PERFORMANCE EVALUATION AND SELECTION THE PROPER SYSTEM OF HARVESTING OF SOME CROPS IN SMALL HOLDINGS

G.M. Nasr[1] A.Z. Taieb[2], R.M. El-Gharbawy[3]

ABSTRACT

Due to the actual problems of manual harvesting, the use of mechanical mowers for crop harvest could be suitable. Many types of mowers are used extensively in many countries of the world. In Egypt, they are used to harvest forage gorage and cereal crops and are widley used nowadays in cleaning the farm of crop residues. The field experiments showed that the selected (suitable) forward operating speeds for cutting cotton stalks, sweet sorghum stalks, mowing clover and harvesting wheat, it gave the highest values of cutting efficiency. It is preferable using the self-propelled reciprocating mower in harvesting wheat, cutting sweet sorghum stalks and cutting cotton stalks. It is not preferable using the self-propelled reciprocating mower in mowing clover, whereas the least of actual field capacity, the highest required energy, the highest costs per unit area and the least cutting efficiency. It is preferable using the tractor-mounted reciprocating mower in small farms and in harvesting wheat, cutting sweet sorghum stalks, cutting cotton stalks and mowing clover. And, it is preferable using the tractor-mounted disc mower in cutting sweet sorghum stalks, cotton stalks and mowing clover, it is not preferable using the tractor-mounted disc mower in harvesting wheat, owing to the cutting efficiency was increased (70.48%), beside the highest both of required energy and costs per unit area, the harvesting losses was increased (29.52%).

INTRODUCTION

The policy of Egypt is to accomplish the utimate agricultural production to meet with the over population, designing new progressed systems, developing and adapting the up to date technology is of great importance to be applied successfully under

[1] **Prof. And Head of Ag. Eng. Dept. Fac. of Ag. Cairo Univ.**
[2] **Assist. Prof. of Ag. Eng. Fac. of Ag. Cairo Univ.**
[3] **Post graduate student (MASTER) Ag. Eng. Dept. Fac. of Ag. Cairo Univ.**

Egyptian conditions. The poor economic conditions of the Egyptian farmer, the height cost of combines, the small size of land holdings and the limited irrigation systems, which now exist, are great hindrances to mechanical harvesting.

The Egyptian arable area is mostly fragmented. More than 50% of the farms are less area than 5 feddans. The small sizes of land holdings cause certain difficulties in using the big and medium sizes of agricultural machinery. Using mowers to harvest crops from small farms, even as an intermediate technology for some crops, would be a vital contribution to increasing the use and decreasing harvesting time for the crops.

Hanna *et al*. (1985) mentioned that the Egyptian agricultural characteristics affected by the mechanical harvesting were as follow: small holding area, limited farmer fincial sources, divided the land to small sections and crop varieties have tendency to lodge and loose grain with high straw ratio.

El-Berry (1985) concluded that the major obstacles limited the uses of mechanical harvesting in Egyptian fields were as follow: the farmer neglected seedbed preparation, divided the lands to small sections increase the harvesting time and decrease the field efficiency, limited farmer's finical sources affected buying harvesting machine and the imported harvesting machine spare parts.

Hanna and Suliman (1986) found that the rear side mounted reciprocaing mower connected with tractor, when they cutting too low, liable to hit many physical obstacles in the field such as cross bunds which may damage the blade and knife assembly.

El-Danasory (1984) stated that the possibility of intensifying the use of different mowers as self-propelled single knife mower, rear side mounted single knife mower, rear side double mounted mower, rear side mounted disc mower and hand tool. Mowers were used on cotton stalks, clover, sorghum, wheat and rice. From the results obtained, some conclusion can be made:

1- Low field capacity and high cost of the self-propelled mowers, as compared with mounted reciprocating mowers, except for wheat harvesting, the cost was higher due to additional labor wage. Also the cost

of the self-propeled mowers was higher than hand tool cost for rice and clover.

2- In the forage farms (clover and sorghum), it was preferred to use the mounted disc mowers due to its high field capacity and low maintenance costs.

Shippen *et al* (1980) showed that many of the mowers used on farms are of the cutter-bar type and they may be either mounted directly on the tractor or partially carried by cast or wheels at the rear. They pointed to the following types:

a) Finger-bar mowers: The knife, driven by pitman or connecting rod, Lies through the fingers, which are bolted to the cutter bar back. The knife sections slide to and for over the flat faces of the fingers, which are known as ledger plats. From the center of one finger to the center of the next, the length of travel being mostly 7.62 cm.

b) Finger-less (double-knife) mowers: These types consist of two similar knives located one above the other by spring-loaded oscillating similar arms and the knife connections operate through sealed ball joints. Individual knife sections move over each other exactly like a pair of scissors. There is a fairly wide spacign betwen adjacent sections on each knife, and this makes it easy to sharpen the knives correctly.

c) Disc mowers: These types of mowers are usually fully mounted on the tractor's three point linkage and driven by the power take off (P.T.O.). These machines consist of four small diameter discs rotating at very high sped (3500 rpm). Attached to each disc, two small blades which may be reversed or replaced when worn. The drive from the P.T.O. is usually transferred by a (V) belt down to the cutter-bar, where gears, running in a sealed casing, transmit the power to the individual discs, two of which rotate clockwise and the pair anti-clockwise. The usual safety devices such as slip clutches and spring loaded release mechanisms are also provided on these mowers.

d) Drum mowers: They are similar in operation to the disc mower but requiring considerably more power to drive them. These, however, consist of two large diameter drums rotating at a lower speed, the drive to these being from belts or shaft and gears running across the

top of the machine. A saucer underneath each drum runs on the ground and the clearance between drum and saucer may be varied to alter cutting height. Again, safety devices are provided on these machines for protection against damage.

e) Flail mowers: These machines are trailed on off-set hitches behind the tractor and consist of a horizontal rotor on to which are mounted four banks of free swing flails which are held at right angles to the rotor by centrifugal force but may fold back when obstruction be struck. Hay or silage blades may be fitted dependent on circumstances. Height of cut is controlled by varying the pivot point of the hydraulic ram connected to the exle, this ram in turn is used for raising and lowering the machine in and cut of work.

Chanceller (1985) indicated that the higher energy requirements for cutting forage crops were at higher levels of moisture content and for serrated edged blades.

Abd El-Motaleb (1985) indicated that the moisture content of the grain and dry matter yield of the crop were considered good parameters to describe the maturity of th crop. He also reported that the optimum period of harvesting wheat crop was when moisture content of grain ranged from 12-28% (wet basis).

Hashish (1985) found that increasing forward speed from 1.5 to 3.0 km/h will result in a decrease in field efficiency. He also found that when increasing the speed more than 3.0 km/h a great number of rice plant was left without harvesting.

