J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 3 (6): 601 - 616, 2012

DEVELOPMENT AND EVALUATION OF CUTTING KNIVES TO SUIT CUTTING WET AND DRY FIELD RESIDUES

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ABSTRACT

The aim of the present work is developing of the performance of cutting knives in crop residues shredder. The items to achieve the aim of the present study are: (1) Study of some physical and mechanical properties of cotton stalks and rice straw. (2) Evaluation of shredder performance and cutting knives before and after development.(3) production of cutting knives from local materials. (4) Development of cutting knives. (5) Chopping machine cost.

The performance of chopping machine was tested under the following parameters:

- **A-** Four cutter speeds (900, 1050, 1200 and 1500 rpm),
- **B-** Three different moisture content (30.0, 40.0 and 50.0 %) and (22.0, 25.0 and 30.0% , w.b.) for cotton stalks and rice straw, respectively.
- **C-** Two different types of shapes cutting knives {smooth-edge (Original knives) and serrated-edge (Modified knives)}.

The final results of this study could be summarized as follows:-

Generally by increasing the cutter head speed from 900 to 1500 rpm tends to increase percentage of cutting length < 2cm from (86.2 to 90.6%) and (83.8 to 87.0%), chopper productivity from (1.10 to 1.70 Mg/h) and (1.00 to 1.50 Mg/h), degree of destruction from (42.5 to 53.0 %) and (29.0 to 35.0%), useful power from (1.19 to 3.05 kW) and (1.10 to 2.80 kW) and unit energy from (1.88 to 1.79 kW.h/Mg) and (1.10 to 1.87 kW.h/Mg) for cotton stalks and rice straw, respectively, with machine before modification at moisture content of 30.0 % and 22.0 % (w.b.) for cotton stalks and rice straw, respectively and type of cutting knives smooth-edge (Original knives). Also, increased percentage of cutting length < 2cm from (91.7 to 94.5 %) and (85.7 to 89.5 %), chopper productivity from (1.30 to 1.80 Mg/h) and (1.20 to 1.60Mg/h), degree of destruction from (50.9 to 72.5 %) and (45.4 to 60.8%), useful power from (1.10 to 2.70 kW) and (1.00 to 2.20 kW) and unit energy from (0.85 to 1.50 kW.h/Mg) and (0.80 to 1.40 kW.h/Mg) with machine after modification at moisture content of 30.0 % and 22.0 % (w.b.) for cotton stalks and rice straw, respectively, and type of cutting knives serrated-edge (Modified knives).

INTRODUCTION

The quantity of crop residues in Egypt was determined to be about 24.4 million ton /year, beside 4 million ton/year of horticultural resides according to to the statistical survey of the Egyptian Ministry of Agric. (1999), with bad effect on economic, environmental, public health and others. In spite of the problems of this big amount of crop residues, it can be considered an important resource of the raw materials.

Crop residues are one of the critical problems which face the Egyptian farmer specially after harvesting crop such as cotton , rice and other different crops. Therefore the Egyptian farmers burn yearly about 4,0 million tons of cotton stalks and rice straw.

Taieb (1982) found that the cost of cotton stalks removal using tractor mounted mower, self propelled mower, cotton shredder, hand hoe and ensilage combine were 5.03, 7.26, 10.44, 13.70 and 27.23 LE/feddan, respectively.

Yumnam and Pratap (1991) indicated that for rotary blade, the minimum power requirement was observed at blade bevel angle between 25 and 30 degree. However, experiments on counter edge cutting of rye grass, luccern and oats suggest an optimum blade angle between 17 and 25 degree.

Metwally *et al*. (1995) evaluated the effect of the different mower units. They found that the by increasing machine forward speed tends to decrease degree of destruction. It can be noticed that by increasing the cotton stalks moisture content tends to decrease degree of destruction. They added also, the forage chopper destroyed the highest number of worms in the infested bolls following the drum mower and rotary mower

Pasikatan *et al*. (1997) used chopper performance with three materials (napier grass, corn stalks and rice straw) was satisfactory. For corn stalks indicated the best setting was 1150 rpm at 2.0 mm clearance. This setting gave 1062 kg/h capacity and specific energy of 1.7 kW.h/Mg.

