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EVALUATION WHEAT STRAW CHOPPING PERFORMANCE USING A DEVELOPED CONICAL ROTOR.

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ABSTRACT

Aiming to obtain the desired cutting lengths from wheat straw, to suit animal feeding and other different uses, proper wheat straw chopping mechanism was developed. That mechanism, involved a conical cutting rotor drum and a coinciding concave, to apply the theory of shearing instead of hammering theory.

The straw cutting performance of the developed mechanism was tested, and evaluated under different drum speed, and straw moisture content levels. The evaluation based on the percentages of four cutting length categories, and the uniformity of chopping lengths.

The obtained results concluded that the maximum percentages(84.7 %) in wheat straw cutting length of less than 30 mm was obtained at cutting speed of1400 rpm (45.7 m/s), feeding rate of 1 kg/sec and knife clearance of 30/20 mm. While, the minimum percentages (25:30%) of that length categories were accomplished the lower cutting speed and the higher straw moisture content levels, at the same feeding rate and knife clearance levels. In addition, the maximum uniformity value(97.8%) for the chopping straw lengths were obtained at cutting speed of1200 rpm (39.25 m/s) and the same mentioned feeding rate and knife clearance.

The results also recommended inserting the conical shape drum and its coinciding concave in the construction of the Turkish threshing machine in order to increase the percentages of acceptable fewer cutting length categories by about 7% , and the length uniformity of chopped wheat straw by about 20%.

INTRODUCTION

Wheat is considered the most important crop in the world. Egypt cultivates annually around 3 million feddans of wheat. The quantity of wheat straw in Egypt reached about 8.274 million ton per year Statistic Agric. Ministry (2005). Chopping is an important process to increase use of wheat straw efficiently either as fodder for animals, or other different uses. In fact, cutting and chopping of crop straw materials is one of the most frequent operations, and applied nearly continuously during harvesting threshing operations.

In general, the primary step in the straw size reduction processing can be accomplished by cutting or grinding the threshing residual. The small pieces of the residual after being cut represent the form of fodder for animals. Straw material is first compressed and deformed under a cutting edge, depending on the lather's shape and velocity. Cutting begins only subsequently.

The Egyptian farmers usually use the Turkish and local types of threshers to thresh and chopping the straw of wheat. These types of machines are usually working according to the un-efficiently cutting hummer system. Whereas, the cutting edge moves normally to the material or at a certain angle. Elbanna, (1979) found that the hammering method needs 300% power compared to the power needed by shearing method.

Griffin (1976) reported that the knives of chopper might be adjusted to any desired position to vary the cut length of straw. On some choppers, knives can be swing out to bruise straw and leave it long. The most frequent forms of cutting are summarized by Richey (1982) and are as shown in Fig. (1).

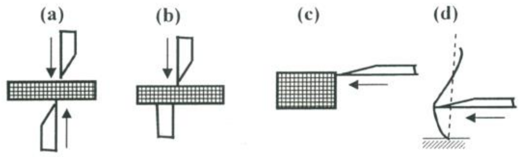

Fig. (1) : Various forms of cutting

a- Cutting involving counter moving blades, where both sets of blades participate in cutting
b- Cutting by means of a resting and a moving blade, where the resting blade supports material.
c- Cutting of thin layers (e.g. beet cutting), where the stress distribution around the cutting edge is significantly distorted by the free surface found close to the cutting plane. The material may be fixed more or less rigidly,
d- Widespread method of free cutting, where one of a relatively bug stalk is fixed and counter support is ensured by the moment of inertia of the stalk. In this case, the velocity of the cutting edge must be high (20 -40 ms^{-1}) silage harvesting methods

El-Sheikha, (1984) found that the force needed to cut plant material using tensile method was three times that needed to cut the same material using the shearing method. Thus threshing by shearing methods needs 33.0% of the force needed for tension comparing the chopping machine, which works, by impact and tension principles.