El-Danasory (1984) found that the suitable working forward speed for self-propelled mower was 3.0 km/h in wheat crop. While in the state of tractor-mounted mower was 3.9 km/h in the clover.

Zhang *et al*. (2000) reported that an experiment was conducted to test the chopping properties of wheat straw under different conditions. On the basis of test results, main cutting curves of wheat straw were given, under different cutting speeds of rotary blade, straw lengths, moisture contents, cutting positions, thickness of knife-edge, and with and without a shear bar. The curves showed that the straw moisture content and the shear bar are the main impact factors to the cutting ration besides cutting speed.

Kamel *et al* (2002) studied the effect of moisture content, harvesting forward speed and cylinder speed on grain losses during the harvesting operation. They indicated that, increasing the harvesting forward speed from 1.3 to 4.8 km/h tends to increase the field capacity from 0.67 to 1.86 fed./h.

Hanna and Suliman (1986) indicated that harvesting machines were greatly affected by both size shape of the experimental plots.

Hanna *et al* (1985) compared mechanization methods of cotton stalk removal including shredding and mowing. Shredding had the highest productivity of 0.41 fed./h with an energy requirement of 98.06 kW/h/fed.

El-Khateeb (2001) studied that on performance evaluation of using rotary mower in cutting and chopping of corn stalks. He indicated that, the maximum value of stubble height was 17.67 cm at forward speed of 4.5 km/h and the minimum value of 8.20 cm at 2.51 km/h. the maximum value of stubble height was 17.67 cm at forward speed of 4.5 km/h and the minimum value of 8.20 cm at 2.1 km/h. The maximum value of cutting officiency was 95.00% at forward speed of 2.5 km/h. The increment in forward speed tends to increase the actual field capacity and decrease field effiiency. The maximum value of effective field capacity and efficiency was 1.40 fed./h and 82.40% at forward speeds of 4.51 km/h and 2.51 km/h, respectively. The highest value of cutting energy was 28.97 kw.h/fed. at forward speed of 2.51 km/h. The lowest value of cutting energy was 12.19 kw.h/fed. at 4.51 km/h, resp.

Hanna and Suliman (1986) carried out a comparison between different tools and equipment capable of harvesting more than one crop in small farms. The harvesting equipment were mainly; hand tools (Sickle, Scythe), rear side mounted reciprocating type mower, self-propelled harvester and combine harvesting of grain is still the predominant way in Egypt and is done by means of sickle. It takes from 40-50 man to harvest one feddan. Self-propelled harvester with wheel steering on operator the hourly production of this machine ranges from 0.4 to 0.7 fed. (0.168-0.294ha) with a working width of 1.27 cm. Cost of harvesting and threshing ranged from 9.15 L.E./fed. with tractor mounted mower up to 13.08 L.E./fed. with harvester. However, for the hand tool.

The aim of research is to reach the harvesting machine (mower) is suitable of the Egptian farmer under Egyptian conditions (Poor economic potentiality and small sizes of land holdings).

MATERIAL AND METHODS

To realize the aim of this study, different types of mowers were used, namely: self-propelled reciprocating mower, tractor-mounted reciprocating mower and tractor-mounted disc mower that would harvest or dispose of more than one crop (cotton, sweet sorghum, clover and wheat by using Nasr tractor 65).

The field experiments were carried out at the El-Bosely and Adfena Farms. Horticultural Services Unit-Agricultural Research Center-Ministry of Agriculture and Land Reclamation, El-Sakran Farm-Village No. 7-Edko and El-Sakran Farm Tolompat Halk El-Gamel-Abo-Homous Center-El-Behera Governorate.

(1) Mowers specification and description, Table (1).

(2) Physical properties of cotton, sweet sorghum, clover and wheat. The stem length, the stem diameter, the number of stems per hill, the number of stems in square meter and stem moisture content were measured, calculated and recorded for samples of crop stems, taken at random during each harvesting operation.

(3) Plant measurements (cutting efficiency):
The suitable operating forward speed was chosen to be the one providing the highest cutting efficiency.
The cutting efficiency (η_c) was calculated by using equation (1):

$$\eta_c = \frac{A - B}{A} \times 100 \qquad \text{.....(1)}$$

Where:
A - The height of stand plants before cutting, cm;
B - The height of stubble left after cutting, cm.

(4) Field work performance:
Field work performance was determined by many indicators which are: the actual field capacity, the theoretical field capacity and the field efficiency.

a- Calculation of the actual field capacity:

The actual field capacity (AFC) was calculated by using equation (2).

Table (1): Mowers specification and description.

No.	Feature	Specification And Description		
		Self. Propelled reciprocating mower	Tractor-mounted reciprocating mower	Tractor-mounted disc mower
1	Source of manufacture	Japan	Italy	Italy
2	Model	AR 120	FBR925	CM 270 F
3	Commercial name	Kubota	Gaspardo	PZ (Green Land)
4	Width of cut, cm	120	150	165
5	Cutting height, cm	10-30	-	28-50
6	Weight, kg	116	-	445
7	Power take of rev.	-	540	540
8	No. Of drums	-	7.6	2
9	Knife stroke, cm	-	Serrated	-
10	Knife edge	-	Hydraulic	-
11	Type of control	-	Reciprocated	Hydraulic
12	Type of knife	-	(Rear Mounted tractor)	Disc Knives
13	Power required, hp (kw)	-	25 (18.64)	30 (22.38)
Engine	Type	4 cycle, air-cooled		
	Model	GS 130-2CN		
	Continuous rated out put	2.3 PS/1800 rpm		
	Maximum out put	3.4 PS (~3.35 hp)		
	Displacement, CC	130		
	Fuel	Regular gasoline for car use		
	Fuel tank volume, litre	3.0		

$$AFC = \frac{1}{Tt} \text{.....fed./h} \quad (2)$$

Where:

Tt = Total consumed time per feddan. (min./fed.)

= TU + TL

TU = Time consumed in providing useful field work (min./fed.)

TL = The lost time per feddan (min./fed.)

$= T_1 + T_2 + T_3$

T_1 = Time spent in turning at the ends of field perfeddan, (min./fed.)

T_2 = Short resttimeand the time spent in moving from one plot to another per feddan, (min./fed.)

T_3 = Time spent in interruptions and simple repair and adjustments of the implements per feddan, (min./fed.)

b- Calculation of the theoretical field capacity:

The theoretical field capacity (TFC) was calculated by using equation (3) (Kepner *et al*., 1982):

$$TFC = \frac{W \times S \times 1000}{4200}$$

$$= \frac{W \times S}{4.2}$$

$= 0.2381 \times W \times S$ fed./h (3)

W = Working width of the performing implements (m).

