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EVALUATION AND OPTIMIZATION THE PERFORMANCE OF TWO DIFFERENT POTATO HARVESTING MACHINERY TECHNIQUES

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ABSTRACT

The present study was carried out during 2006 winter season at Monshat Abbas village, Kafer El-Shiekh Gavernora, to evaluate and compare the performance of two different principles potato digging machinery techniques namely: the application of the normal ridger, and the application of the elevator digger for digging and lifting potato tubers the performance of the two investigated harvesting machinery system were evaluated in terms of the lifted, damaged tubers, harvesting efficiency, energy requirements, effective field capacity, field efficiency and cost of harvesting potato operation. The mechanical harvesting methods were investigated at four levels forward speed of 2.5, 3.78, 5.00 and 6.25 km/h and share tilt angel of 0.227, 0.297 and 0.384 rad. (13, 17 and 22 deg). It must be denoted that, the tested elevator forward speeds are adapted as an equivalent speed ratio (forward speed to elevator speed) of 1, 1.5, 2 and 2.5.

Elevator potato digger speed ratio of 2 gave the proper effective filed capacity of 0.91 fed/h, lifted tubers of 93.93%, total damage of 3.13%, harvesting efficiency of 96.84 and energy requirement of 15.72 kW.h/fed. Whereas, normal ridger the forward speed of 5 km/h gave the proper effective field capacity of 1.01 fed/h, lifted tubers of 86.57%, total damage 4.63%, harvesting efficiency of 95.37% and energy requirement of 7.33 kW.h/fed for.

The best values of previous technical indicators were found to be at tilt angles of 0.297 and 0.384 rad (17 and 22 deg) for elevator potato digger and normal ridger, respectively.

The elevator potato digger exhibited the maximum net profit of 6611.80 L.E*/fed compared with 5856 L.E/fed for normal ridger.

INTRODUCTION

Potato is considered one of the most important vegetable in Egypt as a food for human and stock where as its planting area represents about 24% of vegetable crop area according to (FAO, 2003). The total cultivated area of potatoes in 2005 was about 200000 fed., and about 2 million tons had been produced from this area, 1.8 Teragram have been locally consumed 0.2 Teragram had been exported according to Abd Al-Hakk (2005). Due to the increasing demand of consumers and foreign importers on this important crop, special attention should be given to increase its yield and quality through improving agricultural operations specially harvesting to meet its quota exporting demanding through the Egyptian-European market and the GATT partnership (FAO, 2003).

Harvesting methods have a direct impact on the percentage of yield losses, therefore appropriate methods should be identified in order to minimize this percentage.

The traditional used method in harvesting potato is digging the ridges

* One American dollar ≈ 5.75 Egyptian pound (L.E.) according to prices of 2006.

by the local animal-drawn plough (Baladi plough) and the use of this method can lead to: high percentage of damaged tubers, high costs of harvesting, mixing with animal wastes, long harvesting period and a tedious effort bearded by farmers (El-Raie *et al.,* 1999).

REVIEW OF LITERATURE

Potato plant needs at the beginning of its life temperature ranged from 20 to 25°C with daylong and after six weeks from the beginning, it needs temperature ranged from 15 to 18°C with short day (CIP, 1993). Also, it illustrated that the distance between rows ranged from 0.64 to 0.71 m, depending upon the purpose of using potatoes. Generally, the distance within the row ranged from 0.25 to 0.30 m.

Hyde *et al.* (1983) studied the performance of a potato harvester equipped with a system for controlling the depth of material on the primary chain for adjusting chain speed automatically. They said that if the speed ratio was increased from approximately 1 to 1.5 the amount of soil eliminated by the primary chain would increase greatly without affecting tuber damage significantly.

Abou Elmaged (1987) indicated that of these three types, perhaps the semi-mounted elevator digger is the most popular. It is effectively used in many areas especially where the soil conditions are not too heavy conditions. But wet, sticky conditions the spinner is likely to be more effective. Hence he developed a potato harvester that composed both operating principles of the elevator digger and the spinner.

Younis (1987) studied four forward speeds and their effect on the performance of mechanical potato digger compared with traditional harvesting. He found that the percentages of lifted potatoes ranged between 92.10 and 95.76 at forward speed ranged between 2.36 and 6.54 km/h. The percentages of lifted potatoes ranged between 4.24 and 7.09 in the range of tested speeds.

Hann, *et al.* (1989) stated that the machine performance is influenced by forward speed, operating width and the operator skill ... etc., but there are other important factors such as chain speed to forward speed ratio, depth of harvesting and height of drops. Whereas these factors are affecting the tuber damage and losses.

Abdou (1991) studied some engineering factors affecting the design of elevator potato digger. He found that the forward speed is considered as an important factor affecting both potato digger performance and the total damage.

Hamad *et al.* (1991) indicated that increasing blade tilt angle of 8°, 12°, 16° and 20°, the surface tubace were increased of 10.32, 20.27, 52.06 and 78.36% and the bruised tubers decreased of 86.77, 73.57, 40.36 and 11.41%, respectively. They also found that increasing the undamaged tubers were 86.91, 89.43 and 95.26% and the damaged tubers decreased of 13.09, 10.57 and 4.74%, at forward speed of 1.03, 2.1 and 3.05 km/h, respectively.

