

FABRICATION AND EVALUATION OF A FIELD RESIDUAL CLEARING DOUBLE CHOPPER MACHINE

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ABSTRACT

In the present study a double chopper machine was designed and fabricated locally. It was field tested for evaluating with cotton stalks and corn stalks to measure the machine performance, efficiency and productivity. The machine was modified and fabricated from local materials at a private sector company through project, which was established through the Regional Council For Agricultural Research and Extension in collaboration with Agricultural Engineering Research Institute. The present research work was conducted at Sakha research station, Kafr El Sheikh Governorate. The main objectives of this study were clearing farm fields from crop residues as soon as possible after harvesting to give a chance for planting the next crop at reduced environmental pollution. Also to produce suitable size or length of chopped materials with homogenous cut materials at increased the rate from farming operations. The optimum results were as follow:-

Forward speed 4.7 km/h, rotational speed 1600 rpm (using flail type drum), rotational speed 1200 rpm (at fly wheel) and first cutting efficiency 96.75%, 97.27 % for corn stalks and cotton stalk, respectively. The feed speed to the fly wheel was 4.69 m/sec, smallest cut material 6.5 cm and 4.5cm with corn and cotton stalks and the final cutting efficiencies were 66.25% and 68% for corn stalks and cotton stalks, respectively.

INTRODUCTION

Clearing the fields from crop residuals is one of the most important agricultural activities. The fact that farmers plant their fields several times annually reflects that crop residual should be cleared as soon as possible to give a chance for seed bed preparation for next crop. The following are the facts currently exist in the country side:

1-The total quantities of crop residues are about 30 million ton/year (Ministry of Agriculture 2005) mainly from cotton, rice, wheat , maize , and other field crops. 2-Crop residues represent an environmental problem. It may be a media for insects to complete their life cycle. Other harmful animals like snakes, rats ...etc may increase and represent serious problems. 3-Burning crop residues pollute air with smoke and ash particles which causes serious hazards for human health besides it causes a good part of natural sources of organic mater. Crop residues may become an economical source after treatment to produce animal folder or organic fertilizer (compost).

Barnes et al. (1984) described that harvesting forage plots for yield determination usually involves separate cutting and collection operations. A standard commercial hammer knife flail mower was modified by adding a collecting box for recovery of cut forage.

In an essence of modification, Awady *et al.* (1988) designed an apparatus, measure the resistance of plant stems for cutting. They found that

the cutting force is greatly affected by factors as, stalks diameter, moisture content, plant density and plant type.

Kepener and et al. (1993) mentioned that the engineering properties of plants are séances and not common as engineering materials such as steel, iron ...etc. Some of engineering properties were resulted for some crop residues as cotton stalks and corn stalks as giving in the following table: according to (Sitki G. 1986, Bosoi *et al.* 1991 and Kepner, *et. al.* 1993)

Type	Diameter (cm) (average)	Cross section (cm ²)	C (cm) =D/2	Moment of inertia (I) cm ⁴	I/C	Modules of elasticity/cm ² (E)	Stiffness N.cm ² (EI)
Cotton stalk	2	3.14	1	0.79	0.79	3500	2765
Corn stalk	3.5	0.55	1.75	2.83	1.62	4000	11320

Abdellatif *et al.* (2004), mentioned that most of the region suffers the luck in woods but they have millions tones of agricultural – plant residues which could replace and be utilized for producing panel board, MDF and HDF WOODS- or paper- pulp instead of introducing such material costing several millions of foreign currency every year getting rid of such residues by burning causing deleterious effects on health.

The present study aims to develop a new design of a chopper machine to be used for cutting crop residues. The developed unit should be: of simple design and easy operation, the components could be easily fabricated and or assembled.

MATERIALS AND METHODS

The double chopper machine consists of three main units. Two units are of the same option but different types (first unit FLAIL type which cuts the stalks from the ground, the second (FLYWHEEL type) and the third unit is a heavy duty conveying auger. In the present study two main crop residues were selected to test the machine (cotton stalks and corn stalks) and also to study some of their physical properties.

Components of the double chopper machine. Figure (1) shows the main units and parts of the machine:-

A- Chopper unit (Flail type).

1- Main frame. The machine frame was fabricated from square tube (50 × 50 mm) and angle 50 × 50 × 5 mm steel 37, 30 - 48 kg/mm² (tensile strength).