S = Suitable forward operating speed (km/h)

c – Calculation of field efficiency:

The field efficiency (η_f) was calculated by using equation (4):

$$\eta_f = \frac{AFC}{TFC} \times 100, \% \quad \text{.....(4)}$$

6- Power and energy measurements:

Studying the different parameters of consumed fuel and the total consumed time in any operation helps in calculating the power and energy requirements for the different types of mower.

a- Determination fuel consumption rate:

Fuel consumption volume per time was determined by using the fuel consumption apparatus (fuel cylinder) graded. Then the fuel consumption rate (FC) was determined by using equation (5).

$$FC = \frac{V \times C}{T} \quad \text{L/min. (5)}$$

Where:

V = Volume of fuel consumption, Cm^3;

T = Time of harvesting, min;

C = Constant (0.001).

b- Power requirements:

The power requirement (PR) was calculated by using equation (6) Hunt, 1983:

$$PR = FC \times \frac{1}{60 \times 60} \times PF \times CV \times 427 \times \eta_m \times \eta + h \times \frac{1}{75} \times 0.746$$

$$= 3.209 \times FC \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{kW (6)}$$

Where:

FL = Fuel consumption, L/h;

pf = Density of the fuel, kg/L (for solar fuel = 0.85 kg/L);

cv = Calorific value of fuel, k Cal/kg (average of solar = 10000kCal/kg);

427 = Constant (thermo-mechanical equivalent);

η_m= The mechanical efficiency for the engine (considered to be about 80% for diesel engine);

η+h = The mechanical efficiency for the engine (considered to be about 40% for diesel engine);

0.746 = Coefficient for charging from hp to KW.

c- Energy requirements:

The energy requirement (ER) was calculated by using equation (7):

$$ER = \frac{PR}{AFC} \quad \ldots\ldots\ldots\ldots \quad \text{kW.h/fed}\ldots\ldots\ldots(7)$$

Where:

PR = Power requirement, KW;

AFC = Actual field capacity, fed./h.

7- Operating costs (TC) were estimated from equation 8. (Oida 1997).

$$TC = \frac{\left\{\left[\frac{P-S}{Y} + \frac{P+S}{2}.\frac{1}{100} + (0.02P)\right] + \left[\left(\frac{p.r}{y} + (fp.FC.n) + (OC.C.n) + (N.L.n)\right)\right]\right\}}{n} \quad \ldots\ldots$$

…(8)

Where:

TC = Total cost, LE/h;

P = Purchase price, LE;

S = Salvage value, LE;

= 0.65 $(0.885)^y$ * P for machine

= 0.68 $(0.920)^y$ * p for tractor

i = Interest rate, % = 9%

r = coefficient of repair and maintenance = 0.80, decimal;

y= Anticipated length of time owned, year;

= 5 years for the machine, and 10 years for the tractor;

fp = Fuel price, LE/L

FC = Fuel consumption, Lit/h;

OC = Oil consumption = 0.00059 * pt + 0.02169, Lit/h;

C = Oil price, LE/L;

N = Number of labors;

L = Labor wage, LE/h;

N = Yearly working hours, h/year;

= 500 for the machine and 1000 for tractor.

8- Costs per unit area:

The costs per unit area was calculated by using equation (9).

$$\text{Costs per unit area} = \frac{T}{AFC} \quad \text{LE/fed…..(9)}$$

Where:

TC = Total cost, LE/h;

AFC = Actual field capacity, fed./h

RESULTS AND DISCUSSION

1- Study of physical properties of the cotton stalk, sweet sorghum stalk, clover and wheat crops:

The physical properties of crops were determined as the mean value of twenty readings of different plots in different farms as shown in T able (3).

Table (2): Some physical properties of cotton stalk, sweet sorghum stalk, clover and wheat crops

No.	Crop	Stem length, cm	Stem diameter, cm	No. of stems per hill	No. of stems in $1m^2$	Stem moisture content, %
1	Cotton stalk	147.3	1.25	2	14	32.40
2	Sweet sorghum stalk	151.0	0.98	1	50	45.20
3	Clover	70.4	0.43	1	430	58.78
4	Wheat	105.4	0.41	1	310	20.30

* Mean of 20 readings from different plots.

From the results shown in Table (2), it is clear that the mean value of stem length of cotton stalk, sweet sorghum stalk, clover and wheat crops were 147.3, 151.0, 70.4 and 105.4 cm, respectively.

Also, from the results shown in Table (2), it is clear that the mean value of stem diameter of cotton stalk, sweet sorghum stalk, clover and wheat crops were 1.25, 0.98, 0.43 and 0.41 cm respectively.

And also, from the results shown in the same Table, it is clear that, the number of stems in $1m^2$ of cotton stalks, sweet sorghum stalks, clover and wheat crops are 14, 50, 430 and 310 stem, resp.

2- Effect of operating forward speeds on the stubble height left after harvesting and the cutting efficiency:

The suitable operating forward speed for harvesting operation was studied by many investigators and at the first stage of this investigation to conform with the actual sizes and conditions of small holdings in Egypt.

The suitable operating forward speed was selected according to the ones that gave the highest cutting efficiency and the least stubble height left after harvesting.

From the results shown in Table (3) and Fig. (1), it is clear that the cutting efficiency (%) of the self propelled reciprocating mower decreased from 88.23 to 56.02, from 90.60 to 88.72, from 77.33 to 74.50 and from 89.03 to 87.70 as the operating forward speed increased from 2.38 to 2.74, from 2.65 to 3.06, from 2.72 to 3.18 and from 3.02 to 3.36

km/h in harvesting cotton stalks, sweet sorghum stalks, clover and wheat, respectively.

Also, from the results shown in the same Table and the same Figure., it is clear that the cutting efficiency of the tractor-mounted reciprocating mower decreased from 92.26 to 87.80, from 93.13 to 87.93, from 80.34 to 76.36 and from 91.84 to 86.64% as the operating forward speed increased from 3.45 to 0.430, from 4.10 to 5.18, from 4.20 to 5.50 and from 4.45 to 5.80 km/h in harvesting cotton stalks, sweet sorghum stalks, clover and wheat, respectively.

And, also from the results shown in the same Table and the same Fig., it is clear that the cutting efficiency of the tractor-mounted disc mower decreased from 90.78 to 86.72, from 91.12 to 87.34 and from 70.48 to 63.75% as the operating forward speed increased from 3.64 to 5.18, from 4.28 to 5.30, from 4.34 to 5.76 and from 4.60 to 5.64 km/h in harvesting cotton stalks, sweet sorghum stalks, clover and wheat, respectively. This may be due to the nature of the Egyptian farms besides that the leveling operation is a forgotten technique and the farmer still counting it as a costly operation which forms additional costs that the production cannot bear. On the other hand the tractor driver always cuts high to provide the necessary protection to the cutter bar against wear and breakdown.