Kang and Halderson (1991) illustrated that the sum of unrecovered and damaged potatoes ranged between 1.25 and 8.35 percent. Also, the travel speed is considered as another important factor affecting the performance of the vibrating blade.

Abdel-Galil (1992) developed and evaluated a machine for digging and lifting potato tubers from the ridge with partially separating it from soil and compared that with the traditional method. He found that there are an interaction effects among forward speed and both lifted potato percentage and the total damage.

Derbala (1996) evaluated three different systems to harvest potatoes. These systems were full-mechanized, semi mechanized system and traditional systems. He showed that the increasing forward speed from 1.98 to 3.51 km/h increased the fuel consumption from 5.416 to 6.789 l/h. The effective field capacity increased from 0.51 to 0.76 fed/h and field efficiency decreased from 73.9 to 64.82%.

Sayed *et al.* (1996) found that increasing forward speed from 3.5 to 5.5 km/h in sandy soil and 2.5 to 4.5 km/h in clay soil, the damaged tubers decreased from 9.62 to 5.93% and 11.72 to 9.24% for lifter. They also found that the lowest tuber damage of 5.93 and 9.07%, the highest undamaged tubers of 89.73 and 85.26% and the optimum total costs per unit area of 12.93 and 16.71 L.E/fed were obtained statistically at the optimum forward speed of 5.5 and 3.5 km/h for sandy and clay soil by using lifter, respectively.

El-Sayed *et al.* (1997) stated that the yield components of potato are highly affected by mechanical harvesting compared with baladi plow. The percentages of buried tubers obtained at 0.175 rad (10 deg) rake angle were 8.2, 6.9 and 5.8% at forward speeds of 1.73, 3.10 and 4.13 km/h, respectively.

Emam (1999) showed that increasing digging depth from 25 to 30 cm, share angle from 0.314 to 0.419 rad (18 to 24 deg) and decreasing forward speed from 3.0 to 2.0 km/h, the lifted and undamaged sweet potato tubers increased from 84.73 to 93.81% and 82.4 to 91.73%, but the unlifted, bruised and cut tubers decreased from 15.27 to 5.19%, 9.1 to 4.57% and 8.5 to 3.7% by using chisel share respectively.

Afify and Mechail (2000) developed and constructed a harvester on the frame of a chisel plough. The optimum speed for harvesting was 4.49 km/h to increase the percentage of lifted potato to 96.86% and reduced the skin and cut damage to 1.11% and missing tubers to 3.14%.

Abdel-Al *et al.* (2002) concluded that the optimum engineering parameters for the development harvester which achieved the highest undamaged, lowest damaged and losses tubers percentage were obtained under forward speed of 2.3 km/h, digger tilt angle of 0.245 rad (14 deg), distance between the blade and elevator chain of 5 cm chain speed of 2.41 m/s, riddle speed of 4.63 m/s and riddle inclination of 0.123 rad (7 deg).

Motamed *et al.* (2003) developed a single-row ridge with a variable rake and win angles, depth wheel fixed on a frame with two-roller disc share. The unit was evaluated for its performance and compared with available balady digger. They found the percentage of lifting tubers on the surface was 91.5% at traveling speed of 3.1 km/h and share digging of 0.35 rad (20 deg) and it decreased to 90.9% at traveling speed of 5.8 km/h. Under the same conditions the balady share takes the same trend. They were 90.9% and 89.8% at 3.1 and 5.8 km/h, respectively.

From the above reviewed papers it is important to illustrate more research steps that can be considered. Therefore, the aim of the present research is to evaluate and compare the performance of two different principles potato digging machinery techniques namely: the application of the normal ridger, and the application of the elevator digger for digging and lifting potato tubers. In addition the present work is focused on determing the proper operating parameter levels required for optimizing the performance of the deduced potato digging machines.

MATERIALS AND METHODS

The present study was carried out at the experimental field of the Monshat Abbas, Kafr El-Sheikh Governorate by using two different machinery systems of potato harvesting. The experiments were conducted from 1st of October 2005 till 26th January, 2006. The experimental area was prepared by using a moldboard plow with depth of about 20 cm followed rotary cultivator and hydraulic secraper to complete seedbed preparation. An area of two feddans [1 fed = 4200 m^2] were Alpha planted with potatoes variety. The soil texture was clay soil. Mechanical analysis of the experimental soil is shown in Table 1. The experimental area were planted by using full automatic planter, the specifications of automatic potato planter was mounted with 3-point linkage, Holland Made-Model Gruse VL16, Number of rows 2, space between rows in cm 60-75, Planting distance in was cm 15-45, Hopper capacity was kg 425 and Mass was kg 350. The source of power for these machine was the ground wheels. The average depth of planting was about 15 cm.

Table 1: Soil mechanical analysis

Sand,%	Silt,%	Clay,%	Soil texture	Organic M, %	B. density
27.40	19.10	53.50	Clay	1.82	1.38 g/cm^3

Materials:

The machine specifications:

1. Tractor Model of Nasr 65M 34/T, diesel engine, four stroke, 48.8 kW power, 2540 kg mass.

2. The compared harvesting machines:

a) Elevator potato digger Model Samon, Holland manufacture, mounted with three points linkage, number of rows 2, number of chain 1 and the source of power P.T.O tractor as shown in Fig. 1.
b) Normal ridger, Egypt manufacture, mounted with three points linkage and number of rows 2 as shown in Fig. 2.