2- Flail chopper drum. Drum was designed flail type and fabricated from pipe tube 12.5 cm outer diameter and 11.8 cm inner diameter. The total length of drum was 160 cm but the active length was 130 cm, thirty knives were distributed on the periphery surface of the drum tube to cover the cutting area. Drum active length of 130 cm was designed to be suitable for cutting three rows of cotton stalks and two rows of corn stalks.

3- Flail knives. The theory of cutting in this type depends on impact force. The dimension of flail knives curved types are 24 cm length, 4 cm width and 7mm thickness. The knives were fabricated from flat

spring steel (St. 52). The knives were formed curved and were all heat treated (hardened and tempered).

4- Housing. Chopper drum housing is fabricated from sheet metal 2 mm thickness to cover all the moving parts (drum, knives and auger).

5- Skates. Skates were fabricated from flat iron 50 × 10 mm to adjust the height of cut since they are laid on the ground of the field.

6- Tire wheel. Two tires are used to transport the machine from place to another.

B- Conveying auger unit.

Auger was used to convey cutting materials from the chopper unit to the fly wheel unit. The outer diameter is 0.35 m, inner diameter 0.1 m, pitch 300 mm and length of auger 1.35 m. It was fabricated from sheet metal 2 mm and pip tub 0.1 m outer diameter. Capacity of the auger was calculated according to the equation:

$$Q = 60 \frac{\pi}{4} (D_o^2 - D_{in}^2) \rho p n \quad (\text{El-Sahrigi, 1997}) \quad \text{-----} \quad (1)$$

Where:-

Q = Auger capacity kg/h

D_o = Outer diameter of the auger, m

D_{in} = Inner diameter of the auger, m

ρ = Density of the composting materials, kg/m³

p = Pitch of auger, m

n = Rotational speed rpm * 60 = rph.

C- Fly wheel unit.

It is connected to the chopping unit to unify the cut length of the materials to be homogenous, short. thin for blowing of the cut materials. The outer diameter was 0.81 m. It consists of:-

1- Main blade: It was fabricated from sheet metal (steel 37) 10 mm thickness, of a six sided polygon form. The impeller blades and flywheel knives were distributed among the polygon sides.

2- Impeller blades: Six impeller blades were fabricated (as I beam form) from sheet metal steel 10 mm thickness. The overall dimensions were 0.15 m width, 0.25 m length and 0.1 m height of I beam.

3- Fly wheel knives: Cutting is done by shearing. Six knives were fixed on the six polygon sides.

4- Counter blade: It is shorter than moving knife length and fixed in the housing frame. It can be adjustable for less clearance between it and moving knives to obtain uniform and clean cutting.

5- Housing: It was fabricated from sheet metal steel 2 mm thickness. It has open feed in the inner side of housing to receive materials from conveying auger and throw it through vertical open.

D- Power Transmission. A typical gear-box (bevel gear 1 : 1.5) was used to increase the speed from PTO to the fly wheel, to the chopper unit (flail type) and reduce the rpm from drum flail type to the auger conveyer as shown in Fig. (2).

Theory of cutting by fly wheel unit

Theoretical length of cutting materials: according to (Kanafojski Cz, et. al. 1976)

$$L_t = 6 \times 10^4 \times V_z / N_z \text{ mm} \text{ ----- (2)}$$

Where:-

- V_z = rate of feed (m/sec)
- N = number of revolutions of the cutter head (rpm)
- Z = number of knives.

