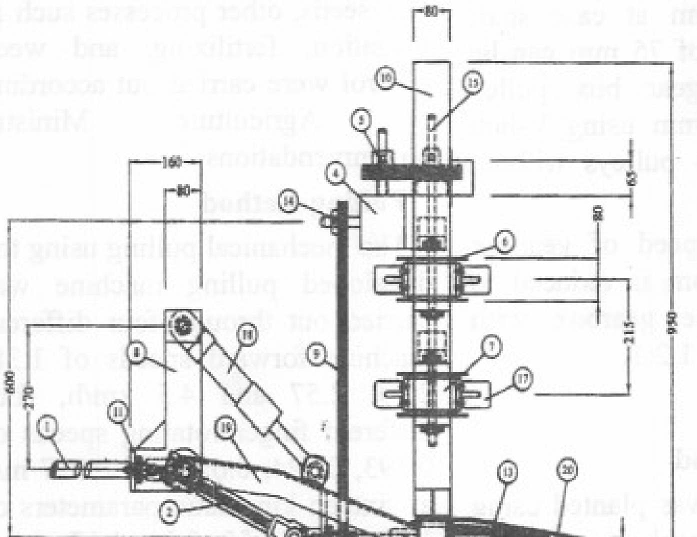


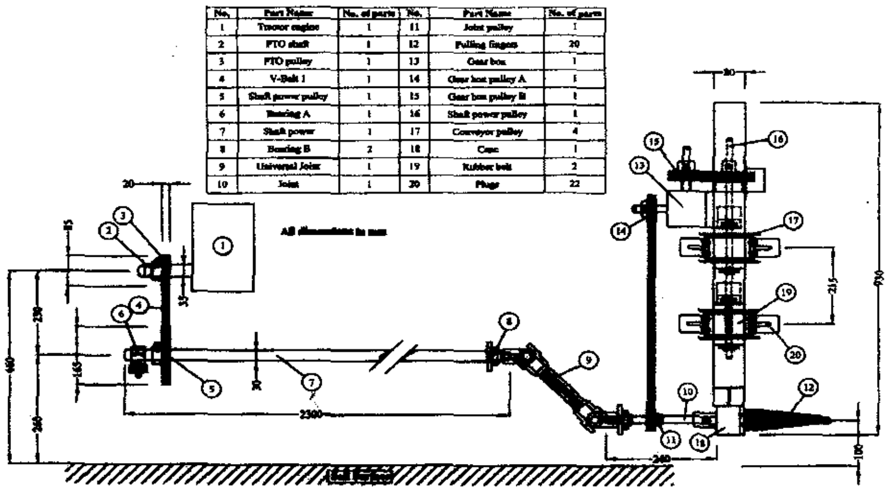
Fig. 3. The photographed of the developed flax harvesting machine



No.	Part Name	No. of parts
1	Shaft power	1
2	Universal Joint	1
3	Joint pulley	1
4	Gear box	1
5	Gear box pulley B	1
6	Conveyor pulley	4
7	Rubber belt	2
8	Iron bar	2
9	O-Belt	1
10	Conveyor frame	1
11	Bearing B	2
12	Joint	1
13	Pulling fingers	20
14	Gear box pulley A	1
15	Shaft power pulley	1
16	Case	1
17	Plugs	22
18	Hydraulic piston	2
19	Main frame	1
20	Divider	11

All dimensions in mm

Fig.4. The side view of the developed vertical conveyor belt



No.	Part Name	No. of parts	No.	Part Name	No. of parts
1	Tractor engine	1	11	Joint pulley	1
2	PTO shaft	1	12	Pulling fingers	20
3	PTO pulley	1	13	Gear box	1
4	V-Belt 1	1	14	Gear box pulley A	1
5	Shaft power pulley	1	15	Gear box pulley B	1
6	Bearing A	1	16	Shaft power pulley	1
7	Shaft power	1	17	Conveyor pulley	4
8	Bearing B	2	18	Case	1
9	Universal Joint	1	19	Rubber belt	2
10	Joint	1	20	Plugs	22

Fig. 5. Power transmission from tractor PTO to pulling fingers and conveyor belts

The rotating speed of power shaft of 278 rpm at case shaft pulley diameter of 75 mm can be transmitted to gear box pulley diameter of 75 mm using V-belt between the two pulleys without reduction ratio.