From the results shown in Table (3) and Fig. (1), it is clear that the suitable operating forward speeds for the self-propelled reciprocating mower were 2.38, 2.65, 2.72 and 3.02 km/h at cutting efficiencies were 88.23, 90.60, 77.33 and 89.03% in harvesting cotton stalks, sweet sorghum stalks, clover and wheat crops, respectively.

Also, from the results shown in the same table and the same Fig., it is clear that the suitable operating forward speeds for the tractor-mounted reciprocating mower were 3.45, 4.10, 4.20 and 4.45 km/h at cutting efficiencies were 92.26, 93.13, 80.34 and 91.84% in harvesting cotton stalks, sweet sorghum stalks, clover and wheat, respectively.

And, also from the results shown in the same Table and the same Fig., it is clear that the suitable operating forward speeds for the tractor-mounted disc mower were 3.64, 4.28, 4.32 and 4.60 km/h at cutting efficiencies were 90.78, 91.12, 73.38 and 70.48% in harvesting cotton stalks, sweet sorghum stalks, clover and wheat, respectively.

From the results shown in Table (3) and Fig. (1), it is clear that the highest value of cutting efficiency was 90.60% for harvesting sweet sorghum stalks

Table (3): The effect of operating forward speeds on the cutting efficiency for different types of mowers for cutting cotton stalks, sweet sorghum stalks, clover and wheat crops.

Type of crop	Cotton stalks				Sweet sorghum stalks				Clover				Wheat			
Type of implement	Forward speed,	Height of the stand plants	Height of the stubble plants	Cutting efficiency	Forward speed,	Height of the stand plants	Height of the stubble plants	Cutting efficiency	Forward speed,	Height of the stand plants	Height of the stubble plants	Cutting efficiency	Forward speed,	Height of the stand plants	Height of the stubble plants	Cutting efficiency
	km/h	fed./h	fed./h	%	km/h	fed./h	fed./h	%	km/h	fed./h	fed./h	%	km/h	fed./h	fed./h	%
Self-propelled reciprocating mower	2.02	143.6	21.2	85.24	2.28	151.8	18.9	87.55	2.34	70.4	18.6	73.58	2.45	105.3	14.2	86.51
	2.10	146.7	22.8	84.46	2.36	152.7	20.8	86.38	2.50	71.8	19.7	72.56	2.78	106.2	15.5	85.40
	2.38	149.5	17.6	88.23	2.65	149.5	14.6	90.60	2.72	69.7	15.8	77.33	3.02	105.5	10.8	89.03
	2.74	148.8	20.8	86.02	3.06	148.9	16.8	88.72	3.18	70.2	17.9	74.50	3.36	104.8	12.8	87.79
Tractor mounted reciprocating mower	3.14	149.5	19.6	86.89	3.30	153.0	20.0	86.92	3.48	69.4	17.2	75.22	3.74	105.7	15.0	85.81
	3.20	150.3	21.5	85.69	3.62	151.6	21.9	85.55	3.90	70.6	17.9	74.64	3.98	106.3	16.2	84.76
	3.45	144.7	11.2	92.26	4.10	152.8	10.5	93.13	4.20	71.2	14.0	80.34	4.45	105.4	8.6	91.84
	3.70	148.5	13.8	90.71	4.28	149.7	13.2	91.18	4.58	70.8	15.0	78.81	4.88	104.7	11.4	89.11
	4.16	143.8	14.5	89.92	4.50	152.4	15.3	89.96	5.10	70.4	15.9	77.41	5.42	105.5	12.8	87.87
	4.30	147.6	18.0	87.80	5.18	149.2	18.0	87.93	5.50	69.8	16.5	76.36	5.80	104.8	14.0	86.64
Tractor mounted disc mower	3.25	149.6	21.6	85.56	3.58	152.6	21.5	85.91	3.54	71.4	22.5	68.49	3.70	104.0	35.3	66.06
	3.50	151.1	22.8	84.81	4.06	151.4	23.5	84.48	4.02	70.3	23.6	66.43	3.34	104.8	36.4	65.27
	3.64	146.5	13.5	90.78	4.28	148.6	13.2	91.12	4.31	69.5	18.5	73.38	4.60	105.7	31.2	70.48
	4.32	147.6	16.6	88.75	4.64	149.3	15.5	89.62	4.78	68.6	19.6	71.43	4.96	105.8	34.0	67.86
	4.60	148.7	18.6	87.49	4.90	151.2	17.9	88.16	5.25	70.4	20.5	70.88	5.20	104.5	36.8	64.78
	5.18	148.3	19.7	86.72	5.30	148.5	18.8	87.34	5.76	70.5	21.6	69.36	5.64	104.3	37.8	63.75

* The dimensions of one plot were 105 m in length and 12m in width.