3. Measurement instrumentation:

a) Fuel consumption apparatus was used for measuring the fuel consumption.
b) Draw bar dynamometer measuring rang from 300-2300 kg was used for measuring draft force.
c) Stop watch was used for measuring the actual operating time.
d) Tape of 30 m long was used for measuring different dimensions.

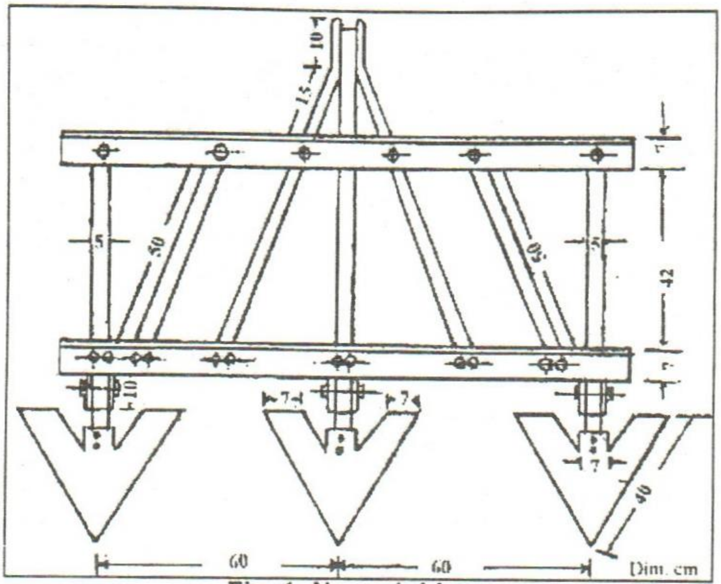

Fig. 1: Normal ridger.

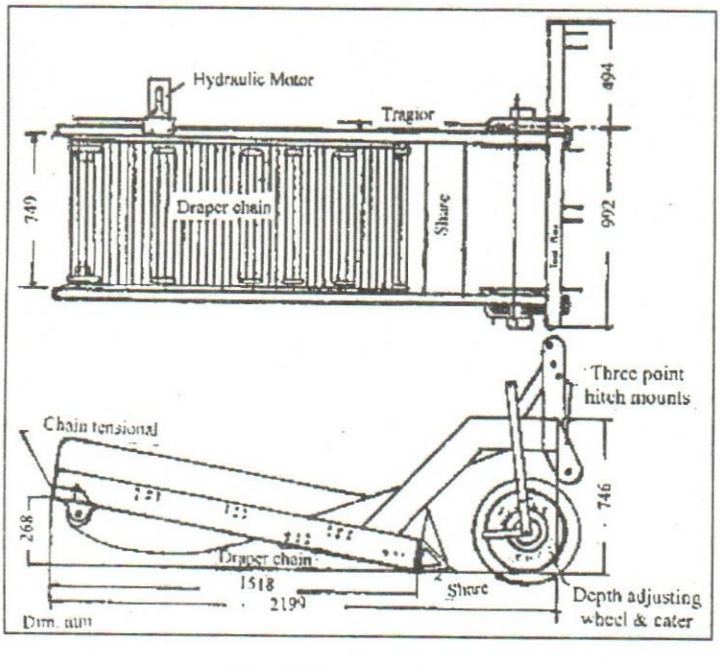

Fig. 2: Potato digger.

The two deduced harvesting machinery system were tested against the following variables.

For both tested machines four levels forward speed of 2.5, 3.78, 5.00 and 6.25 km/h and share tilt angel of 0.227, 0.297 and 0.384 rad. (13, 17 and 22 deg). It must be denoted that, the tested elevator forward speeds are adapted as an equivalent speed ratio (forward speed to elevator speed) of 1, 1.5, 2 and 2.5.

The performance of the two investigated harvesting machinery system were evaluated in terms of the lifted, damaged tubers, harvesting efficiency, energy requirements effective field capacity, field efficiency and cost of harvesting potato operation.

The average values of ridge distance, ridge height, plant pitch, potato thickness and potato width were obtained as follows 0.39 m, 0.20 m, 0.28 m, 0.19 m and 0.15 m, respectively, as shown in Fig. 3. Determinations of the shape and dimensions of the root crop ridge at time of harvesting allow for tractors and harvesting machines to securely travel between the rows to harvest without causing damage for the crop according to (Abou Elmaged, 2002). The average of soil moisture content was 22.5% (d.b). The haulm was removed manually before harvesting.

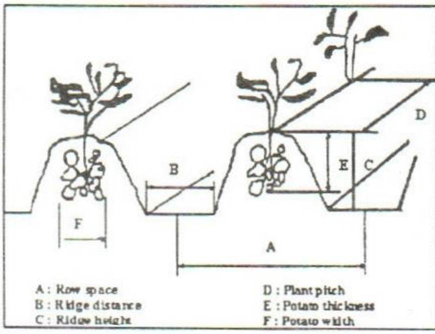

Fig. 3: Shape of ridge.