Khader (1997) studied the interaction effect between different speeds of cutter head and number of knives for cutting some field crop residues such as cotton stalks, been stalks and rice straw and its effect on power requirement and cutting length. He found that the cutting length decreased by increasing number of knives and cutter head drum speed. The recommended cut length for preparing animal fodder ranged from 1.5 to 3.0 cm, with obtaining silage may be produced by using cut length ranged from 3.0 to 6.0 cm.

El-Khateeb (2001) indicated that the increasing the forward speed for chopper corn stalks by rotary mower from (2.51 to 4.51 km/h) tends to increase the stubble height from (8.20 to 12.0 cm), effective field capacity from (0.6 to 1.4 fed/h), and power requirement from (11.06 to 17.06kW), and decrease the cutting efficiency from (95.0 to 89.0%), degree of destruction from (35.0 to 21.0%) and cutting energy from (18.43 to 12.19kW.h/fed).

El-Iraqi and El-Khawaga (2002) mentioned that the maximum percentage in cutting length of less than 5cm of 87.8% and 92.0% were obtained for rice straw and corn stalk residues, respectively at cutting speed of 10.09 m/s, feeding rate of 0.77 ton/h and knife clearance of 1.5mm.

Kamel *et al*. (2003) using the forage chopper for chopping rice straw. They found that he maximum values of chopping cost were 22.07 LE/fed (12.46 LE/ton) when chopping rice straw under forward speed of 0.53m/s and moisture content of 13.49% with 12 cutterhead knives.

Lotfy (2003) develop and evaluate a machine for cut and throw agricultural residues. He found that the machine output was (1822, 2128 and 1976 kg/h), average cut length was (2.8, 2.5 and 2.6 cm), energy requirements was (12.14, 11.45 and 11.03kW.h/Mg) and operating cost was (8.13, 6.80 and 7.02 L.E/Mg) for cutting rice straw, cotton stalks and corn stalks, respectively, under cutting speed 43.35m/s, feeding speed 2 m/s and cutting clearance 2 mm.

Suliman *et al*. (2004) developed the performance of cutting knives in crop residues shredder by improving of mechanical properties of cutting knives, found that , using new material lead to decrease the wear rate from 9.67g/h with original knives to 3.98g/h with modified knives. The proper selection of new material leads to decrease the sharp edge angle of modified knives to 20 degree without deformation.

Metwally *et al*.(2006) developed a chopper machine for agricultural residual. They found that the increase of cutter head speed from 0.75 to 1.88 m/s tends to increase the chopping length by 24.1 and 60.5 % for serrated and straight-edge shapes, respectively.

The aim of the present work is development of the performance of cutting knives in crop residues shredder. The items to achieve the aim of the present study are: (1) Study of some physical and mechanical properties of cotton stalks and rice straw. (2) Evaluation of shredder performance and cutting knives before and after development.(3) production of cutting knives from local materials. (4) Development of cutting knives. (5) Chopping machine cost.

MATERIAL AND METHODS

The plan of the experimental work was executed through the following stages:

Stage 1: Evaluation the machine before development (Original knives).

Stage 2: Manufacturing of cutting knives from local materials (Modified knives). The experimental work was carried out at research farm of Rice Mechanization Center, Meet El Deba, Kafr El- Sheikh, Governorate. During summer season 2011.To evaluate the operating parameters affecting on power and energy requirements for chopping cotton stalks and rice straw, and to fulfill the objectives of this research work, the chopper machine was used under the following variables:

- - Four cutter speeds (900, 1050, 1200 and 1500 rpm),
- -Three different moisture content (30.0, 40.0 and 50.0 %) and (22.0, 25.0 and 30.0 %,w.b.) for cotton stalks and rice straw, respectively.
- -Two different types of shapes cutting knives {smooth-edge (Original knives) and serrated-edge (Modified knives)}.

These factors were studied for the following determinations; machine productivity, chopping length, chopping power requirements, degree of destruction and chopping cost for the cotton stalks variety was Giza 86 and rice straw variety was Giza 177.

Table 1: Some physical properties of cotton stalks and rice straw.