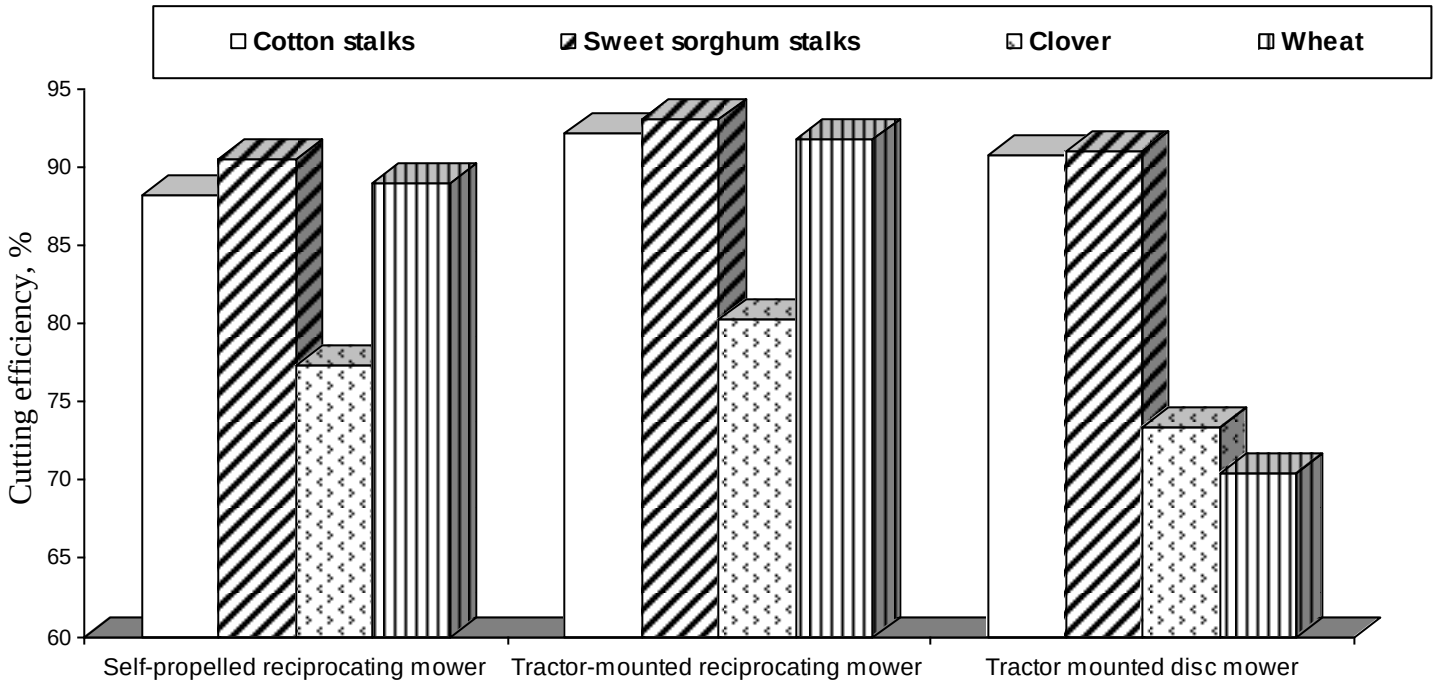

Fig. (1): The effect of operating forward speeds on the cutting efficiency for the different types of mowers for cutting cotton stalks, sweet sorghum stalks, clover wheat crops.

and the least value of cutting efficiency was 77.33% for harvesting clover by using the self-propelled reciprocating mower.
Also, the highest value of cutting efficiency was 93.13% for harvesting sweet sorghum stalks and the least value of cutting efficiency was 70.48% for harvesting wheat.
According to this results it is better than the using of the self-propelled reciprocating mower in harvesting sweet sorghum stalks; wheat, cotton stalks and clover, resp. And it is better than the using tractor-mounted reciprocating mower in harvesting sweet sorghum stalks, cotton stalks, wheat and clover, resp. And, also it is better than the using tractor-mounted disc mower in harvesting sweet sorghum stalks, cotton stalks, clover and wheat, resp.

3- Effect of suitable forward speeds on the actual field capacity, theoretical field capacity and field efficiency:

Field efficiency is affected by operating forward speed, effective width of cutting, time lost in turning, time spent in moving from one plot to another, interruptions repair, adjustment and other factors. The differences in the calculated values of actual field capacities is due to the differences in land topography, the value of time consumed in harvesting one feddan, operating forward speeds, and working widths for the different types of mowers. The main reason to reduce the field efficiency of the mowers, this may be due to the higher operating forward speed, the possibility to hit the land obstacles increased and consequently the time lost due to repair of moving parts actually increased.
From the results shown in Table (4), it is clear that the highest value of field efficiency was 58.82% for harvesting cotton stalks and the least value of field efficiency was 35.78% for harvesting clover by using the self-propelled reciprocating mower.
Also, the highest value of field efficiency was 74.91% for harvesting cotton stalks and the least value of field efficiency was 51.87% for harvesting clover by using the tractor-mounted reciprocating mower. And, also the highest value of field efficiency was 76.22% for harvesting cotton stalks and the least value of field efficiency was 39.51% for harvesting wheat by using the tractor-mounted disc mower.
According to the highest value of the actual field capacities, it is better than the using of the self-propelled reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover, resp. And it is better than the using tractor-mounted reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover, resp. And, also it is better than the using tractor-mounted disc mower in harvesting sweet sorghum stalks, cotton stalks, clover and wheat, resp.

Table (4): Suitable forward speed, coefficient of useful time, actual field capacity, theoretical field capacity of field efficiency for the different types of mowers.

Type of crop	Cotton stalks				Sweet sorghum stalks				Clover				Wheat			
Type of implement	Suitable forward speed	Actual field capacity	Theor. field capacity	Field efficiency	Suitable forward speed	Actual field capacity	Theor. field capacity	Field efficiency	Suitable forward speed	Actual field capacity	Theor. field capacity	Field efficiency	Suitable forward speed	Actual field capacity	Theor. field capacity	Field efficiency
	km/h	fed./h	fed./h	%	km/h	fed./h	fed./h	%	km/h	fed./h	fed./h	%	km/h	fed./h	fed./h	%
Self-propelled reciprocating mower	2.38	0.400	0.680	58.82	2.65	0.420	0.757	55.48	2.72	0.278	0.777	35.78	3.02	0.461	0.863	53.42
Tractor mounted reciprocating mower	3.45	0.923	1.232	74.91	4.10	1.050	1.464	71.72	4.20	0.778	1.500	51.87	4.45	1.120	1.589	70.48
Tractor mounted disc mower	3.64	1.090	1.430	76.22	4.28	1.226	1.681	72.93	4.32	1.059	1.697	62.40	4.60	0.714	1.807	39.51

* The working wid the for self-propelled reciprocating mower, tractor mounted reciprocating mower and tractor mounted disc mower are 1.20, 1.50 and 1.65m.

4. Energy requirements for the different types of mower:

Study the different parameters of the fuel consumed and the total consumed time in any operation helps in calculating the power and energy requirements for the different types of mowers.

The differences in the calculated values of power and energy requirements is due to the differences in fuel consumption and the total consumed time of the different types of mowers.

From the results shown in Table (5), it is clear that the highest value of energy required was 8.079 kW.h/fed. for harvesting clover and the least value of energy required was 4.176 kW.h/fed. for harvesting wheat by using the self-propelled reciprocating mower.

Also, the highest value of energy required was 15.426 kW.h/fed. for harvesting clover and the least value of energy required was 10.257 kW.h/fed. for harvesting what by using the tractor-mounted reciprocating mower.

And, Also the highest value of energy required was 16.899 kW.h/fed. for harvesting wheat, and the least value of energy required was 10.941 kW.h/fed. for harvesting sweet sorghum stalks by using the tractor-mounted disc mower.

According to the least values of the energy required, it is better to use the self-propelled reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover, resp. Also it is better to use tractor-mounted reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover, resp. And, also it is better than the using tractor-mounted disc mower in harvesting sweet sorghum stalks, clover, cotton stalks and wheat, resp.

5- Costs per unit area for the different types of mowers:

Calculating the different parameters of the total service price, actual field capacity, and power requirement in any operations helps in calculating the costs per unit area for the different types of mowers.

From the results shown in Table (6), it is clear that the highest value of costs per unit area was 105.39 LE/fed. for harvesting clover and the least value of costs per unit area was 63.56 LE/fed. for harvesting wheat by using the self-propelled reciprocating mower.

Also, the highest value of costs per unit area was 48.33 LE/fed. for harvesting clover, and the least value of costs per unit area was 33.57 LE/fed. for harvesting wheat by using the tractor-mounted reciprocating mower.