Kepner *et al.* (1992) defined the length of cut as the amount of advance of feed mechanism between the cutting successive knives. They added that, cutting takes place due to a system of forces acting on the material to cause it to fail in shear. This shear failure is almost invariably accompanied by some deformation in bending and compression, which increase the amount of the work required for the cutting. A common way of applying the cutting forces is by means of two opposite shearing elements, which meet and pass each other with little or no clearance between them. Either one or both of elements may be moving on linear with uniform velocity

Abdel Maksoud, *et al* (1994) reported that successful chopping reduces the length of straw avoiding long pieces of material fouling on cultivation and swing implement. They manufactured locally straw chopper and mounted it on a john Deer combine and operated it at rotor speed of 2300 rpm under three different clearances of 12.5.25 and 31 mm : five field speeds of 2.6,3.2,3.8,4.3 and 4.8 km/h; three-row spacing 20.40 and 60 cm and two moisture contents 10% and 20%. The found out that the lowest power (0.26 kWh/ton) achieved at row spacing of 60 cm, field speed of 2.6km/h clearance between free and fixed knives of 31 mm, and straw moisture content of 10%. While the maximum (2.23kWh/ton) achieved at row spacing of 20 cm, field speed of 4.8km/h, clearance between free, and fixed knives of 12.5 mm, and straw moisture content of 20%.

Badr (1997) reported that cutting with significant energy consumption is the main operation in fodder preparation. Other processing operations also frequently require cutting. He showed that increasing the clearance between the fixed knife and movable knives the cutting length of the field wastes increased. This due to the same reason mentioned in two and three knives. Adapting the optimum clearance helps in obtaining the recommended cutting length.

Arif (1999) mentioned that the cut length of residual depends on the feeding drum speed, moisture content and knives clearance.

El-Iraqi and El-khawaga, (2002) designed cutting machine which could be attached with threshing machine to cut the straw directly. That machine was cutting straw and corn stalks residual with high performance at 0.771 ton/h feeding rate and 10.09m/s cutting speed with 1.5 mm knife clearance.

The main objective of this study is to design and test the performance of a proper wheat straw chopping mechanism. That mechanism involved conical cutting rotor drum and its coinciding concave to change the theory of threshing from hammering to shearing, to give the desired cutting wheat straw lengths, which is suitable for animal feeding. In addition investigating the effect of feed rate, drum speed, moisture content and clearances between the knives and concave on the chopping performance of the threshing machine during threshing wheat crop was deduced in terms of the percentages of cutting length categories, and the uniformity of cutting lengths.

MATERIALS AND METHODS

Materials

To achieve successful wheat straw chopping process, a proper threshing mechanism was developed for reducing the length of wheat straw, for avoiding long straw pieces, and for obtaining more uniform cutting lengths

Description of the thresher development

The basic development includes changing the threshing drum and the concave shapes and positions inside the construction of the Turkish thresher and locally threshing machine. The developed drum was constructed of a double a conical shape rotor for threshing and separating wheat grain Fig (2). The developed concave Fig (3) is constructed with a length of 140 cm, middle diameter of 50 cm and outer end diameters of = 75cm That construction arrangement was done to add second important purpose of the threshing process. That is cutting the straw to an acceptable length suitable for animal feeding after threshing beside the proper separating of grain from plant and avoiding long straw pieces, and more uniformity of cutting lengths.

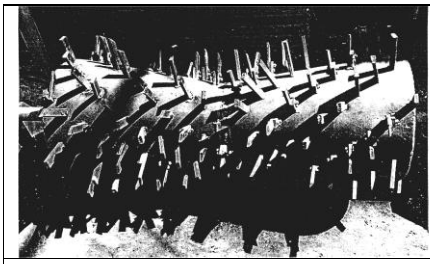

Fig (2)The developed drum

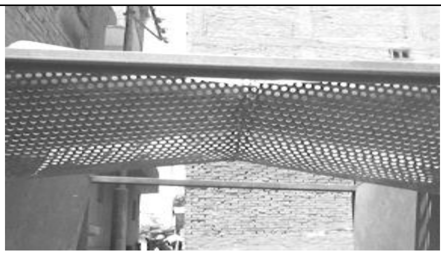

Fig (3)The developed concave

The manufacturing of the developed machinery parts and units were conducted in Egyptian private workshops using local materials. While, test performance experiments of the straw cutting were conducted for the Turkish thresher before and after development during the agricultural summer season 2007 in a private farm at Alexandria Governorate .