No.	Characteristic	Cotton stalk	Rice straw
1	Length, cm	145	76
2	Diameter, mm	19.5	3
3	Mass of one stalk, kg	0.150	0.0065
4	Average number of branches	12	---
5	Moisture content,% (w.b)	40	25.7

Equipment:

The stationary chopper machine was mounted on the engine 5hp (3.7kW)

The main components of this chopping are showed in Figures (1,2) and technical specifications of this chopper are summarized in Table 2.

Table 2: Machine Specifications:

Item	Detail
Model	Fc-1 Flywheel – Type Inclined Axis Chopper
Country	Philippines
Power source	Gasoline Engine 5hp
Feeding system	Manually
Number of knives on cutter head	4- Knives
Cutting, rpm.	900 – 1500 rpm
Weight	40 Kg
Labor requirement	2 persons

Machine performance determination:

Lengths of chopping cotton stalks and rice straw:-

After each chopping treatment a sample of 1kg from chopping crop material was taken into laboratory and separated into three categories (< 2cm – 2-4cm and 5-6cm) each chopping length in the sample was weighed and calculated as a percentage from the total weight of the sample.

Machine Productivity:-

Was calculated by using the following formula:

P = W x 3600 / T , Mg/h,……..……..…1

where:

P = productivity in Mg/h;

W = mass of the sample in Mg, and

T = time in min.

Degree of destruction of the pink bollworm and stem borer:-

The number of attacked bolls was counted before and immediately after chopping operation in 5kg weight. The degree of destruction was calculated by using the following formula by **Hanna *et al*.1985.**

Degree of Destruction, = F – L / F x 100, ..%.....2

where:

F = the number of the worms or borers in the infested bolls and stem before chopping operation in 5kg weight and

L = the number of the worms or borers in the infested bolls and stem after chopping operation in 5kg weight .

Fig. (1): Side view and elevation for modified chopper machine.

Estimation of power requirement :

Chopping power requirements was estimated by using the following formula, Suliman *et al*., 1993.

$$E_P = (F_C \times \frac{1}{3600})\rho_F \times L.C.V. \times 427 \times \eta_{th} \times \eta_m \times \frac{1}{75} \times \frac{1}{1.36} \text{ kW, ...3}$$

where;

E_P = power requirement ;

F_C =the fuel consumption, L/h;

ρ_F = the density of fuel, 0.85 kg/l;

$L.C.V$ = the lower calorific value of fuel, 10000 k cal/kg;

η_{th} = the thermal efficiency of engine, 35% for diesel engine;

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

η_m = the mechanical efficiency of engine, 80% for diesel engine.

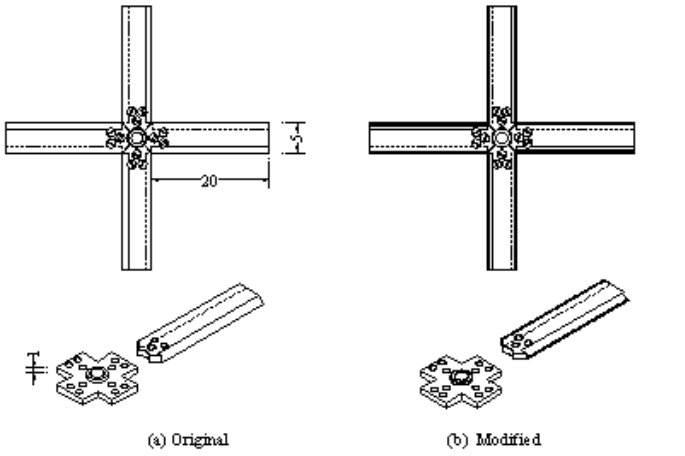

Fig. 2 : Original and modified knifes.

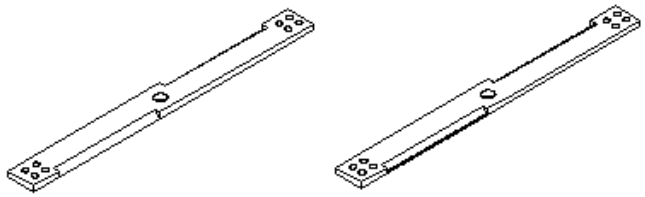

Fig. 2 (c): Original and modified fixed knifes.