And, also the highest value of costs per unit area was 77.17 LE/fed. for harvesting wheat, and the least value of costs per unit area was 44.94 LE/fed. for harvesting sweet sorghum stalks by using the tractor-mounted disc mower.

Table (5): Power and energy requirements for the different types of mower for cutting cotton stalks, sweet sorghum stalks, mowing clover and harvesting wheat..

Type of crop	Cotton stalks				Sweet sorghum stalks				Clover				Wheat			
Type of implement	Measured fuel consumption	Power required	Actual field capacity	Energy required	Measured fuel consumption	Power required	Actual field capacity	Energy required	Measured fuel consumption	Power required	Actual field capacity	Energy required	Measured fuel consumption	Power required	Actual field capacity	Energy required
	L/h	kW	fed./h	kW /h/fed.	L/h	kW	fed./h	kW /h/fed.	L/h	kW	fed./h	kW /h/fed.	L/h	kW	fed./h	kW /h/fed.
Self-propelled reciprocating mower	0.83	2..663	0.400	6.657	0.74	2.375	0.420	5.655	0.70	2.246	0.278	8.079	0.60	1.925	0.461	4.176
Tractor mounted reciprocating mower	4.12	13.221	0.923	14.324	3.95	12.675	1.050	12.071	3.74	12.002	0.778	15.426	3.58	11.488	1.120	10.257
Tractor mounted disc mower	4.35	13.959	1.090	12.806	4.18	13.414	1.226	10.941	3.90	12.515	1.059	11.817	3.76	12.066	0.714	16.899

Table (6): The costs per unit area in LE/fed. According to level the year 2001/2002 for the different types of mowers for cutting the cotton stalks, sweet sorghum stalks, mowing clover and harvesting wheat.

Type of crop	Cotton stalks			Sweet sorghum stalks			Clover			Wheat		
Type of Implement	Total service price	Actual field capacity	Costs per unit	Total service price	Actual field capacity	Costs per unit	Total service price	Actual field capacity	Costs per unit	Total service price	Actual field capacity	Costs per unit
	L.W/h	fed.h	L.E./fed.	L.W/h	fed.h	L.E./fed.	L.W/h	fed.h	L.E./fed.	L.W/h	fed.h	L.E./fed.
Self-propelled reciprocating mower	29.30	0.400	73.25	29.30	0.420	69.76	29.30	0.278	105.39	29.30	0.461	63.56
Tractor mounted reciprocating mower	37.60	0.923	40.74	37.60	1.050	35.81	37.60	0.778	48.33	37.60	1.120	33.57
Tractor mounted disc mower	55.10	1.090	50.55	55.10	1.226	44.94	55.10	1.059	52.03	55.10	0.714	77.17

According to the least values of the costs per unit area, it is better than the using of the self-propelled reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clovers, resp. Also it is better than the using tractor-mounted reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover, resp. And, also it is better than the using tractor-mounted disc mower in harvesting sweet sorghum stalks, cotton stalks, clover and wheat, resp.

6- Comparison of the technical and economical parameters using for the different types of mowers:

According to data from the Table (7), it is preferable using any for the different mowers for the suitable both the operating forward speed and cutting efficiency, the highest value of actual field capacity, the least value of energy required and the least value of costs per unit area.

According to data from the Table (7) it is preferable using the self-propelled reciprocating mower in:

1- Harvesting wheat whereas the highest actual field capacity (0.461 fed./h) the least required energy (4.176 kW.h/fed.), the least costs per unit area (63.56 LE/fed. and the suitable cutting efficiency (89.03%).
2- Cutting sweet sorghum stalks whears the actual field capacity (0.420 fed./h), the required energy (5.655 kw.h/fed.), the costs per unit area (69.76 LE/fed. and the suitable cutting efficiency (90.60%).
3- Cutting cotton stalks whereas the actual field capacity (0.400 fed./h), the required energy (6.657 kW.h/fed.), the costs per unit area (73.25 LE/fed.) and the suitable cutting efficiency (88.23%).
4- And, it is not definitely for mowing clover whereas the least actual field capacity (0.278 fed./h), the highest required energy (8.079 kW.h/fed.), the highest costs per unit area (105.39 LE/fed.) and the least cutting efficiency (77.33%).

According to data from the same Table (7) it is preferable using the tractor-mounted reciprocating mower in:

1- Harvesting wheat whereas the highest actual field capacity (1.120 fed./h) the least required energy (10.257 kw.h/fed.), the least costs per unit area (33.57 LE/fed.) and the suitable cutting efficiency (91.48%).
2- Cutting sweet sorghum whereas the actual field capacity (1.050 fed./h), the required energy (12.071 kw.h/fed.), the costs per unit area (35.81 LE/fed.) and the cutting efficiency (93.13%).
3- Cutting cotton stalks whereas the actual field capacity (0.923 fed./h), the required energy (14.324 kw.h/fed.), the costs per unit area (40.74 LE/fed.) and the cutting efficiency 92.26%).

Table (7): Parameters of evaluation for the different types of mowers for cutting the cotton stalks, sweet sorghum stalks, mowing clover and harvesting wheat.

Type of crop	Cotton stalks					Sweet sorghum stalks					Clover					wheat				
Type of implement	Suitable forward operating speed	Cutting effic. Capacity	Actual field capacity	Energy required	Costs per unit area	Suitable forward operating speed	Cutting effic. Capacity	Actual field capacity	Energy required	Costs per unit area	Suitable forward operating speed	Cutting effic. Capacity	Actual field capacity	Energy required	Costs per unit area	Suitable forward operating speed	Cutting effic. Capacity	Actual field capacity	Energy required	Costs per unit area
Self-propelled reciprocating mower	2.38	88.23	0.400	6.657	73.25	2.65	90.60	0.420	5.655	69.76	2.72	77.33	0.278	8.079	105.39	3.02	89.03	0.461	4.176	63.56
Tractor-mounted reciprocating mower	3.45	92.26	0.923	14.324	40.74	4.10	93.13	1.050	12.071	35.81	4.20	80.34	0.778	15.426	48.33	4.45	91.84	1.120	10.257	33.57
Tractor-mounted disc mower	3.64	90.78	1.090	12.806	50.55	4.28	91.12	1.226	10.941	44.94	4.32	73.38	1.059	11.817	52.03	4.60	70.48	0.714	16.899	77.17

4- Mowing clover whereas the least actual field capacity (0.778 fed./h), the highest required energy (15.426 kW.h/fed.), the highest costs per unit area (48.33 LE/fed.) and the least cutting efficiency (80.34%).