The rotating speed of gearbox pulley of 278 rpm is reduced to 232 rpm in the gearbox with reduction ratio of 1.2:1.

Methods

Planting method

The flax crop was planted using seed drilling machine at row spacing of 11 cm between rows, the planting depth was about 3 cm and the machine forward speed was adjusted at 3 km/h. The seed drilling required about 40 kg/fed of flax seeds, other processes such as irrigation, fertilizing, and weed control were carried out according to Agriculture Ministry recommendations.

Pulling method

The mechanical pulling using the developed pulling machine was carried out through four different machine forward speeds of 1.38, 2.00, 2.57 and 4.5 km/h, four different finger rotating speeds of 0.393, 0.524, 0.654 and 0.837 m/s at sixteen kinematic parameters of 1.02, 0.71, 0.55, 0.31, 1.37, 0.94, 0.73, 0.42, 1.71, 1.18, 0.92, 0.52, 2.18, 1.51, 1.17, 0.67 and four different soil moisture contents of 29.24, 21.96, 18.35 and 15.75 %

(w.b), to evaluate the flax pulling machine performance during pulling operation.

Measurements

Pulling efficiency

$$Pe = \frac{N_P}{N_T} \times 100$$

Where

Pe = pulling efficiency, %.

N_T = number of plants/m^2.

N_p = number pf pulling plants/m^2.

Actual field capacity

AFC = 1/T (Kepner et al., 1983)

Where:

AFC = Actual field capacity, fed/h.

T = Actual time in hours required per travel, h.

Theoretical field capacity

TFC = W× S / const. (Kepner et al., 1983)

Where

TFC = Theoretical field capacity, fed / h.

W = Pulling working width, m.

S = Average forward working speed, km /h.

Field efficiency

$$\eta_f = \frac{AFC}{TFC} \times 100$$ (Kepner et al.,1983)

Fuel consumption rate

FC = VF / t

Where

FC = Fuel consumption rate, L/h.

VF = Fuel consumption volume, L.

t = time, h.

Power requirements

$$Pr = \left\{\frac{1}{3600} \times \rho_f \times L.C.V \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times \frac{1}{1.36}\right\}$$

(Embaby et al., 1985).

Where:

Pr = Power requirements, kW.

ρf = Density of the fuel, kg / L (0.85 kg/L for solar fuel).

L.C.V = Lower calorific value of fuel, k.cal/ kg (average L.C.V of solar fuel is 10000 k.cal / kg).

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

ηth = Engine thermal eff. (assumed to be 40% for diesel engine).

ηm = Engine mechanical eff. (assumed to be 80% for diesel engine).

So, the power requirements equation can be equal as following:

$$Po = 3.16 \times F.C$$

Energy requirement

Er = Po / AFC

Where

Er = Energy requirement, (kW.h/fed).

Pr = Power required, (kW).
AFC = Actual field capacity, (fed/h).

Criterion cost

Criterion cost/fed. = Operating cost + Seed(stalks+seeds), (L.E/fed.)

Where

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

The machine cost was determined by using the following equation (El-Awady, 1978):-

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

Where:
C = Hourly cost, L.E. /h.
P = Price of machine, L.E.
h = Yearly working hours, h/year.
A = Life expectancy of the machine, h.
i = Interest rate / year.
T = Taxes, over heads ratio.
R = Repairs and maintenance ratio.
F = Fuel price, L.E./L.
m = The monthly average wage, L.E.
0.9=Factor accounting for lubrications.
W = Engine power, hp.
S = Specific fuel consumption, L/hp .h.
144 = Reasonable estimation of monthly working hours.