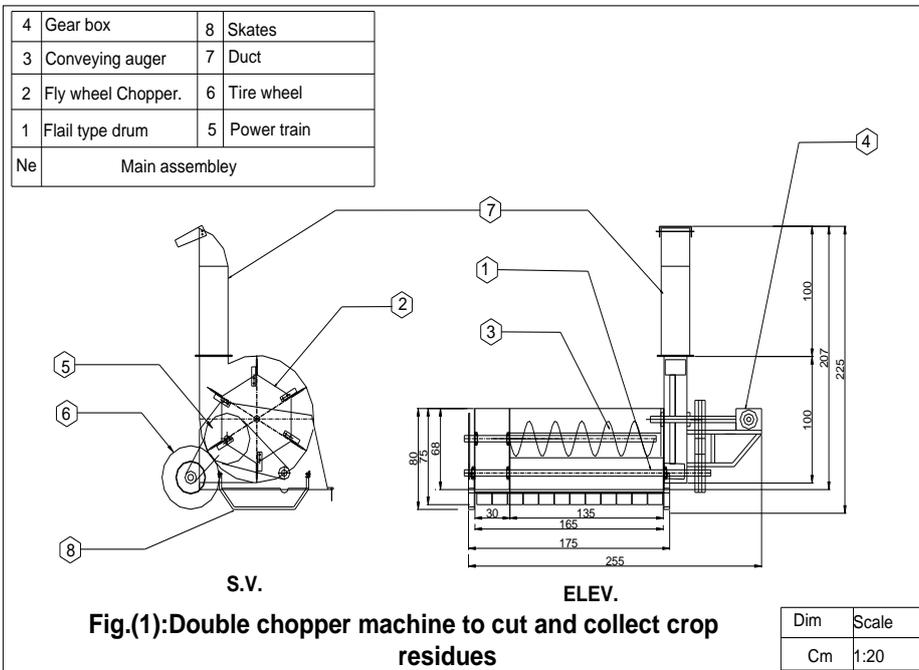


Fig. (2) Double chopper machine during and after cutting cotton stalks.

-Theoretical output

Theoretical output (Tale 1) of a forage harvester of cutting plants may be expressed according equation:-

$$Q = St \times Q_{ha} \times V_m / 100 \text{ Ton/hr (kanafojski Cz., et. al. 1976)}$$

Where:-

St = working width

Qha = volume of yield m³/ha

Vm = machine speed, km/h

At picking up from windrows

$$Q = Qw \times Vw \quad \text{Tons/hr}$$

Where:-

Qw = specific mass of the windrow(kg/ running meter).

Efficiency of cut:-

$$\xi = Q / Qact$$

where: Qact. = actual output

Table (1) Theoretical, actual length (cm) and cutting efficiency %.

Auger rotational speed (rpm)	Auger peripheral speed (feed speed) m/sec.	Fly wheel rotational speed (rpm)	Theoretical cut length (mm)	Actual cut length (mm) corn	Cutting efficiency % (corn stalks)	Actual cut length (mm) cotton	Cutting efficiency % (cotton stalks)
320	5.86	830	70.6	90	78.44	95	74.32
400	7.33		88.31	125	73.59	126	70.08
500	9.16		110.36	150	73.57	150	73.57
320	5.86	1000	58.60	70	83.71	75	78.13
400	7.33		73.30	118	62.12	100	73.30
500	9.16		91.6	125	73.28	130	70.46
320	5.86	1200	48.83	60	81.31	55	88.78
400	7.33		61.10	85	76.37	90	67.88
500	9.16		76.33	105	72.69	120	63.60

Field experiments:

The tests and experiments of the double chopper machine were run on two main crop residues cotton stalks and corn stalks at three forward speeds (3.6, 4.7, 5.4 km/h) and three rotational speeds (1100, 1400, 12600 rpm) for flail type and three rotational speeds for fly wheel (830, 1000 and 1200 rpm). 100 samples from each corn stalks and cotton stalks were selected randomly and measured as the lengths before and after cutting. The samples after cutting were measured as the stubbles height and size of cut material.

1- Performance:-

A- Cutting efficiency:

1- From cutting of cotton stalks and corn stalks the cutting efficiency was calculated according to the following relationship. (for chopper unit flail type)

$$\eta_{cut1} = (L_b - L_a) / L_b \quad \dots\dots\dots (3)$$

where:-

η_{cut1} = cutting efficiency, L_b = Sample length before cutting (cm).

L_a = The length -of plant remaining in soil (stubble height) after cutting (cm)

2- Final cutting efficiency: It is depending on fly wheel unit and it was calculated according to the following equation:-

$$\eta_{cut2} = L_{th} / L_{act} \quad \dots\dots\dots (4)$$

where:-

- η_{cut2} = Final cutting efficiency,
- L_{act} = Average length for cut materials (cm).
- L_{th} = Theoretical length-of cut materials according to equation (1)

B- Stubble height: Stubble height was measured at each of forward speed with each of rotational speed for flail type drum.

Average actual length of chopped material was determined by measuring 100 samples collected from the outlet of the fly wheel chopper.