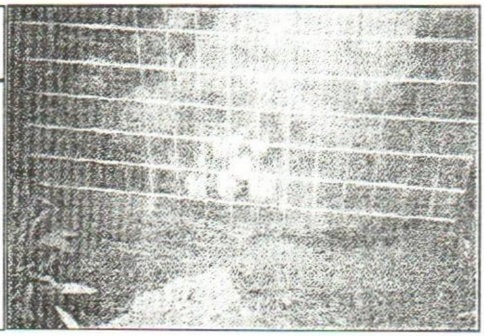

Fig. 4: Location of potato.

The location of potato is appreciated by a transparent and squared panel as shown in Fig. 4.

Methods:

Measurement during harvesting:

1.The effective field capacity (E.F.C.) is estimated by using the following formula:

$$E.F.C. = \frac{1}{\text{Effective total time in hours required per feddan}}, \text{fed/h} \text{ ------------ } 1$$

2. The field efficiency is calculated by using the following formula:

$$\eta_f = \frac{E.F.C}{T.F.C} \times 100, \% \text{ ------------ } 2$$

Where:

T.F.C = Theoretical field capacity, fed/h.

3. Power and energy requirement:

The power and energy requirement were calculated by using the following equation:

$$\text{Power} = \frac{\text{Draft force, kN} \times \text{Forward speed, km/h}}{3.6}, \text{kW} \quad \text{------} \quad 3$$

For elevator the power required for elevator chain was estimated by measuring the fuel consumption rate for tractor when drawing the machine without operation the elevator chain (F_1) and tractor fuel consumption during harvesting operation (F_2).

Consequently the fuel consumption in operating elevator chain = $F_2 - F_1$

Therefore the power required for elevator chain to calculated by the following equation (Embaby 1985):

$$EP = \frac{F.C \times \rho_r \times L.C.V \times 427 \times \eta_m \times \eta_{th}}{3600 \times 75 \times 1.36}, \text{kW} \quad \text{------} \quad 4$$

Where:

EP	= power requirements consumption during the harvesting operation, kW;
F.C	= fuel consumption, l/h;
ρ_f	= density of the fuel, 0.85 kg/l;
L.C.V	= lower calorific value of fuel, 1000 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 to 40% for diesel engine).

Energy requirements, = Power, kW × Productivity, h/fed, kW.h/fed -- 5

Measurements after harvesting:

1. Tuber harvesting:

After the harvesting lifted tubers were collected from a row length of 50 m and the losses tubers were extracted manually by hand digging tool for the same length. The lifted, damaged tuber percentage (lif_t and D_t, %) and harvester efficiency (E,%) were determined by using the followings equations:

$$Lif_t\ \% = \frac{m_1}{m_1 + m_2} \times 100 \quad \text{------} \quad 6$$

$$D_t\ \% = \frac{m_3}{m_1 + m_2} \times 100 \quad \text{------} \quad 7$$

$$E\ \% = \frac{m_4}{m_1 + m_2} \times 100 \quad \text{------} \quad 8$$

Where:

m_1 = mass of lifted tubers, kg/plot;

m_2 = mass of unlifted tubers, kg/plot;

m_3 = mass of damaged tubers, kg/plot and

m_4 = mass of undamaged tubers, kg/plot.

2. Cost analysis:

The total hourly cost of operation could be estimated by using the following formula (Awady, 1978):

$$C=\frac{P}{A}\left(\frac{1}{a}+\frac{i}{2}+t+r\right)+(1.2\,W.S.F)+\frac{m}{144} \quad \text{------------------------------------} \; 9$$

Where:

C = Hourly cost, L.E/h;
P = Price of machine, L.E;
A = Yearly working hours, h;
a = Lift expecting of the machine, year;
i = Interest rate/year ratio;
t = Taxes, overheads ratio;
r = Repairs and maintenance ratio;
W = Power, hp;
F = Fuel price, L.E;
S = Specific fuel consumption, l/hp.h;
M = Operator monthly salary;
144= The monthly average working hours.
1.2= Factor accounting for lubrication and1

RESULTS AND DISCUSSION

1. Effect of tilt angle, speed ratio (forward speed to chain speed) and type of harvesting on lifted, unlifted and damaged tubers:

Data presented in Table 2 and Figs. 5 and 6 show that the highest values of lifted tubers and the lowest values of damaged tubers were obtained at tilt angle of 0.384 rad (22 deg). for both harvesting machines. The tilt angles of 0.227, 0.297 and 0.384 rad (13, 17 and 22 deg). gave total damage of 4.5, 4.2 and 3.7% at speed ratio of 1.0 by using elevator potato digger. This is due to the floating blade caused cut of tubers and the amounet of soil lifted with tuber is less in case of tilt angle of 0.227 rad (13 deg).

Also, Table 2 and Figs. 5 and 6 show that increasing the speed ratio from 1.0 to 2.5 the lifted tubers and the total damage decreased from 96.2 to 92.0% and 4.2 to 2.9%, respectively, at tilt angle of 0.297 rad (17 deg). The other tilt angles had the same mentioned above trend. These results may be due to by increasing the forward speed to chin speed the amount of soil on the chian increased which create a cushioning effect reducing tubers damage.