RESULTS AND DISCUSSION

The results of developed pulling machine were discussed under the following headlines as follows:

1-Pulling Efficiency

The machine forward speed of 2.00 km/h recorded the maximum pulling efficiency of 82.56, 93.30, 90.21 and 88.24 % at different soil moisture contents of 29.24, 21.96, 18.35 and 15.75% at finger rotating speed of 0.654 m/s (kinematic parameter of 1.18) as shown in Fig. 5-B. The decrease of forward speed less than 2.00 km/h or increase forward speed more than 2.00 km/h leads to decease pulling efficiency resulting from unsuitable speed ratio which gave less pulling efficiencies.

On the other hand, the effect of finger rotating speed on pulling efficiency since the speed ratios were increased or decreased causing unsuitable conditions during pulling process at the same Fig. 5-B.

Referring to, the soil moisture content, it has a great effect on pulling efficiency due to its affect on required pulling force, which increased with the increase of soil moisture content resulting minimum pulling efficiencies. The suitable soil moisture content was 21.96 %, which recorded the maximum values of pulling efficiencies of 77.52, 93.30, 83.35 and 54.12% at different machine forward speed 1.38, 2.00, 2.57 and 4.50 km/h and constant finger rotating speed of 0.654 m/s.

2- Actual Field Capacity

Fig. 6-B showed that the maximum value of actual field capacity of 0.860 fed/h was obtained at forward speed of 4.50 km/h, finger rotating speed of 0.654 m/s and soil moisture content of 21.96 %. On the other hand, the minimum value of actual field capacity of 0.184 fed/h was obtained at forward speed of 1.38 km/h, finger rotating speed of 0.393 m/s and soil moisture content of 29.24 %.The actual field capacity is greatly affected by pulling time consumed. Therefore, increase actual field capacity by increasing in forward speed was attributed to the short time to pull the flax plants from the planting area.

As to the effect of finger rotating speed of 0.654 m/s gave the best value of actual field capacities of 0.655, 0.860, 0.736, 0.687 fed/h at different soil moisture contents of 29.24, 21.96, 18.35, 15.75%, respectively and constant machine forward speed of 4.50 km/h. Any further increase or decrease in finger rotating speed from 0.654 m/s resulting less actual field capacity since the speed ratios were increased or decreased causing unsuitable conditions during pulling process. Increasing speed ratio than 1.18 leads to increase pulling plants in the unit time causing more clogging plants in the pulling unit consumed more time to remove then. Also decreasing speed ratio than 1.18 leads to decrease machine forward speed which affecting directly in machine field capacity with reduction machine.

The highest value of actual field capacity of 0.860 fed/h was obtained at soil moisture content of 21.96% using machine forward speed of 4.50 km/h and finger rotating speed of 0.654 m/s. On the other, the decrease of soil moisture content to 15.75% leads to decrease actual field capacity to 0.687 fed/h. at the same previous conditions. The decrease of actual field capacity with the decrease of soil moisture content may attribute to increase the catching force for flax roots causing unsuitable conditions for pulling operation resulting less field capacity.

3- Field Efficiency

Fig 6-B illustrated that field efficiency was gradually decreased by increasing machine forward speed from 1.38 to 4.50 km/h., at all treatments. The machine forward speed of 1.38 km/h. recorded the maximum field efficiencies of 69.53, 90.32, 86.29, 76.14 % at different soil moisture contents of 29.24, 21.96, 18.35 and 15.75% and constant finger rotating speed of 0.654 m/s (speed ratio of 1.71). On the other hand, the machine forward speed of 4.50 km/h. recorded the minimum field efficiency of 50.90, 66.87, 57.23, 53.42 % at soil moisture contents of 29.24, 21.96, 18.35 and 15.75% and constant finger rotating speed of 0.654 (speed ratio of 0.52). Increasing machine field efficiency with the decrease in machine forward speed may attribute to the reduction of lost time compared with the actual pulling time. Meanwhile, increasing forward speed leads to decrease machine field efficiency since the lost time increased.

As indicated in Fig. 6-B the higher field efficiency was occurred at the speed ratio of 1.71, which gave a suitable relation between finger rotating speed and machine forward speed. Finger rotating speed of 0.654 m/s gave the best value of field efficiency of 69.53, 90.32, 86.29 and 76.14%, at different soil moisture contents of 29.24, 21.96, 18.35, 15.75%, respectively and constant machine forward speed of 1.38 km/h. Any further increase or decrease in finger rotating speed from of 0.654 m/s, resulting less pulling efficiency since the speed ratioes were increased or decreased causing unsuitable conditions during pulling process.