Useful Power = power with load – power without load, kW, ……..…4

The energy requirement was calculated by using the following equation:

Energy requirement =

$$\frac{usefulPower(kw)}{machineproductivityMg/h}, kW.h/Mg, \text{.....5}$$

Chopping cost:

The total hourly cost of chopping using the forage chopper could be estimated by using the following equation according to EL-Awady, 1978 as follows:

$$C = \frac{p}{h}(\frac{1}{L} + \frac{i}{2} - + a + r) + (0.9w \times f \times u) + b \text{ , ...6}$$

where;

C = cost per hour of operation, L.E/h;
P = estimated price of the machine, 1000 L.E for chopper machine ;
h = estimated yearly hour operation ,500 for chopper machine;
L = life expectancy of the machine, 5 years;
i = annual interest rate, 10 %;
a = annual taxes and overheads, 2 %;
r = annual repair and maintenance rate, 18 %;
0.9 = correction factor for rated load ratio and lubrication;
w = engine power, 5 hp;
f = specific fuel consumption, L/h ph;
b = hourly labor wage, 3 L.E/h, and
u = fuel price, 0.80L.E/L .

RESULTS AND DISCUSSION

1- Percentage of cut length:-

The effect of cutter head speed and raw material moisture content for cotton stalk and rice straw for two different types of cutting knives edge on cutting length percentages are listed in Table 3.

From the results listed in this table, it could be cleared that there is high effect for cutter head speed on the cutting length of residues. Increasing the cutter head speed from 900 to 1500 rpm increased the first percentage category of cutting length (**<**2cm**)** and decreased the other two categories of 2-4cm and 5-6cm, this may be due to the increase in the amount of stalks to be cut by increasing cutting speed, increase the number of cuts per unit time and this increase the cut length of less than and equal 2cm. In generally it could be stated that the distribution percentage of cutting length less than 2cm of residues material were increased by decreasing moisture content from 50 to 30 % and 22.0 to 30.0% (w.b) for cotton stalks and rice straw, respectively. The maximum percentage of **<**2cm cutting length of 94 % and 93.9% for cotton stalks and rice straw, respectively, were obtained at cutter head speed of 1500 rpm and type of cutting knives serrated-edge (modified

knives). Type of cutting knives serrated-edge gives higher percentage from the desired chopping length **<**2cm compared with type of cutting knives smooth-edge (Original knives).

The Minimum percentage of **<**2cm cutting length was 86.6% and 81.0% for cotton stalks and rice straw, respectively, were obtained at cutter head speed of 900 rpm type of cutting knives smooth-edge and cotton stalks moisture content of 50 % and 30.0% (w.b.) .

Table 3:-Effect cutter head speed, raw material moisture content on the percentage of cotton stalks and rice straw lengths for two different types of cutting knives.

Type of cutting knives	Moisture content, % (w.b.)	Cutter head speed, rpm	Cutting length, %					
			<2 cm		2-4cm		5-6 cm	
			Co	Ri	Co	Ri	Co	Ri
Smooth-edge	30.0 Co 22.0 Ri	900	86.2	83.8	8.8	15.2	2.4	1.0
		1050	89.0	84.0	8.8	14.0	2.2	2.0
		1200	89.6	85.5	8.4	13.0	2.0	1.5
		1500	90.6	87.0	8.2	12.0	1.8	1.0
	40.0 Co 25.0 Ri	900	87.6	82.5	9.4	16.0	3.0	1.5
		1050	87.8	83.0	9.2	15.0	3.0	2.0
		1200	88.4	84.0	9.0	14.0	2.6	2.0
		1500	88.6	85.0	8.8	13.0	2.6	2.0
	50.0 Co 30.0 Ri	900	86.6	81.0	10.2	17.0	3.2	2.0
		1050	87.0	82.0	10.0	15.0	3.0	3.0
		1200	87.6	83.0	9.8	14.0	2.6	3.0
		1500	88.0	83.5	9.6	14.0	2.4	1.5
Serrated-edge	30.0 Co 22.0 Ri	900	91.7	85.7	5.6	8.0	1.6	1.8
		1050	93.2	91.5	5.4	7.0	1.4	1.5
		1200	93.8	92.8	5.2	6.0	1.0	1.2
		1500	94.5	89.5	5.5	5.0	0.8	1.1
	40.0 Co 25.0 Ri	900	91.4	89.0	6.4	9.0	2.2	2.0
		1050	91.8	90.0	6.2	8.0	2.0	2.0
		1200	92.4	91.0	6.0	7.0	1.6	2.0
		1500	92.8	92.0	5.6	5.0	1.6	3.0
	50.0 Co 30.0 Ri	900	90.0	88.0	7.0	10.0	3.0	2.0
		1050	90.2	89.0	7.0	8.0	2.8	3.0
		1200	90.8	90.0	6.6	7.0	2.6	3.0
		1500	91.0	91.0	6.6	7.0	2.4	2.0