According to data from the same Table (7) it is preferable using the tractor-mounted disc mower in:

1- Cutting sweet sorghum whereas the highest actual field capacity (1.226 fed./h), the least required energy (10.941 kw.h/fed.), the least costs per unit area (44.4 LE/fed.) and the suitable cutting efficiency (91.12%).
2- Cutting cotton stalks whereas the actual field capacity (1.090 fed./h), the required energy (12.806 kw.h/fed.),t he costs per unit area (50.55 LE/fed.) and the cutting efficiency (90.78%).
3- Mowing clover whereas the actual field capacity (1.059 fed./h), the required energy (11.817 kw.h/fed.), the costs per unit area (52.03 LE/fed.) and the cutting efficiency (73.38%).
4- And, it is not definitely for harvesting wheat whereas the least actual field capacity (0.714 fed./h), the highest required energy (16.899 kw.h/fed.), the highest costs per unit area (77.17 LE/fed.) and the least cutting efficiency (70.48%).

CONCLUSION

The obtained results from the present investigation could be summarized as follow:

1- The suitable operating forward speed for the self-propelled reciprocating mower: 2.38, 2.65, 2.72 and 3.02 km/h at cutting efficiencies: 88.23, 90.60, 77.33 and 89.03% in harvesting cotton stalks, sweet sorghum stalks, clover and what crops.
2- The suitable operating forward speeds for the tractor-mounted reciprocating mower: 3.45, 4.10, 4.20 and 4.45 km/h at cutting efficiencies: 92.26, 93.13, 80.34 and 91.84% in harvesting cotton stalks, sweet sorghum stalks, clover and wheat crops.
3- The suitable operating forward speeds for the tractor-mounted disc mower: 3.64, 4.28, 4.32 and 4.60 km/h at cutting efficiencies: 90.78, 91.12, 73.38 and 70.48% in harvesting cotton stalks, sweet sorghum stalks, clover and wheat crops.
4- According to the highest values of cutting efficiencies, it is better than the using of the self-propelled reciprocating mower in harvesting sweet

sorghum stalks, wheat, cotton stalks and clover crops, resp. Also, it is better than the using of the tractor-mounted reciprocating mower in harvesting sweet sorghum stalks, cotton stalks, wheat and clover crops, resp. And also it is better than the using of the tractor-mounted disc mower in harvesting sweet sorghum stalks, cotton stalks, clover and wheat crops.

5- According to the highest values of the actual field capacities, it is better than the using of the self-propelled reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover crops. Also it is better than the using tractor-mounted reciprocating mower in harvesting what, sweet sorghum stalks, cotton stalks and clover crops. And, also it is better than the using of the tractor-mounted disc mower in harvesting sweet sorghum stalks, cotton stalks, clover and wheat crop.

6- According to the least values of the energy required it is better than the using of the self-propelled reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover crops. Also, it is better than the using of the tractor-mounted reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover crops. And, it is better than the using tractor-mounted disc mower in harvesting sweet sorghum stalks, clover, cotton stalks and wheat crops.

7- According to the least values of the costs per unit area, it is better than the using of the self-propelled reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton talks and clover crops. Also, it is better than the using tractor-mounted reciprocating mower in harvesting wheat, sweet sorghum stalks, cotton stalks and clover crops. And, also it is better than the using tractor-mounted disc mower in harvesting sweet sorghum stalks, cotton stalks, clover and wheat crops.

8- According to the technical and economical parameters, it is preferable using the self-propelled reciprocating mower in harvesting wheat, cutting sweet sorghum stalks, cutting cotton stalks and it is not definitely for mowing clover

9- According to the technical and economical parameters, it is preferable using the tractor-mounted reciprocating mower in harvesting wheat, cutting sweet sorghum stalks, cutting cotton stalks and mowing clover.

10- According to the technical and economical parameters, it is preferable using the tractor-mounted disc mower in cutting sweet sorghum stalks,

cutting cotton stalks, mowing clover, and it is not definitely for harvesting wheat.

REFERENCES

Abd El-Motaleb, I.A. 1985. Studies on harvesting machines under local conditions (A study on the optimum periods for harvesting rice and wheat crops by small harvester). M.Sc. Thesis, Ag. Mech. Dept., Fac. of Ag. Kafr El-Sheikh, Tanta Univ.

Chanceller, W.J. 1985. Energy requirement for cutting forage, Ag. Eng., 39(10): 633-636.

El-Berry, E.M. 1985. The main obstacles which limited the used of agricultural mechanization for harvesting the Egyptian farms. Ag. Eng. Dept. Fac. of Ag. Cairo Univ. Egypt. Vol (1): 18.

El-Danasory, M.M. 1984. Intensifying the use of mowers under Egyptian Condition. M.Sc. Ag. Eng., Fac. of Ag. Cairo Univ. Egypt.

El-Khateeb, H.A. 2001. Performance evaluation of using rotary mower in cutting and chopping of corn stalks. Misr J. Ag. Eng. 18(3): 461-474.

Hanna, G.B.; A.E. Suliman; S.M. Younis and A.Z. Taieb, 1985. Evaluation of different mechanical methods of cotton stalk removal. Misr J. Ag. Eng., 2(1): 3-25.

Hanna, G.B. and A.E. Suliman, 1986. Appropriate harvesting equipment for small Egyptian farms. Misr J. Ag. Eng., 3(1): 58-72.

Hashish, A.I. 1985. Rice combine harvesting parameters. J. Ag. Res. Tanta Univ., 10(43): 736-749.

Hunt, D.R. 1983. Farm power and machinery management. 8th Ed. Iowa State Univ. Press. Ames. IA, USA. 364-368.

Kamel, O.M.; L. Badawy and H.A. El-Khateeb, 2002. A study on some operating parameters affecting the performance of corn combine harvesting. Misr. J. Ag. Eng., 19(4): 901-917.

Kepner, R.A.; R. Bainer and E.L. Barger. 1982. Principles of Farm Machinery, Third Edition. AVI Publishing Company, INC. USA, pp: 392-431.

Oida, A. 1997. Using personal computer for agricultural machinery management. Kyto Univ. Japan. Jica Pub. Smith, H.P. 1976. Farm Machinery and Equipment, 5th Ed./McGraw. Hill of Pub.

Shippen, J.M.; R.C. Ellin and H.C. clover. 1980. Basic Farm Machinery. Oxford, New York. P. 195-215.

Zhang, J.; G.H. Wen; Y. Guang; J.G. Zhangard; H.W. Goa. 2000. Study on the chopping property of wheat straw. Trans. Of Chinese Society of Ag. Eng., 16: 3, 70-72, 3 ref.