The same figure 6-B illustrated that the soil moisture content of 21.96% was the suitable value which gave the maximum machine field efficiencies of 65.99, 82.32, 90.32 and 75.17 %, and constant machine forward speed of 1.38 km/h, at finger rotating speed 0.393 , 0.524, 0.654 and 0.837 m/s., respectively . The decrease of soil moisture content less to 21.96% leads to decrease machine field efficiency to 53.34, 63.76, 76.14, and 56.82% at the same previous conditions. This result may attribute to increasing catching force for plants causing more lost time during pulling operation.

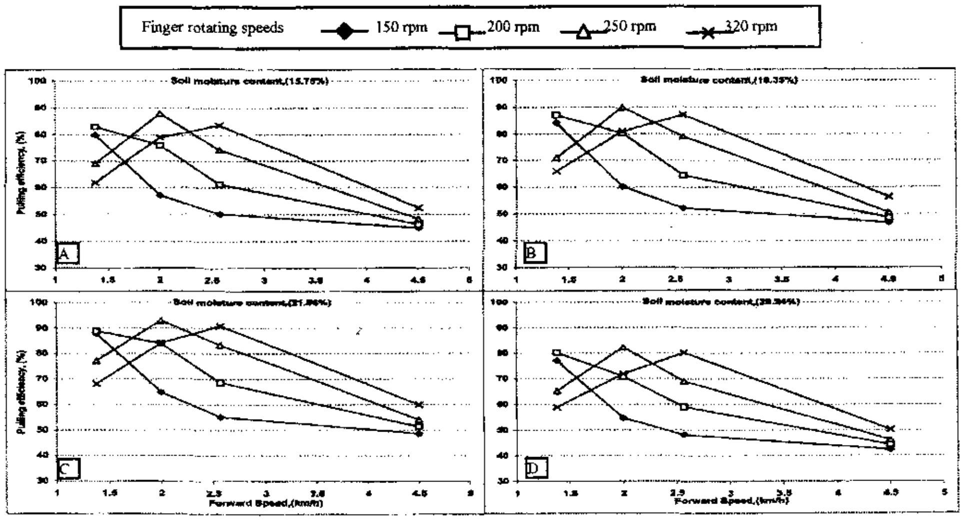


Fig. 5. Effect of machine forward speed on pulling efficiency at different soil moisture content

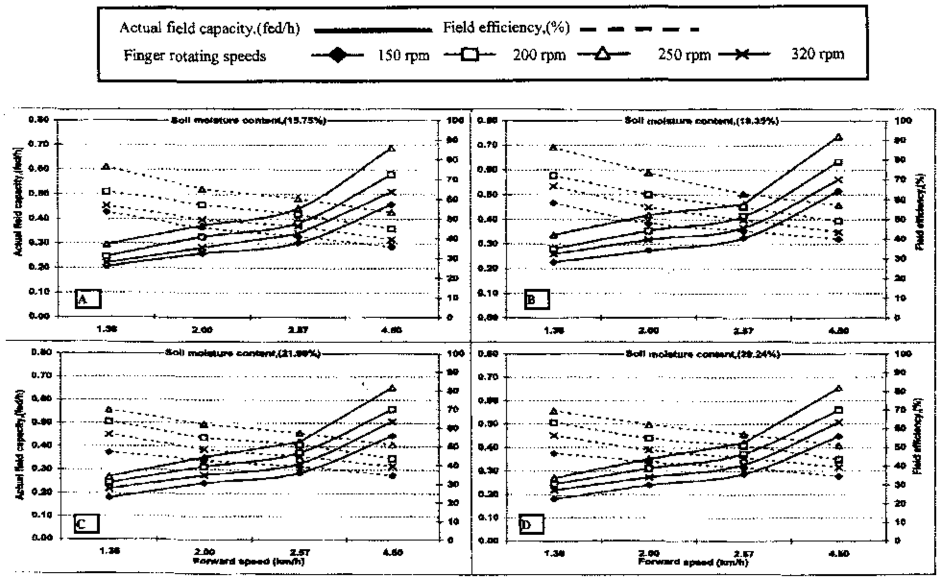


Fig. 6. Effect of machine forward speeds on effective field capacity and field efficiency at different finger rotating speeds and different soil moisture content