2- Chopper productivity (Mg/h):-

The results of chopper productivity are shown in Figure 3. From these results it could be indicated that an increase in cutter head speed, results in an increment in the chopper productivity ,Mg/h. and decrement in the chopper productivity Mg/h when the moisture content increased. The average values of the chopper productivity were (1.10, 1.30, 1.40 and 1.70 Mg/h) and (1.0, 1.20, 1.30 and 1.50 Mg/h) for cotton stalks and rice straw, respectively, were obtained when using type of cutting smooth-edge under cutter head speed of 900, 1050, 1200 and 1500 rpm at moisture content of 30 % and 22.0% compared with chopper productivity of (1.3, 1.4, 1.6 and 1.8 Mg/h) and (1.2, 1.3, !.4 and 1.6 Mg/h) for cotton stalks and rice straw, respectively, were obtained when using type of cutting knives serrated-edge

under cutter head speed of 900, 1050, 1200 and 1500 rpm at moisture content of 30 % and 22.0%.

Fig.3: Effect of cutter head speed and moisture content on chopper productivity at two different cutting knives for cotton stalks and rice straw.

3- Degree of destruction of stalk borer (%):-

The degree of destruction may be considered as a qualitative and quantitative to evaluate the effect of chopper machine on control of pink bollworms and stem borer. Fig. 4 illustrates the effect of cutter head speed on degree of destruction at three different moisture content and two types of cutting knives. The results indicated that the increase in the cutter head speed from 900 to 1500 rpm tends to increase the degree destruction from (42.5 to 53.0 %, 38.5 to 50.0 % and 28.7 to 38.2 %) at cotton stalks moisture content of 30, 40 and 50 %, respectively, and (29.0 to 35.0 %, 27.0 to 33.0% and 24.0 to 32.0 %) at rice straw moisture content 22.0, 25.0 and 30.0%, respectively, with type of cutting knives smooth-edge. Also, increase in cutter head speed from 900 to 1500 rpm tends to increase the degree of destruction from (50.9 to 72.5 %, 42.9 to 56.2 % and 32.5 to 42.3 %) for cotton stalks and (45.4, to 60.8%, 40.6 to 52.3% and 30.0 to 40.0%) for rice straw, respectively, at type of cutting knives serrated-edge.

The results show that the cutter head speed of 1500 rpm, moisture content of 30.0 % and 22.0% for cotton stalks and rice straw, respectively with type of cutting knives serrated-edge destroyed the highest number of worms in the infested bolls and stem borer 72.5 % and 60.8 % respectively.

4- Useful power (kW):-

Results of useful power required to chopping cotton stalks as affected by different variables are shown in Figure 5. Generally, the useful power increased with the increase of cutter head speed and moisture content. This trend due to increase of fuel consumption that tends to increase power.

The minimum useful power 1.10 kW and 1.0 kW was observed at cutter head speed of 900 rpm, type of cutting knives serrated-edge and moisture content of 30.0 % 22.0% for cotton stalks and rice straw respectively. However the maximum value of useful power 3.70 kW and 3.3 kW were obtained at cutter head speed of 1500 rpm and moisture content of 50.0 % and 30.0% with type of cutting knives smooth-edge.

5- Unit energy (kW.h/Mg):-

The unit energy (kW.h/Mg) is the best indicator to show the effect of these parameters. Figure 6 shown the unit energy increased as the when the cutter head speed increased and moisture content increased, this finding may be attributed to the increase in the amount of stalks to be cut by increasing cutting speed, increase the number of cuts per unit time (increase the energy consumed in transfer of kinetic energy to the cut residues at high knife impact speed), this required to increasing in fuel consumption and energy requirements.