The same Table and Figuers reveled that at all tilt angles and forward speeds, the elevator potato digger gave the highest values of lifted tubers and lowest values of damage compared with normal ridger.

2. Effect of tilt angle, forward speed and type of harvesting on harvesting efficiency:

Harvesting efficiency related with the lifted, damage, undamaged and lifted tubers also the forward speed are considered important parameters.

Data in Table 2 and Figs. 5 and 6 show that in case of elevator potato digger, increasing speed ratio tends to increase the harvesting efficiency at all tilt angles. The highest harvesting efficiency of 98% was obtained at tilt angle of 0.384 rad (22 deg) and speed ratio of 2.5, but the lowest percentage was 95.5 at tilt angle of 0.227 rad (13 deg) and speed ratio of 1. Whereas for normal ridger, the harvesting efficiency increased by increasing tilt angle and decreasing forward speed. The highest harvesting efficiency of 97.15% was obtained at tilt angle of 0.384 rad (22 deg) and forward speed of 2.5 km/h, but the lowest percentage was 93.10 at tilt angle of 0.227 rad (13 deg) and forward speed of 6.25 km/h.

Table 2: Effect of tilt angle; speed ratio (forward speed to chain speed) and forward speed on the percentage of lifted, total damaged tubers and harvesting efficiency for elevator potato digger and normal ridger

Machine type	Variables	Average values		
		Lifted tuber, %	Total damaged tuber, %	Harvesting efficiency, %
Elevator potato digger (EPD)	Speed ratio:			
	1.0	96.13	3.80	96.20
	1.5	94.63	3.33	96.40
	2.0	93.93	3.13	96.84
	2.5	91.80	2.90	97.10
	Mean	94.13	3.29	96.63
	Tilt angle rad (deg):			
	0.227 (13)	93.53	4.17	95.81
	0.297 (17)	94.28	3.37	96.43
	0.384 (22)	94.58	2.34	97.66
	Mean	94.13	3.29	96.63
Normal ridger (NR)	Forward speed, km/h:			
	2.50	89.00	3.82	96.22
	3.78	88.26	3.95	96.05
	5.00	86.37	4.63	95.37
	6.25	84.77	5.57	94.43
	Mean	87.10	4.49	95.52
	Tilt angle rad (deg):			
	0.227 (13)	86.10	5.50	94.50
	0.297 (17)	87.10	4.44	95.56
	0.384 (22)	88.10	3.54	96.49
	Mean	87.10	4.49	95.52

3. Effect of forward speed and type of harvesting machine on effective field capacity and efficiency:

For types of potato harvester, used in the present study, increasing the forward speed tends to increase the effective field capacity, while the field efficiency decreased. The effective field capacity is the actual performance rate for a machine. This technical indicator includes loss time during machine operation. By increasing forward speed the effective field capacity increased.

Increasing the forward speed from 2.5 to 6.25 km/h tends to increase the effective field capacity by 102% and 109% by using elevator potato digger and normal ridger respectively. The results from the present study indicated that, the field efficiency decreased by increasing forward speed for all potato harvesters used as shown in Fig. 7.

Increasing the harvesting forward speed from 2.5 to 6.250 km/h tends to decrease the field efficiency from 70.30 to 56.75% and 77.25 to 64.5%, in case of elevator potato digger and normal ridger, respectively, in Fig. 7.

It is observed that the field efficiency for elevator potato digger less than normal ridger this result may be due to the time required to repair during operation in case of elevator potato digger was higher than the normal ridger.