On the other hand, increasing soil moisture content more than 21.96% leads also to decrease machine field efficiencies to 46.70, 63.20, 69.53 and 56.34% at the same previous conditions. This result may attribute to increase elastic conditions causing more clogging plants between fingers leads to increase lost time and then decrease field efficiency.

4- Energy Requirements

Fig. 7-B indicated that, increasing machine forward speed from 1.38 to 4.50 km/h, led to decrease specific energy rate from 67.7 to 15.7 kW.h/fed, at soil moisture content of 21.96% and finger rotating speed of 0.393 m/s. The decrease in specific energy by increasing in machine forward speed was attribute to the decrease in fuel consumption which depend on the time consumed to clear the flax plants area and also the short time of pulling finger when passing over flax plants.

Fig. 7-B indicate that the higher specific energy rate was occurred at the higher finger rotating speed of 0.837 m/s. Which, consumed more fuel at pulling operation. Specific energy rate increased from 175.3 to 186.8, 72.9 to 93.9, 91.0 to 114.0 and 119.4 to 153.6 kw.h/fed. by increasing finger rotating speed from 0.393 to 0.837 m/s, at machine forward speed of 1.38 km/h and soil moisture contents of 29.24, 21.96, 18.35 and 15.75%, respectively. Increasing specific energy rate by increasing finger rotating speed was due to increase the revelation of tractor rpm consumed more fuel and power.

The results indicated that the lowest value of specific energy rate was 14.0 kW.h/fed, obtained at soil moisture content of 21.96%, finger rotating speed of 0.393 m/s and machine forward speed of 4.50 km/h. This result was due to the low revelation of tractor rpm consumed low fuel and energy. Meanwhile, any further increase in soil moisture content more than 21.96% leads to increase specific energy rates 100.0, 88.7, 86.8 and 121.4 kW.h/fed, at constant machine forward speed of 2.00 km/h and finger rotating speeds of 0.393, 0.524, 0.654 and 0.837 m/s, respectively. This increase was due to more fuel consumption during high soil moisture content. Since the slippage was in the maximum value. On the other side, any further decrease in soil moisture content from 21.96% leads to increase specific energy rate to

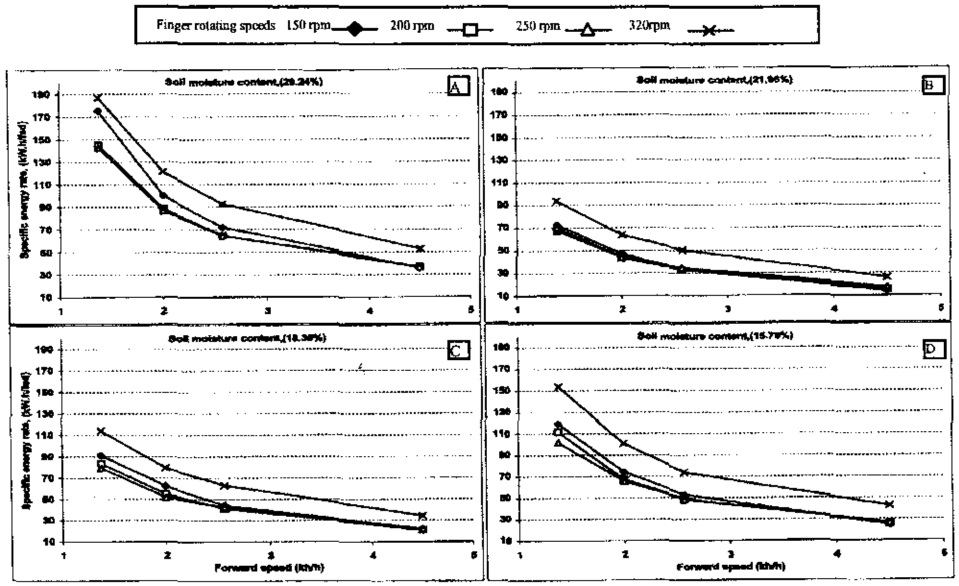


Fig. 7. Effect of machine forward speeds on specific energyat different finger rotating speed and different soil moisture contents.