The maximum value of unit energy 3.17 kW.h/Mg and 2.75 kW.h/Mg was obtained at moisture content of 50 % and 30.0% for cotton stalks and rice straw, respectively, with cutter head speed of 1500 rpm and type of cutting knives smooth-edge. The minimum value of unit energy 0.85 kW.h/Mg and 0.80 kW.h/Mg was obtained at moisture content of 30 % and 22.0% for cotton stalks and rice straw respectively, with cutter head speed of 900 rpm and type of cutting knives serrated-edge Imbabi, (2003).

Fig.4: Effect of cutter head speed and moisture content on degree of destruction(%) at two different cutting knives for cotton stalks and rice straw.

Fig. 5: Effect of cutter head speed and moisture content on useful power at two different cutting length for cotton stalks and rice straw.

Fig. 6: Effect of cutter head speed and moisture content on unit energy at two different cutting length for cotton stalks and rice straw.

6- Chopping cost (L.E/Mg) :-

The chopping machine cost of residues using forage chopper was estimated at the optimum conditions operate the chopping machine. It could be cleared that the chopping machine cost was found to be 12.06 L.E/h. The chopping machine cost was 9.27, 8.61, 7.54 and 6.7 L.E/Mg, when the cutter head speed was 900, 1050, 1200 and 1500 rpm at moisture content of 30 % and 22.0 % with type of cutting knives serrated-edge.

CONCLUSION

The conclusions of this study are summarized as follows:-

1- The maximum percentage of **<**2cm cutting length of 94.0% and 93.3% were obtained at cutting peed of 1500rpm and moisture content of 30 % and 22.0% (w.b.) for cotton stalks and rice straw respectively, at type of cutting knives serrated-edge.

2- The minimum value of useful power 1.10 kW and 1.0 kW were obtained at cutting speed of 900rpm and moisture content of 30 % and 22.0% for cotton stalks and rice straw respectively, at type of cutting knives serrated-edge.

3- By increasing cutter head speed from 900, 1050, 1200 and 1500rpm tends to increase the degree of destruction from (50.9, 55.8, 65.1 and 72.5 %) and (45.4, 51.5, 55.7 and 60.8 %) for cotton stalks and rice straw, respectively, at moisture content 30% and 22.0% with type of cutting knives serrated-edge.

4- The average values of the chopper productivity of (1.30, 1.40, 1.60 and 1.80 Mg/h) and (1.2, 1.3, 1.4 and 1.6 Mg/h) were obtained when using type of cutting knives serrated-edge under cutter head speed of 900, 1050, 1200 and 1500rpm at moisture content of 30 % and 22.0% for cotton stalks and rice straw, respectively,.

5- The minimum value of unit energy 0.85 kW.h/Mg and 0.80 kW.h/Mg was obtained at lowest moisture content of 30 % and 22.0% for cotton stalks and rice straw, respectively, and cutting speed of 900rpm with type of cutting knives serrated-edge.

6- Total chopping machine cost was found to be 9.27, 8.61, 7.54 and 6.70 L.E/Mg, when the cutter head speed increased from900, 1050, 1200 and 1500rpm, at moisture content of 30 %and 22.0% with type of cutting knives serrated-edge.

Recommendation :-

Results of this study may be recommended, that using the chopping machine for chopping residues at cutter head speed of 1500rpm and cotton stalks moisture content of 30 % and 22.0 % (w.b) by using type of cutting knives serrated-edge (Modified cutting knives) where as give the highest percentage from the desired chopping length **<**2cm was (94.0 % and 93.9 %), higher productivity (1.80 Mg/h and 1.6 Mg/h), higher degree of destruction (72.5 % and 60.8 %) and lower useful power (1.10 kW and 1.0 kW) and unit energy (0.85 kW.h/Mg and 0.80 kW.h/Mg).

REFERENCES

El-Awady, M. N. (1978). Engineering of tractors and agricultural machinery.Tex book. Col. Agr., Ain- Shams univ., 5th.Ed:161-164.