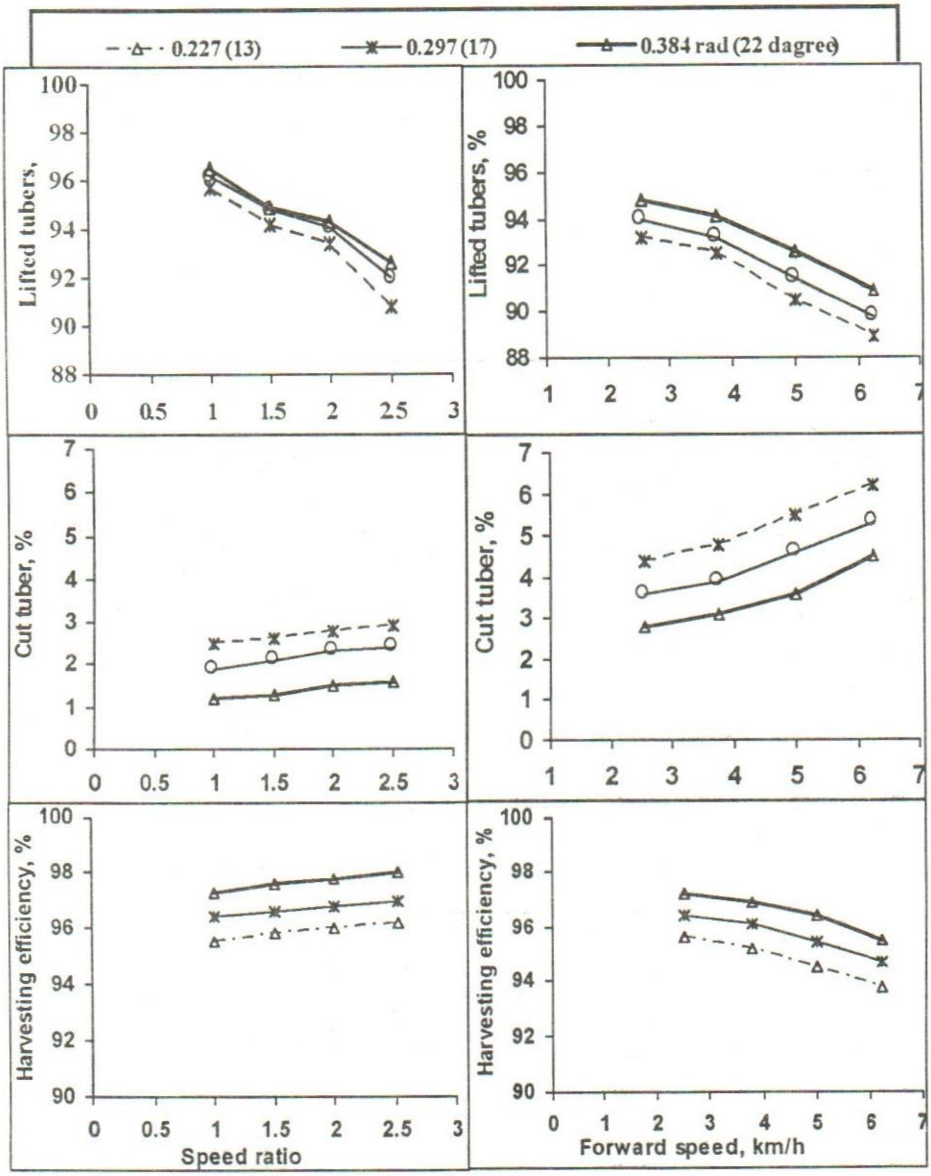

Fig 5: Effect of speed ratio and tilt angle on lifted, unlifted, cut tubers and harvesting efficiency for elevator potato digger.

Fig 6: Effect of speed ratio and tilt angle on lifted, unlifted, cut tubers and harvesting efficiency for normal ridger.

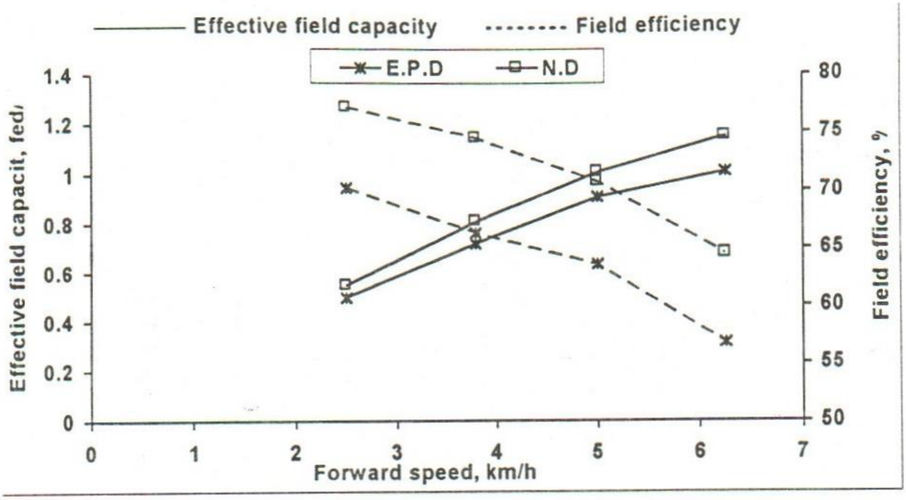

Fig 7: Effect of forward speed and type machine harvesting on effective field capacity and field efficiency

4. Effect of forward speed and tilt angle on draft force, power energy required and fuel consumption for both harvesting system:

Data presented in Table 5 indicted that the highest draft force, power and energy requirements of 9.07 kN, 18.11 kW and 17.93 kW.h/fed were recorded at forward speed of 6.25, respectively, by using elevator potato digger compared with 5.57 kN, 9.66 kW and 8.40 kW.h/fed by using normal ridgger at the same condition but the lowest values were 7.83 kN, 6.60 kW and 13.20 kW.h/fed under forward speed of 2.50 km/h, respectively, for elevator potato digger compared with 4.43 kN, 3.08 kW and 5.60 kW.h/fed for normal ridger at the same conditions. It is evident that the power in case of elevator potato digger is higher than in case of normal digger. These results may be due to the elevator potato digger needs a power not only for draft but also for the drive of elevator, besides the mass of the elevator potato digger which is higher than the mass of the normal ridger.

5. Relationship between type of harvesting machine and the average of potato yield cost of harvesting operation:

Yield is considered an important indicator to evaluate the different harvesting systems. Table 6 shows the relationship between the type of potato harvester and the average potato yield. However, the average yield in case of elevator potato digger was higher than in case of normal ridger. The average yield for elevator potato digger and normal ridger were 9.50 and 8.50 Mg/fed, respectively. The total cost of harvesting operation is considered an important indicator to evaluate the utilized system.