The double conical shape drum was equipped with two ball bearings and mounted on the Turkish thresher body. Along the outer circumference of each cone of the two drum parts fig (2) and along 70 cm long, l01 knives were fixed and arranged in a lateral distance of 5 cm between each knife and the other. . Each knife was with a long of 12.5 cm and thick of10 mm. Of course, adding these knives by such arrangement and dimensions on the outer drum circumference will change the threshing theory from hammering to shearing.

The drum-concave clearance was adjusted for four clearance levels by moving the rotor bearing towards and concave. The designed cutting mechanism was balanced dynamically for rotating parts to protect the v belts, pulley, gear and bearing from unusual wear or damage, as the cutting rotor rotates at high speed.

The chopping energy is inversely proportional to length of cut for short cuts {Kepner *et al.* (1972) and Srivastava, *et al* (1995)}. While the relationships become inaccurate as the length of cut increase (1 beyond 1.0 to 1.5 inches). Thus Deutze motor of 41.8 KW (56 hp) was used for transmitting the power for the developed Turkish thresher. For accomplishing, the investigated cutting length, six desired speed levels (from 350 r.p.m to 1400) transmitted from the motor shaft to the threshing drum shaft through a pair of pulleys and v-belts. The different investigated speed levels of the drum are as listed in the following table:-

Speed levels	S1	S2	S3	S4	S5	S6
rpm	350	500	750	1000	1200	1400
Average (m/s)	11.45	16.35	24.53	32.70	39.25	45.7

At the end of the drum axial, a flywheel was assembled to store the rotating energy and overcome any drum chock. The investigated speed levels were calibrated using speedometer model (3200 Jones U.S.A).

Experimental Procedures:-

1-Performance tests:

In order to study the performance effectiveness of the developed threshing mechanism, two groups of tests were done as follows:

The first group of tests was conducted to evaluate the effect of the feed rate, and clearances between the drum knives and concave (at inlet and outlet respectively, on the chopping performance as follows:-

1-Five different feed rate levels namely: - f_1= 0.5, f_2=1.0, f_3=1.5, f_4=2.0, and f_5= 2.5 kg/sec,
2- Four different clearances levels namely: - c1 (20/10mm), c2 (25/20mm), c3 (30/20mm), and c4 (35/25mm).

All tests of first group were carried out at rotational drum speed level of about === rpm, and of straw moisture content of about ==%

The second group of tests was done under the optimum values of feed rate, and clearances that obtained from the first group of tests. These tests were focused on the effect of the following factors on the chopping performance:-

1-Two threshing drum types, namely:- the traditional (cylindrical drum shape), and the developed (double cone shape drum)

2-Six different rotational speed levels were tested with each drum namely: - 350r.p.m. (**S_1**), 500 r.p.m. (**S_2**), 750 r.p.m. (**S_3**), 1000 r.p.m. (**S_4**). 1200 r.p.m.(**S_5**), and 1400r.p.m.(**S_6**),

3-Straw moisture content, whereas, three different moisture content levels (d.b.) were tested with each drum namely: - 14.3(M_1); 11.2 (M_2; and (M_3= 9.1 %).

Each experimental test was repeated three times, thus 72 tests, were performed during the first group of tests. While, ==tests, were performed during the second group of tests

Two detrimental quantities were chosen to judge the straw cutting performances of the developed mechanism under the effect of the previously mentioned parameters. These quantities were the percentages of different cutting length, and the uniformity of chopped straw lengths.

Measurements:-

Measurements of the first and the second group of tests conducted according to ASAE standard. The procedure of evaluating the developed mechanism was conducted. However, after each tested treatment, a sample of 1 kg from cutting straw material was taken to laboratory for measuring cutting length of the chopped straw. Whereas, the percentages of different cutting length sorted into four length categories and the uniformity of chopped straw lengths were measured and estimated.