2- Productivity:

- Productivity (operation rate)

(A) - Theoretical operation rate.

$$R_{th} = L \times W / t \quad m^2/s. \dots\dots\dots(5)$$

$$R_{th} = L \times W / t \times 3600 / 4200 = (A / t) \times (6 / 7) \quad fed\dots\dots(6)$$



Fig. (3) Double chopper machine during and after cutting corn stalk

Where:-

- R_{th} = Theoretical field capacity (m^2/s or fed/h).
- L = Traveled distance (m). , W = The machine rated width (m).
- t = The theoretical time (h).

or $R_{th} = V \times W / 4200 = fed/h$
 $\dots\dots\dots(7)$

Where:- $4200 m^2 = feddan$, V = The rated forward speed (m/h).

(B) - The actual rate of field operation.

$$R_{act.} = L \times W / T \times 3600 / 4200 \dots\dots\dots (8)$$

$$V = L / T$$

where:-

- $R_{act.}$ = Actual rate of field operation. fed/h
- T = Total time . ($t + t_1 + t_2 + t_3 + \dots$) or Actual operational time
- t_1 = losses for turning, t_2 = losses for repairing, t_3 = time lost in adjusting.

(C) – Production rate

$$P_r = W_s \times 4200 / 1000 \quad Ton/fed \dots\dots\dots(9)$$

Where:

- P_r = Theoretical production rat Ton/fed
- W_s = Weight of stalks per m^2 kg / m^2
- P_{act} = $P_r \times 0.85$ assume the production efficiency = 85%
- P_{act} =Actual production rate Ton/fed

In case of corn stalks, the stubbles height increased from an average of 14.6 cm to an average of 22.7 cm with the increase of forward speed from 3.6 km/h to 5.4 km/h. The stubble height decreased with the increase of the rotational speed. At 3.9 km/h the stubble height decreased from 20, 14, and 10 cm with the increase of the rotational speeds from 1100, 1400 and 1600 rpm, respectively. The optimum forward speed for less stubble height was 4.7 km/h and the stubble height decreased from 15cm to 9 cm to 6.5 cm with the increase of the rotational speed for drum flail type from 1100 to 1400 to 1600 rpm, respectively. In case of cotton stalks, the stubble height increased from 11.16cm to 16.5 cm with the increase of the forward speed from 3.6 to 5.4 km/h, respectively at fixed rotational speed. Also it decreased from 8 to 7 to 4.5 cm with the increase of the rotational speed from 1100 to 1400 to 1600 at fixed forward speed 4.7 km/h. The optimum stubble height was 6.5 cm and 4.5 cm for corn stalks and cotton stalks, respectively at 4.7 km/h and 1600 rpm.

2 - Cutting efficiency:

Cutting efficiency from ground as the primary (first) cut was affected by forward speeds and rotational speeds (drum flail type) as shown in table (3). At fixed rotational speed (as the average) cutting efficiency decreased with the increase of the forward speed but at the optimum conditions of forward speed (4.7 km/sec), the cutting efficiency was higher than the cutting efficiency with the other speeds. At corn stalks the cutting efficiency decreased from 92.6% to 88.6% when forward speed increase from 3.6 km/h to 5.4 km/h respectively because the lower of each forward speed and rotational speed of knives has more chances to impact and cut the stalks at low height from the ground but at the higher of the forward speed the rotational knives has less chance to impact and cut the stalks and the stubble height increase. But the optimum cutting efficiency was 96.75 % at 4.7 km/h and 1600 rpm rotational speed. At cotton stalks, the cutting efficiency decreased from 92.12 % to 87.9 % with the increase of the forward speed from 3.6 km/h to 5.4 km/h at 1100 rpm. But the optimum cutting efficiency was 97.6% at 4.7 km/h and 1600 rpm.

3 – Size of cut material:

The size of cut material from corn stalks and cotton stalks was affected by the forward speed and rotational speed for both flail type drum and fly wheel chopper as shown in table s(5 and 6). In case of corn stalks: The size of cut material in the first stage (Flail type drum) was not homogenous and has long length. The average length of this stage ranged between 8 cm to 20 cm. But the size in the second stage was short. The average length ranged between less than 2 cm to 15 cm. For example, at optimum forward speed 4.7 km/h the average of size from less than 2cm to 10 cm was 48.4 % compared to size from 12 cm to 15 cm was 51.6 % . But the average sizes from less than 2cm to 10 cm increased from 31.2 % to 37 % to 77 % with the increase of the rotational speed (flail type drum) from 1100 to 1400 to 1600 rpm and increase of the rotational speed (fly wheel chopper) from 830 to 1000 to 1200 rpm. In case of cotton stalks: At 4.7 km/h the average of size from less than 2cm to 10 cm was 46.6 % compared to size from 12 cm to 15 cm was 53.4 %. At optimum forward speed (4.7 km/h) the average sizes from less than 2cm to 10 cm increased from 26.7 % to 36.5 % to 76.6 % with the increase of the rotational speed (flail type drum) from 1100 to 1400 to 1600 rpm and increase of the rotational speed (fly wheel