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

El-Iraqi,M. and S.El-Khawaga (2003). Design and test performance of cutting machine for some crop residues. Misr J. Agr. Eng., 20 (1): 85- 101.

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. Agr. Eng., 2 (1): 3-25.

Imbabi,A.T. (2003). Improving a crop-residual cutting machine for environmental preservation. Misr J.Ag Eng., 20(3):783 -805.

Khader, S. B. (1997). Development of a simple cutting system using the field wastes in small farms. Ph. D. Thesis, Fac. of Agr. Zagazig univ. Egypt.

Kamel, O.M.; M.El-Iraqi and M.Egela (2003). Maximizing utilization of forage chopper for chopping rice straw residues. Misr J.Ag.Eng., 20 (3): 751-766.

Lotfy, A. (2003). Development and performance evaluation a machine for cut and throw agricultural residues. Misr J. Agr. Eng., 20 (3): 724- 736.

Metwally,M.M.; M.A.Helmy; S.M.Gomaa and H.A.El-Khateeb (1995). Evaluation of different mechanical methods of cutting and chopping cotton stalks. Misr J.Ag Eng., 12(1):205 – 217.

Metwalli,M.; I.Sayedahmed; N.Mansour and A.El-Nagar (2006). Development of a chopping machine for agricultural residual (A case study on grape trashes). J. Agric. Sci. Mansoura Univ., 31(5) : 2943 – 2955.

Pasikatan, M.C., G. C. Salazar and G. R. Quick (1997). A low- cost straw and forage chopper. AMA., 28 (1): 43-46.

Suliman, A.E.; G.E.Nasr and W.M.Adawy (1993). Energy requirements for land preparation of peas crop under Egyptian conditions. Misr J.Ag Eng., 10(2):190 -206.

Suliman,A.; G.Nasr: M.Baiomy and A.Ghany (2004). Development of cutting knives in crop residues shredder. Misr.J. Agric.Eng., 21(4): 381-396.

Taieb,A.Z. (1982). Shredding and mechanical handling of cotton stalks.M.Sc. Thesis, Ag. Eng.Dept., Cairo Univ.

Yumnam,J., and S.Pratap. (1991). Energetic of forage chopping. AmA, vol.22 No.1: 59-63.

تطوير وتقييم سكاكين التقطيع لتناسب تقطيع المخلفات الحقلية الرطبة والجافة

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معهد بحوث الهندسة الزراعية- مركز البحوث الزراعية- الدقي- الجيزة.

أجرى البحث بهدف تطوير سكاكين آلة تقطيع المخلفات الحقلية وللوصول لهذا الهدف تم دراسة النقاط التالية (١) دراسة الخواص الطبيعية والميكانيكية لحطب القطن وقش الأرز (٢) تقييم لأداء آلة تقطيع المخلفات الحقلية قبل التطوير (٣) تصنيع سكاكين التقطيع من خامات محلية (٤) تطوير سكاكين التقطيع (٥) تكاليف آلة تقطيع المخلفات الحقلية.

ولتحقيق هذا الهدف أجريت تجارب على آلة فرم المخلفات الحقلية قبل وبعد عملية التعديل وهى آلة فلبنية الصنع صغيرة الحجم سهلة النقل بين الحقول وسهلة الصيانة والتخزين لفرم حطب القطن وقش الأرز في مركز ميكنة الأرز بميت الدبية موسم صيف ٢٠١١ م تحت تأثير المتغيرات آلاتية:-

١- أربعة سرعات دورا نية لسكاكين الفرم (٩٠٠ – ١٠٥٠ – ١٢٠٠ – ١٥٠٠ لفة/ دقيقة)٠

٢- شكلان مختلفان من سكاكين الفرم (النوع الأملس – النوع الخشن أو المشرشر)٠

٣- ثلاث محتويات لرطوبة المخلف على اساس رطب (٣٠ – ٤٠ – ٥٠ %) لعيدان القطن و (٢٢- ٢٥- ٣٠ %)
لقش الأرز