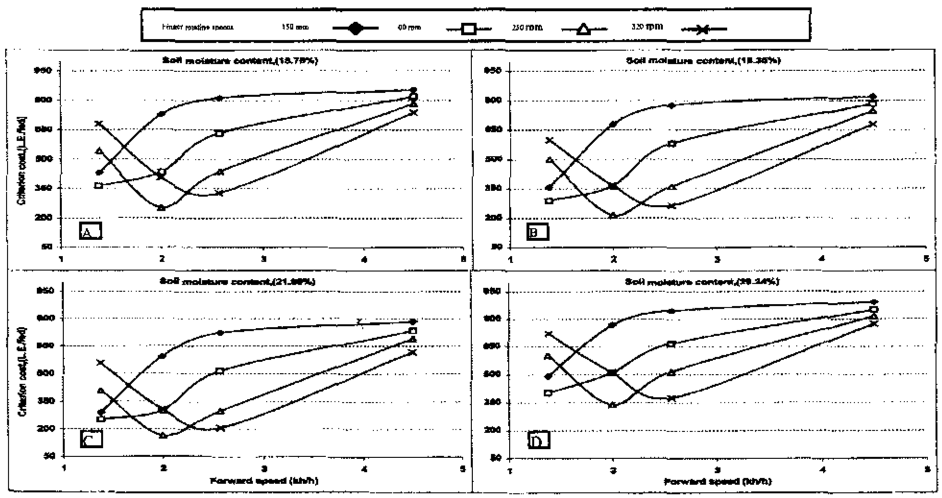


Fig. 8. Effect of machine forward speeds on criterion cost at different finger rotating speed and different soil moisture contents

74.3, 67.5, 65.8 and 100.9 km.h/fed, at the same previous conditions. This result may attribute to increase catching force for flax roots consumed more fuel and power.

5- Criterion Cost

Fig. 8-B show that the machine forward speed of 2.00 km/h recorded the minimum criterion cost of 336.6, 163.7, 213.8 and 251.2% at different soil moisture contents of 29.24, 21.96, 18.35 and 15.75% and constant finger rotating speed of 0.654 (kinematic parameter of 1.18), respectively. The decrease of forward speed less than 2.00 km/h or increase forward speed more than 2.00 km/h leads to increase criterion cost resulting from unsuitable (speed ratio) which gave less pulling efficiencies (move unpulling plants) resulting high criterion cost. Finger rotating speed of 0.654 m/s gave the best value of criterion cost of 336.6, 163.7, 213.8 and 251.2% at different soil moisture contents of 29.24, 21.96, 18.35, 15.75% and constant machine forward speed of 2.00 km/h, respectively. Any further increase or decrease in finger rotating speed from of 0.654 m/s resulting high criterion cost since the speed ratio were increased or decreased causing unsuitable conditions during pulling process.

Referring to the effect of soil moisture content has a great effect on criterion cost due to its affect on required pulling force, which increased with the decrease of soil moisture content resulting minimum pulling efficiencies. The suitable soil moisture content was 21.96%, which recorded the minimum values of criterion costs of 408.0, 163.7, 298.5 and 690.1% at different machine forward speeds of 1.38, 2.00, 2.57 and 4.50 km/h and constant finger rotating speed of 0.654 m/s, respectively.