Table 5: Effect of forward speed and tilt angle on draft force, power energy required and fuel consumption for both harvesting system

Harvesting machine type		Fuel cons., l/h		Draft force, kN	Power require., kW		Total Power, kW	Energy req., kW.h/fed
		F1	F2		P_1,	P_2,		
Elevator potato digger (EPD)	Forward speed, km/h							
	2.50	5.42	5.78	7.83	5.44	1.16	6.60	13.20
	3.78	5.87	6.43	8.17	8.58	1.79	10.37	14.40
	5.00	6.47	7.18	8.67	12.04	2.26	14.30	15.72
	6.25	6.92	7.67	9.07	15.74	2.37	18.11	17.93
	Tilt angle, rad							
	0.227 (13 deg)	5.91	6.50	8.20	10.16	1.86	12.02	14.87
	0.297 (17 deg)	6.25	6.85	8.38	10.37	1.90	12.27	15.26
	0.384 (22 deg)	6.34	6.95	8.73	10.81	1.94	12.74	15.81
Normal ridger (NR)	Forward speed, km/h							
	2.50		5.05	4.43	3.08		3.08	5.60
	3.78		5.65	4.73	4.97		4.97	6.14
	5.00		6.55	5.33	7.41		7.41	7.33
	6.25		6.90	5.57	9.66		9.66	8.40
	Tilt angle, rad							
	0.227 (13 deg)	5.85	4.83	6.04			6.60	6.61
	0.297 (17 deg)	6.03	5.00	6.25			6.88	6.84
	0.384 (22 deg)	6.24	5.23	6.55			7.15	7.15

P_1 = Draft power requirement, kW.
P_2 = Elevator chain power requirement, kW.

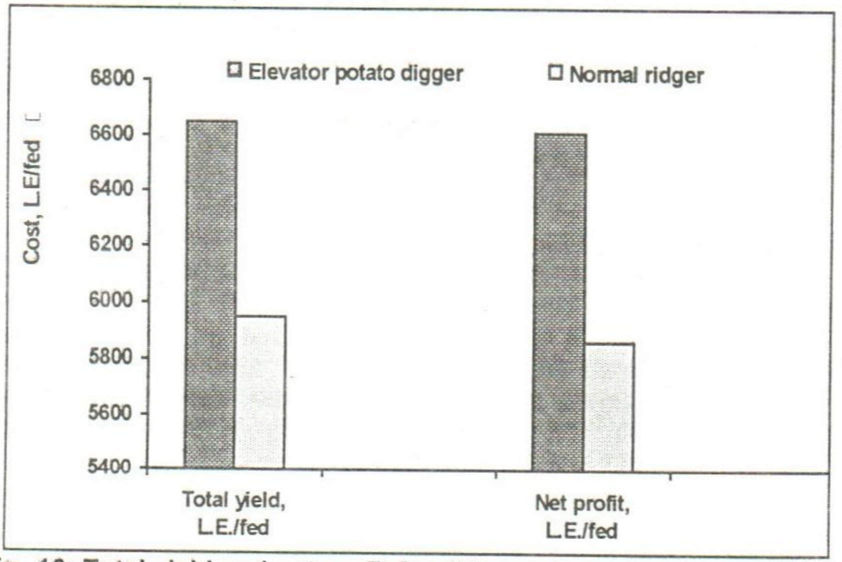

Fig. 10: Total yield and net profit for different harvesting systems.

Table 6: Total cost, total yield and net profit for different harvesting systems

Machine type	Total cost, L.E./fed	Total yield, Mg*/fed	Total yield price, L.E./fed	Net profit, L.E./fed
Elevator potato digger	38.2	9.5	6650	6611. 8
Normal ridger	85.0	8.5	5950	5865

* price of one Mg of potatoes equal 700 L.E

Table 6 and Fig. 10 indicates that the cost of harvesting operation for elevator potato digger and normal ridger method were 38.2 and 85.0 L.E/fed, respectively. The net profit of the same systems was 6611. 8 and 5865 L.E/fed, respectively.

Conclusion

The conclusion can be summarized as follows:

1. The optimum operation condition for elevator potato digger were found to be 0.297 rad (17 deg) tilt angle and speed ratio of 2.0 at these conditions, the lifted tubers, total damaged tubers, harvesting efficiency, effective field capacity, field efficiency and energy requirement were 94.10%, 3.09%, 96.91%, 0.91 fed/h, 63.60% and 13.07 kW.h/fed, respectively.
2. The optimum operation condition for normal ridger were found to be 0.384 rad (22 deg) tilt angle and forward speed of 5.0 km/h. These conditions gives the following results: lifted tubers, cut tubers, harvesting efficiency, effective field capacity, field efficiency and energy requirement were 87.60%, 3.60%, 96.40%, 1.01 fed/h, 70.85% and 7.69 kW.h/fed, respectively.
3. Potato harvesting by using elevator potato digger gave total yield of 9.5 Mg/fed and net profit of 6611.8 L.E/fed compared with 8.5 Mg/fed and 5865 L.E/fed for normal ridger, respectively.