chopper) from 830 to 1000 to 1200 rpm, respectively. The forward speed was affected slightly on the size of cut materials and the size reduction depends on the drum rotational speed more than the forward speed. The double chopper also was affected to reduce the size of cut material length.

4- Final cutting efficiency %:

Run on fly wheel chopper second unit in the double chopper machine and it was depended on the feed speed (m/sec) and rotational speed (rpm) according equation (2). It was increasing with increasing the feed speed and decreasing rotational speed. From table (2) the less actual cutting length as the average was 66 mm in corn stalks, 55 mm in cotton stalks at feed speed 320 rpm (5.86 m/sec), rotational speed 1200 rpm and the theoretical cutting length was 46.9 mm at same feed rate and rotational speed, cutting efficiency was 81.38 % with corn and was 88.78 % with cotton stalks respectively.

3- Productivity and estimated costs:

- Productivity (operation rate) as shown in Tables (3 and 4)

Productivity (theoretical, actual operation rate and field efficiency) as affected by machine forward speed. The productivity is tended to increase linearly with an increase in the forward speed. Theoretical, actual operation rate and field efficiency were increased from (1.485, 1.79 and 2.057 fed/h), (1.1, 1.5 and 1.7 fed/h) and (74.1%, 83.8%, and 84.6%) when forward speed was increased from 3.9, 4.7 and 5.4 km/h respectively.

Table (3) Relationship between forward speed, flail chopped rotor speed and stubble height (corn stalks).

Forward speed km/h	Rotation speed RPM (m/sec)	Rotation speed RPM (m/sec)	Stubble height Cm.	Cutting efficiency %	Theoretical productivity Fed/h	Actual Productivity Fed/h	Field effic. %
	1100 (35.11)	830 (35.18)	20	90.0			
3.6	1400 (44.7)	1000 (42.4)	14	93.0	1.485	1.1	74.1
	1600 (51.1)	1200 (50.8)	10	95.0			
	1100.0	830 (35.18)	12	94.0			
4.7	1400.0	1000 (42.4)	9	95.5	1.79	1.5	83.8
	1600.0	1200 (50.8)	6.5	96.75			
	1100.0	830 (35.18)	28	86.0			
5.4	1400.0	1000 (42.4)	22	89.0	2.057	1.74	84.6
	1600.0	1200 (50.8)	18	91.0			

Table (4) Relationship between forward speed, flail chopped rotor speed and stubble height (cotton stalks).

Forward speed km/h	Rotation speed RPM (m/sec)	Rotation speed RPM (m/sec)	Stubble height Cm.	Cutting efficiency %	Theoretical productivity Fed/h	Actual Productivity Fed/h	Field effic. %
	1100 (35.11)	830 (35.18)	13.0	92.12			
3.6	1400 (44.7)	1000 (42.4)	11.5	93.00	1.485	1.1	74.1
	1600 (51.1)	1200 (50.8)	9.0	94.55			
	1100 (35.11)	830 (35.18)	8.0	95.15			
4.7	1400 (44.7)	1000 (42.4)	7.0	95.76	1.79	1.5	83.8
	1600 (51.1)	1200 (50.8)	4.5	97.27			
	1100 (35.11)	830 (35.18)	20.0	87.90			
5.4	1400 (44.7)	1000 (42.4)	16.0	90.30	2.057	1.74	84.6
	1600 (51.1)	1200 (50.8)	13.0	92.12			

Table (5) Relationship between forward speed, rotation speed and cutting length %(Corn)