Increasing soil moisture content more than 21.96% led to increase criterion costs to 603.8, 336.6, 514.5 and 815.7 L.E/fed at the same previous conditions and high soil moisture content of 29.24%. The increase in criterion cost with increasing in soil moisture content may attribute to decrease both pulling efficiency and machine field capacity. On the other side, decreasing soil moisture content less than 21.96% led to increase criterion cost to 542.2, 251.2, 437.4 and 783.3 L.E/fed at the same previous conditions and low soil moisture content of 15.75%. The increase in criterion cost with decreasing in soil moisture.

content may attribute to decrease pulling efficiency and increase fuel consumption since the pulling force increased.

CONCLUSIONS

The results can be concluded that the developed machine can be used at the optimum operating parameters of 2.00 km/h forward speed of 0.654 m/s finger rotating speed of 1.18 kinematic ratio and 21.96 % moisture content to obtain the suitable performance in pulling efficiency of 93.30%, effective field capacity of 0.458 fed/h, field efficiency of 80.00%, fuel consumption rate of 6.40 L/h, specific energy of 44.20 kW.h/fed and total pulling cost of 163.70 LE/fed.

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تطوير آله لتقليع محصول الكتان

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تم تطوير آلة تقليع العدس لتناسب تقليع محصول الكتان تحت الظروف المصرية، وقد شيدت وطورت آلة تقليع الكتان للتغلب علي مشاكل التقليع اليدوي بالنسبة لتقليل فواقد الكبسولات. تتكون الآلة المطورة من مصدر القدرة (الجرار) ونقل الحركة من (PTO) الجرار للأمام لتناسب الآلة المطورة وسير النقل الرأسي ليلائم نبات الكتان وإزاحته لجانب الآلة المطورة وجهاز التقليع، تحت سرعات أمامية للآلة ١,٣٨، ٢,٠٠ ، ٢,٥٧ و ٤,٥٠ كم/س, سرعات دورانية لأصابع التقليع ١٥٠، ٢٠٠، ٢٥٠، و ٣٢٠ لفه/د, ونسب رطوبة للتربة ٢٩,٢٤، ٢١,٩٦، ١٨,٣٥ و ١٥,٧٥ %. والنتائج التي تم الحصول عليها يمكن تلخيصها علي النحو التالي:

تم الحصول علي أعلي قيمه لكفاءة التقليع وهي ٩٣,٣٠% وذلك عند نسبة رطوبة للتربة ٢١,٩٦ % و سرعة دورانية لأصابع التقليع ٢٥٠ لفه/د وسرعة أمامية للآلة ٢,٠٠ كم /س . تم الحصول علي أعلي قيمة للسعه الحقلية الفعلية وهي ٠,٨٦ ف/س

وذلك عند نسبة رطوبة للتربة ٢١,٩٦ % وسرعة أمامية للآلة ٤,٥٠ كـم /س وسـرعة دورانية لأصابع التقليع ٢٥٠ لفه/د .من ناحية أخري فإنه عند استخدام سرعة أمامية للآلة ١,٣٨ كم /س وسرعة دورانية لأصابع التقليع ١٥٠ لفه/د، تم الحصول علي اقـل قيمـة للسعه الحقلية الفعلية وهي ٠,١٨ ف/س. أعلي قيمة للكفاءة الحقلية كانت ٩٠,٣٢ % وتم تسجيلها عند نسبة رطوبة للتربة ٢١,٩٦ % وسرعة أمامية للآلة ١,٣٨ كم /س وسرعة دورانية لأصابع التقليع ٢٥٠ لفة/د وكانت أقل قيمة لمعدل اسـتهلاك الوقـود هـو ٢,٦٢ لتر/س وأقل طاقة مستهلكة كانت ١٤,٠ (كيلووات.س/ف) وتم تسجيلهم عند سرعة أمامية للآلة ٤,٥٠ كم /س وسرعة دورانية لأصابع التقليع ١٥٠ لفة/د و نسبة رطوبـة للتربـة ٢١,٩٦ % وأقل قيمة لتكاليف عملية التقليع باسـتخدام الآلـة المطـورة كانـت ١٦٣,٧ جنية/ف سجلت عند سرعة أمامية للآلة ٢,٠٠ كم /س، وسرعة دورانية لأصابع التقليـع ٢٥٠ لفه/د ونسبة رطوبة التربة ٢١,٩٦ %.