وقد كانت النتائج المتحصل عليها كما يلي :-

١- لقد أوضحت النتائج إمكانية استخدام آلة الفرم بكفاءة عالية حيث تعطى أعلى نسبة من أطوال القطع الأقل من ٢ سم من حطب القطن وقش الأرز والتي تصل إلى ٩٤ % - ٩و٩٣ عند سرعة دورا نية لسكاكين الفرم ١٥٠٠ لفة/ دقيقة ومحتوى رطوبى على أساس رطب ٣٠ % - ٢٢% وذلك لحطب القطن وقش الأرز على التوالي ونوع سكينة الفرم المشرشرة (السكينة المصنعة) ٠

٢- بلغت أعلى درجة لتدمير ديدان لوز القطن وثاقبات الأرز حيث كانت ٥و٧٢ % ٨و٦٠% عند سرعة دورا نية لسكاكين الفرم ١٥٠٠ لفة/ دقيقة ومحتوى رطوبى ٣٠ % - ٢٢% وذلك لحطب القطن وقش الأرز على التوالي ونوع سكينة الفرم المشرشرة (السكينة المصنعة) ٠

٣- كانت اقل طاقة مستفادة هي ١٠و١ كيلوات – ١ كيلوات تم الحصول عليها عند سرعة دورا نية لسكاكين الفرم ٩٠٠ لفة/ دقيقة ومحتوى رطوبى على أساس رطب ٣٠ % - ٢٢% وذلك لحطب القطن وقش الأرز على التوالي ونوع سكينة الفرم المشرشرة (السكينة المصنعة) ٠

٤- كانت اقل متطلبات لوحدة الطاقة ٨٥و كيلووات. ساعة/ميجا جرام – ٠٨و كيلووات. ساعة/ميجا جرام تم الحصول عليها عند سرعة دورا نية لسكاكين الفرم ٩٠٠ لفة/ دقيقة ومحتوى رطوبى على أساس رطب ٣٠ % - ٢٢% وذلك لحطب القطن وقش الأرز على التوالي ونوع سكينة الفرم المشرشرة (السكينة المصنعة) ٠

٥- لقد بلغت إنتاجية الآلة (٣٠و١ – ٤٠و١ – ٦٠و١ – ٨٠و١ ميجا جرام/ساعة) – (٢٠و١- ٣٠و١- ٤٠و١- ٦٠و١) عندما زادت سرعة سكاكين الفرم من ٩٠٠ – ١٠٥٠ – ١٢٠٠ – ١٥٠٠لفة/ دقيقة عند المحتوى الرطوبى على أساس رطب ٣٠ % - ٢٢% وذلك لحطب القطن وقش الأرز على التوالي ونوع سكينة الفرم المشرشرة (السكينة المصنعة) ٠

٦- كانت تكاليف آلة الفرم ٢٧و٩ – ٦١و٨ – ٥٤و٧ – ٧٠و٦ جنية / ميجا جرام عندما زادت سرعة سكاكين الفرم من ٩٠٠ – ١٠٥٠ – ١٢٠٠ – ١٥٠٠لفة/ دقيقة عند المحتوى الرطوبى على أساس رطب ٣٠ % - ٢٢% وذلك لحطب القطن وقش الأرز على التوالي ونوع سكينة الفرم المشرشرة (السكينة المصنعة) ٠

ألتوصيات:-

يوصى باستخدام آلة فرم الأعلاف محل الدراسة في فرم حطب القطن وقش الأرز عند سرعة سكاكين الفرم ١٥٠٠ لفة/دقيقة ومحتوى رطوبى على اساس رطب ٣٠ % - ٢٢% وذلك لحطب القطن وقش الأرز على التوالي وسكينة الفرم الخشنة اوالمشرشرة (السكينة المصنعة) وذلك للحصول على أعلى نسبة أطوال قطع صغيرة لعيدان حطب القطن وقش الأرز (٩٤ % - ٩و٩٣%) وأعلى إنتاجية للآلة (٨و١ميجا جرام/ساعة – ٦٠و١ ميجا جرام/ساعة) وأعلى درجة لتدمير الديدان (٥و٧٢ % - ٨و٦٠%) واقل طاقة مستفادة (١٠و١كيلوات – ١كيلوات) واقل وحدة طاقة (٨٥و كيلوات٠ساعة/ميجا جرام – ٨٠و٠ كيلوات٠ساعة/ميجا جرام)٠

قام بتحكيم البحث

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