1-The percentages of cutting length categories

A chopped straw material sample of 1 kg from each investigated treatment was taken randomly from the threshing product of each treatment with three replicates. Into the laboratory, each sample was separated into four grade categories The chopped straw of each sample were sorted into four grades, namely:-

I) **< 20 mm,** II) **20 - 30 mm**
III) **30 – 40 mm** IV) **> 40 mm**

To define the percentages of cutting length categories each sorted length in the sample was weighed and calculated as a percentage from the total weight of the sample. However, according to that classification the cutting length values of less than 30mm are acceptable straw length and proper to animal feeding. The calculation and estimation were carried out using the Microsoft Excel Computer Program.

However, each of the four cutting length category in each sample was sorted and accounted. Hence, its percent in each sample was estimated. The percentage of each cutting length category in the threshing product could be estimated as follows:

$$\text{Category \%} = \frac{straw\ \ weight\ of\ \ that\ category\ in\ the\ \ sample}{Total\ weight\ of\ \ the\ sample} \times 100 \quad \ldots(=)$$

2--The uniformity of chopped straw lengths CU ,(%)

The average lengths of chopped straw, for each sample each experimental treatment were measured using digimatic caliper. Whereas, ten readings of the three subsequent measurement trails were recorded as an average of the actual seed space (b) for each treatment,

The uniformity of chopped straw lengths (CU %) for each experimental treatment and within (into) each of the four sorted grades was evaluated in terms of three uniformity indexes. The first index is the average (X_a) of the recorded readings. The second index is the standard deviation Std or (δ) of the reading around that average. While, the third is the coefficient of variation (C.V).

According ASAE standard 1997 the coefficient of variation CV, uniformity coefficient of the cutting straw lengths could calculated from mass of materials in the collecting samples according to following sequence equations.

$$X_a = \frac{\sum x_i}{n} \text{ --- (1)}$$

$$\text{Standard deviation(}\delta = \sqrt{\frac{\sum (x_i - x_a)^2}{n-1}} \text{ ------ ---------- (2)}$$

$$\text{The coefficient of variation } C.V = \frac{\delta}{x_a} \times 100 \text{ ---------- (3)}$$

$$\text{Cutting uniformity } C.U = 1 - C.V \text{ ----------------------- (4)}$$

Logically the treatment exhibits low C.V value represents more uniformity and visa versa.

RESULTS AND DISCUSSION

The straw cutting performance of the developed mechanism, was tested within two groups of tests

Results of the first group of tests

Within the first group of tests, the developed mechanism was tested under three different feeding rate levels and four different clearance pairs between the drum knives and concave (at inlet and outlet respectively, The obtained results concluded as follows:-

Effects of the feed rates on the cutting length categories

The individual effects of the tested feed rate levels on the percentages of different cutting length categories are shown in Fig (4)..

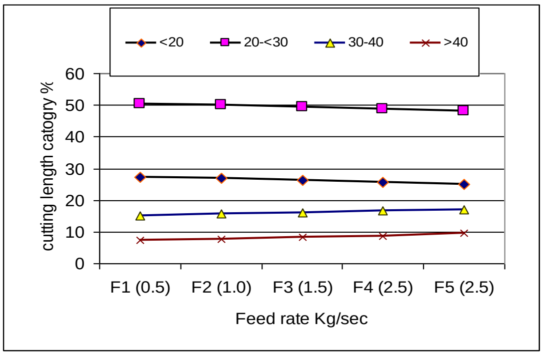

Fig (4) Effect of feed rate on the percentages of cutting length categories

It can be found that Increasing the feed rate from 0.5 to 2.5 kg/sec, the percentages of cutting length categories of (<20) and (20-<30) were slightly decreased by about 1.5%.