Forward Speed km/h	Chopper drum speed RPM	Fly wheel RPM	Auger RPM	Cutting Length %								
				<2cm	2 - 3	4 -5	6 - 7	8 - 9	10-11	12-13	14 -15	
3.6	1100.0	830	320	1.0	2.0	6.0	6.0	6.0	12.0	27.0	40.0	
	1400.0	1000	400	8.6	4.5	8.8	6.3	7.6	11.0	31.0	22.2	
	1600.0	1200	500	13.3	12.4	10.2	6.3	8.0	16.0	20.0	13.8	
4.7	1100.0	830	320	2.1	3.0	6.0	7.0	6.5	6.6	27.6	41.2	
	1400.0	1000	400	5.6	4.0	6.5	5.7	5.6	11.2	30.0	31.4	
	1600.0	1200	500	13.3	10.0	18.0	16.6	7.0	12.8	12.1	10.2	
5.4	1100.0	830	320	1.6	1.4	3.8	2.8	2.8	8.6	20.0	59.0	
	1400.0	1000	400	3.4	3.4	6.4	4.0	5.0	11.2	33.0	33.6	
	1600.0	1200	500	10.0	6.0	22.0	19.0	11.0	10.0	12.0	10.0	

Table (6) Relationship between forward speed, rotation speed and cutting length% (Cotton stalks).

Forward Speed km/h	Chopper drum speed RPM	Fly wheel RPM	Auger RPM	Cutting Length %								
				<2cm	2 - 3	4 -5	6 - 7	8 - 9	10-11	12-13	14 -15	
3.6	1100.0	830	320	1.5	1.6	5.5	7.8	3.0	6.0	29.6	45.0	
	1400.0	1000	400	5.0	4.0	6.0	11.2	5.0	7.5	31.3	30.0	
	1600.0	1200	500	7.0	10.0	8.2	10.0	7.5	14.0	20.8	22.5	
4.7	1100.0	830	320	2.6	2.0	5.5	7.0	3.0	6.6	28.3	45.0	
	1400.0	1000	400	4.0	3.5	6.0	8.5	6.0	8.5	28.5	35.0	
	1600.0	1200	500	14.2	17.8	16.2	15.2	5.4	7.8	13.4	10.0	
5.4	1100.0	830	320	2.8	2.4	5.0	4.2	5.2	6.0	23.7	50.7	
	1400.0	1000	400	3.0	2.0	5.0	4.0	5.2	8.0	32.8	40.0	
	1600.0	1200	500	13.5	15.0	15.0	11.5	7.5	5.0	20.0	12.5	

- Estimated cost of the field operation:

Machine costs were calculated from equation (11). They were 8.25 L.E./h. Also the tractor cost was calculated. Tractor cost is increased with increased the forward speed and rotational speed. The total costs were 23.25 L.E

CONCLUSIONS AND DISCUSSIONS

1–Locally designed and fabricated double chopper machine proved to be suitable system for cutting and collecting residues crops with optimum cut length resulted. (Flail type chopper and fly wheel chopper)

2–Machine cleared the land from stalks in short time.

3-The optimum results with double chopper machine were in case of corn and cotton stalks as follow:-

- Forward speed = 4.7 km/h.
- Drum speed = 1600 rpm (51.1 m/sec).
- Fly wheel speed = 1200 rpm (50.8 m/sec)
- Feed speed = 320 rpm (4.96 m/sec).

The same condition with maize stalks but the drum ground clearance is 10 cm.

- 4- Cutting efficiency was affected by machine forward speed, rotational speed of flail drum, rotational speed of fly wheel and feed rate m/sec to the fly wheel. Maximum primary cutting efficiency was 96.75 % and 97.27% at forward speed 4.7 km/h and rotational speed 1600 rpm with corn and cotton stalks respectively. Cutting efficiency was decreased to 82.5 % and 84.8% at forward speed 5.4 km/h and rotational speed 1100 rpm with corn and cotton stalks respectively.
- 5- Maximum final cutting efficiency was 64 % and 68% at forward speed 4.7 km/h, fly wheel rotational speed 1200 rpm and feed rate 4.69 m/sec with corn and cotton stalks respectively.
- 6- Actual operation rate and field efficiency were increased from (1.1, 1.5 and 1.7 fed/h) and (74%, 83% and 84.5%) when forward speed was increased from 3.9, 4.7 and 5.4 km/h respectively

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تصنيع وتقييم آلة التقطيع المزروجة لتنظيف الأرض من مخلفات المحاصيل

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معهد بحوث الهندسة الزراعية.