الملخص العربى

تقييم أداء واختيار أنسب نظام لحصاد بعض المحاصيل فى الحيازات القزمية

أ.د. جمال الدين محمد نصر[١] **د. عبد العال زكى نايب[٢]**

م. رجب محمود الغرباوى[٣]

تسبب المشاكل الناتجة من الحصاد اليدوى إلى الاتجاه إلى الحصاد الميكانيكى وذلك بالنسبة لظروف الزراعة المصرية وتستخدم المحشات فى مصر فى حصاد الأعلاف ومحاصيل الحبوب وكذلك التخلص من المخلفات الزراعية والهدف من هذا البحث هو التوصل إلى آلة حصاد (محشة) تناسب وتخدم المزارع المصرى لما يمتلك من حيازات زراعية صغيرة بالإضافة إلى إمكانياته المادية المحدودة وكما هو معروف فإن الحيازات القزمية لا يناسبها استخدام آلات الحصاد الكبيرة نظراً للمعوقات الكثيرة التى تعوق استخدام هذه الآلات بكفاءة بالإضافة إلى الارتفاع المبالغ والمستمر فى أسعارها والقياسات المطلوبة لهذا البحث تم أخذها فى مزارع مختلفة فى محافظة البحيرة ٢٠٠١/٢٠٠٢وذلك لتقييم أداء بعض أنواع المحشات واختيار أنسب نظام لحصاد بعض المحاصيل تحت ظروف الحيازات القزمية وكانت أهم نتائج البحث ما يلى:

١- سرعات التشغيل المناسبة للمحشة ذاتية الحركة ذات السكين المفردة هى ٢.٣٨، ٢.٦٥، ٢.٧٢، ٣.٠٢كم/ساعة والمستخدمة فى تقطيع سيقان القطن، سيقان الذرة السكرية، حش البرسيم، حصاد القمح على الترتيب وذلك عند أعلى كفاءات قطع وهى ٨٨.٢٣، ٩٠.٦٠، ٧٧.٣٣، ٨٩.٠٣%.

٢- سرعات التشغيل المناسبة للمحشة الترددية المعلقة بالجرار ذات السكين المفردة هى ٣.٤٥، ٤.١٠- ٤.٢٠، ٤.٤٥ كم/ساعة والمستخدمة فى تقطيع سيقان القطن، سيقان الذرة السكرية، حش البرسيم، حصاد القمح على الترتيب وذلك عند أعلى كفاءات قطع وهى ٩٢.٢٦، ٩٣.١٣، ٨٠.٣٤، ٩١.٨٤%.

٣- سرعات التشغيل المناسبة للمحشة القرصية المعلقة بالجرار هى ٣.٦٤، ٤.٢٨، ٤.٣٢، ٤.٦٠ كم/ساعة والمستخدمة فى تقطيع سيقان القطن، سيقان الذرة السكرية، حش البرسيم، حصاد القمح على الترتيب وذلك عند أعلى كفاءات قطع وهى ٩٠.٧٨، ٩١.١٢، ٧٣.٣٨، ٧٠.٤٨%.

٤- تراوحت قيم الإنتاجية الفعلية ما بين ٠.٢٧٨ إلى ٠.٤٦١ فدان/ساعة عند استخدام المحشة ذاتية الحركة وكانت أقل قيمة عند حش البرسيم وأعلى قيمة عند حصاد القمح، بينما تراوحت هذه القيم ما بين ٠.٧٧٨ إلى ١.١٢٠ فدان/ساعة عند استخدام المحشة الترددية المعلقة بالجرار وكانت أقل

(١) أستاذ ورئيس قسم الهندسة الزراعية – كلية الزراعة – جامعة القاهرة.

(٢) أستاذ الهندسة الزراعية المساعد – كلية الزراعة – جامعة القاهرة.

(٣) طالب دراسات عليا (ماجستير) – قسم الهندسة الزراعية – كلية الزراعة – جامعة القاهرة.

قيمة عند حش البرسيم وأعلى قيمة عند حصاد القمح، وتراوحت هذه القيم ما بين ٠.٧١٤ إلى ١.٢٢٦ فدان/ساعة عند استخدام المحشة القرصية وكانت اقل قيمة عند حصاد القمح وأعلاها عند تقطيع سيقان الذرة السكرية.

٥- تراوحت قيم الطاقة المطلوبة للحصاد ما بين ٤.١٧٦ إلى ٨.٠٧٩ ك وات.ساعة/فدان عند استخدام المحشة ذاتية الحركة وكانت أقل قيمة عند حصاد القمح وأعلى قيمة عند حش البرسيم، بينما تراوحت هذه القيم ما بين ١٠.٢٥٧ إلى ١٥.٤٢٦ ك وات.ساعة/فدان عند استخدام المحشة الترددية المعلقة بالجرار وكانت أقل قيمة عند حصاد القمح وأعلى قيمة عند حش البرسيم وعند استخدام المحشة القرصية تراوحت هذه القيم ما بين ١٠.٩٤١ إلى ١٦.٨٩٩ ك وات.ساعة/فدان وكانت أقل قيمة عند تقطيع سيقان الذرة السكرية وأعلى قيمة عند حصاد القمح.

٦- تراوحت قيم التكاليف لوحدة المساحة ما بين ٦٣.٥٦ إلى ١٠٥.٣٩ جنيه/فدان عند استخدام المحشة ذاتية الحركة وكانت أقل تكاليف عند حصاد القمح وأعلى تكاليف عند حش البرسيم، بينما تراوحت هذه القيم ما بين ٣٣.٥٧ إلى ٤٨.٣٢ جنيه/فدان عند استخدام المحشة الترددية المعلقة بالجرار وكانت أقل تكلفة عند حصاد القمح وأعلى تكلفة عند حش البرسيم وعند استخدام المحشة القرصية تراوحت هذه القيم ما بين ٤٤.٩٤ إلى ٧٧.١٧ جنيه/فدان وكانت أقل تكاليف عند تقطيع سيقان الذرة السكرية وأقل تكاليف عند حصاد القمح.

ومن النتائج المتحصل عليها يمكن أن نصل إلى التوصيات الآتية:

١- يمكن استخدام المحشات ذاتية الحركة فى الحيازات القزمية وذلك فى حالة عدم توفر المحشات الترددية المعلقة بالجرار فى هذه المناطق ويفضل استخدام المحشات ذاتية الحركة فى حصاد القمح وفى تقطيع سيقان الذرة السكرية والقطن على الترتيب ولا يفضل استخدامها فى حش البرسيم.

٢- يفضل استخدام المحشات الترددية المعلقة بالجرار فى الحيازت القزمية وكما يفضل استخدامها فى حصاد القمح، تقطيع سيقان الذرة السكرية والقطن وحش البرسيم على الترتيب.

٣- يفضل استخدام المحشات القرصية المعلقة بالجرار فى تقطيع سيقان الذرة السكرية والقطن وحش البرسيم على الترتيب ولا يفضل استخدامها فى حصاد القمح.