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المراجع العربية:

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تقييم وتحديد الأداء الأمثل لنظامين آليين لتقليع البطاطس

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تحتل البطاطس مركزاً هاما بين المحاصيل الغذائية، حيث تشغل المركز الرابع بعد الأرز والقمح والذرة تعتبر مصر من الدول المنتجة والمصدرة لمحصول البطاطس حيث يمكن إنتاج وتصدير البطاطس المصرية فى الأوقات التى لا تتوافر فيها بطاطس طازجة (حديثة الحصاد) فى أوربا وتعتبر البطاطس إحدى السلع التصديرية الهامة فى مصر حيث يزرع منها سنويا ما يقرب من ١٨٠–٢٠٠ ألف فدان، تعطى إنتاجية كلية تقدر بحوالى ١,٨ – ٢,٠ تيرا جرام موزعة على العروات الثلاثة الصيفية والنيلية والمحيرة، كما يتم سنويا تصدير حوالى ٣٠٠ – ٣٥٠ جيجا جرام بطاطس طازجة. لذلك يجب تقييم أداء هذه الأنظمة وقد استخدم صنف دايمونت حيث أجريت التجارب الحقلية بأرض طينية متوسطة القوام بمحافظة كفر الشيخ – مركز سيدي سالم – قرية منشأة عباس.

وكان الهدف من هذه الدراسة تقييم أداء نظامين من أنظمة حصاد البطاطس وهى:

أ) آلة حصاد البطاطس ذات حصيرة فصل خطين.

ب) الخطاط العادى المستخدم لإقامة الخطوط خطين.

على مؤشرات الكفاءة للدرنات المحصودة كالتالي:

الوقود المستهلك، القدرة المستهلكة، الطاقة المستهلكة، السعة الحقلية الفعلية، الكفاءة الحقلية، نسبة الدرنات المرفوعة من التربة (سليمة تماما)، نسبة الدرنات المتروكة بالتربة، الدرنات المقطوعة أو التى حدث بها ضرر، تكاليف الحصاد وإنتاجية الآلات المختبرة.

تحت تأثير كل من نسبة السرعة بين السرعة الأمامية وسرعة الحصيرة لآلة الحصاد ذات الحصيرة تحت أربعة مستويات هى ١,٠، ١,٥، ٢,٠، ٢,٥ والسرعة الأمامية لآلة الحصاد العادية (الخطاط) وهى ٢,٥، ٣,٧٨، ٥,٠، ٦,٢٥ كم/ساعة وزاوية اختراق السلاح للتربة عند أربعة مستويات هى ٠,٢٢٧، ٠,٢٩٧، ٠,٣٨٤ زاوية نصف قطرية (١٣، ١٧، ٢٢ درجة) .

وكان ملخص النتائج كما يلى:–

– فى آلة حصاد البطاطس ذات الحصيرة أدت زيادة نسبة السرعة بين السرعة الأمامية وسرعة حصيرة رفع الدرنات من ١,٠ إلى ٢,٥ إلى زيادة كل من نسبة الدرنات المتروكة بالتربة من ٣,٨٧ إلى ٨,٢٠٪ ، وكفاءة الحصاد من ٩٦,٢ إلى ٩٧,١٪ ، والسعة الحقلية الفعلية بنسبة ١٠٢٪ ، والطاقة المطلوبة بنسبة ٤٣,٣٣%. بينما أدت إلى نقصان كل من نسبة الدرنات المرفوعة من التربة من ٩٦,٣ إلى ٩١,٨ ٪ ، والتالف الكلى للدرنات من ٣,٨ إلى ٢,٩%.

– فى آلة حصاد البطاطس العادية بزيادة السرعة الأمامية من ٢,٥ إلى ٦,٢٥ كم/ساعة أدت إلى زيادة كل من نسبة التلف الكلى للبطاطس من ٣,٨٢ إلى ٥,٥٧٪ ، و السعة الحقلية بنسبة ١٠٩,١٪ والطاقة المطلوبة بنسبة ٤٨,٩٤٪ . بينما انخفضت كل من نسبة الدرنات المرفوعة من ٨٩,٠ إلى ٨٤,٧٧٪، وكفاءة الحصاد من ٩٦,٢ إلى ٩٤,٤٣٪.

– أعطت زاوية اختراق السلاح للتربة ٠,٢٢٧ زاوية نصف قطرية (١٣درجة) أقل قيمة لنسبة الرنات المرفوعة (٢٩٣,٥٣ ، ٩١,١٠٪) وكفاءة الحصاد (٩٥,٨ ، ٩٤,٥٠٪) والطاقة المطلوبة (١٤,٨٧ ، ٦,٦١ كيلو وات. ساعة/فدان). بينما أعطت أعلى قيمة لكل من نسبة التلف الكلى للدرنات (٤,١٧ ، ٥,٥٠ ٪) لكل من آلة الحصاد ذات الحصيرة والخطاط العادى على التوالى.

– استخدام نظام تقليع البطاطس بآلة الحصاد ذات الحصيرة أعطى أعلى صافى عائد ٦٦١١,٨ جنية/فدان عند سعة حقلية فعلية ٠,٧٩ فدان/ساعة وكفاءة حقلية ٦٤,٢٦٪ مقارنة بصافى عائد ٥٨٦٥,٠ جنية/فدان عند سعة حقلية ٠,٨٨ فدان/ساعة وكفاءة حقلية ٧١,٨٠٪ للخطاط العادى.