تنظيف الأرض من مخلفات المحاصيل من أهم متطلبات الزراعة وذلك لسرعة تجهيز التربة للمحاصيل التالية من عمليات التربة والزراعة بلغت إجمالى المخلفات الزراعية 30 مليون طن طبقاً لحصر المحاصيل بوزارة الزراعة (الإدارة المركزية للإقتصاد والأحصاء) (2004-2005).

ومن أهم الأهداف فى هذا البحث هو تطوير آلة التقطيع ذات السكاكين لتكون مزروجة التقطيع وتجميع المواد المفتتة خلفها فى مقطورة بحيث يتميز التطوير بالآتى :-

- بسساطة التصميم - سهولة التصنيع محلياً - توفير عملة صعبة بعدم الاستيراد
- ثم تجربة الآلة بعد الانتهاء من التصنيع مع كل من حطب القطن وحطب الذرة حيث انها من أصعب المخلفات فى التقطيع وكذلك فى وقت الإخلاء من الأرض .
- تم اختيار الآلة عند ثلاث سرعات تقدمية 5.4 ، 4.7 ، 3.9 كم / ساعة كذلك ثلاث سرعات دورانية 1100 ، 1200 ، 1600

النتائج والقياسات :

- تم دراسة الحواص الطبيعية لكل من حطب القطن وحطب الذرة من حيث :-

الخاصية	حطب الذرة	حطب القطن
الطول	200	165
متوسط القطر	18(قمة) 30مم(قاعدة العود)	15 23
وزن عمود الحطب	0.22	0.165
عرض العيدان م ²	8	2.65
إجمالى الوزن فى م ²	1.76	16

تم قياس الأطوال المتبقية فى الأرض بعد التقطيع عند كل سرعة تقدمية مع الثلاث سرعات الدورانية لدرفيل التقطيع الرئيسى من النوع Flail Type ذات السكين الحرة وكان أقل الأطوال المتبقية فى الأرض عند سرعة تقدمية 4.7 كم/ث وذلك مع سرعة دورانية 1600 لفة/د وكانت 6.5 سم، 4.5 سم مع كل من حطب الذرة وحطب القطن على التوالى. ثم استخدم وحدة نقل للمواد المقطعة من الدر فيل ذات السكينة الحرة الى آلة التقطيع ذات الحدافة وهى عبارة عن بريمة قطرها 35 سم.

- تم ادارة البريمة الناقلة بثلاث سرعات دورانية 320 ، 400 ، 500 لفة /د ، وكذلك آلة تقطيع الأعلاف بثلاث سرعات 1200 ، 1600 ، 830 . - وحساب أطوال المواد المقطعة

$$L = 6 \times 10^4 \times Vz / N z$$

- تم حساب الأطوال النظرى من المعادلة
- تم حساب الأطوال المواد المقطعة عملياً وكانت تتراوح بين أقل من 2 سم الى 15 سم
- تأثرت أطوال التقطيع بمعدلات التغذية والسرعات الدورانية (السرعة المحيطة) للآلة ذات الحدافة كلما زادت معدلات التغذية كلما زادت أطوال المواد المقطعة والعكس وكذلك كلما زادت السرعة الدورانية قلت أطوال المواد المقطعة نظرياً وعملياً عند ثبات معدلات التغذية. وكانت أحسن النتائج عند معدلات تغذية 3.4 م/ث وسرعة دورانية لآلة التقطيع عندد 1200 لفة/د.

كفاءة التقطيع

اولاً : كفاءة التقطيع من الأرض وتعتمد على أطوال المتبقى فى الأرض بعد التقطيع ويتأثر بالسرعة التقدمية وكذلك السرعة الدورانية

كما زادت السرعة الدورانية لدر فيل التقطيع ذات السكاكين الحرة.

كما زادت أطوال الأجزاء المتبقية بالأرض.

كذلك كلما زادت السرعة التقدمية كلما قلت كفاءة التقطيع وزاد طول الجزء المتبقى بالأرض.

ثانياً : كفاءة التقطيع النهائية وتقدر على التقطيع بالآلة ذات الحدافة وكلما زادت معدلات التغذية كلما قلت أطوال الأجزاء المقطعة وقلت كفاءة التقطيع.

وايضا كلما زادت السرعة الدورانية لحدافة التقطيع كلما زادت كفاءة التقطيع لإنخفاض أطوال الأجزاء المقطعة.