On the other side, the percentages of cutting length categories of (30-40) and (>40) were slightly increased from23 to25%, and from 15 to 17 % as the feed rate was increased from 0.5 to 2.5 kg/sec for each measured cutting length categories. Approximately the average percentages of cutting length categories could be considered as 18.7,40.7,24.2,and16.4% as Increasing the feed rate from 0.5 to 2.5 kg/sec for cutting length grades of (<20) , (20-30) (30-40), and (>40) mm respectively.

It can concluded from the above discussion that the feed rate factor has slightly effects or even no dependant effect on the percentages of different cutting length categories

Effects of the clearance pairs on the cutting length categories

Fig (5) illustrates the effects of the investigated clearance pairs on the cutting length categories at different feed rates and at the average values of the other tested variables.

From the shown data it can be found that increasing the clearance pairs in general decrease the percentages of cutting length categories of < 20 ,and 20-30 mm,, and increase the percentages of cutting length categories of of 30-40 mm and > 40 mm. It can be seen that, there are inverse trend accomplishing the effect of 30/20 mm clearance on the percentages of different cutting length categories. Whereas, at that clearance value the percentages of all cutting length categories exhibited a regular variations. Consequently the 30/20 mm clearance may be considered optimum level to be adjusted.

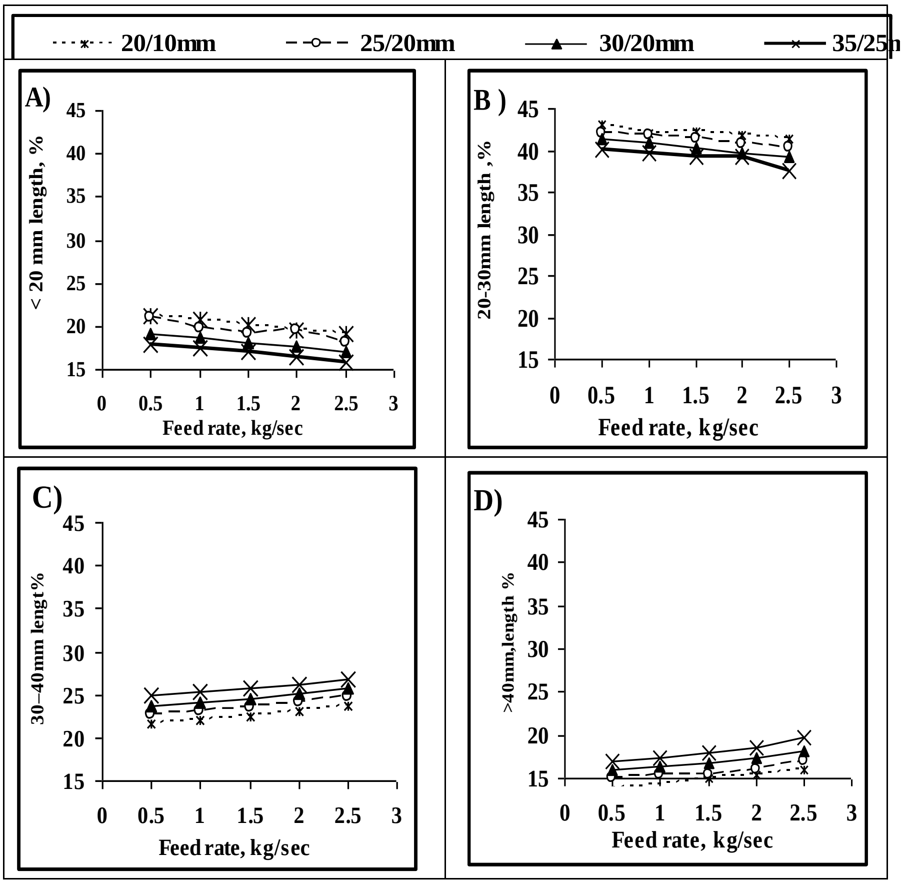

Fig (4) Effect of feed rate and the investigated clearance pairs on the percentages of cutting length categories

A) Effects on length of < 20 mm B) A) Effects on length of 20 - 30 mm

C) A) Effects on length of 30 – 40 mm D) Effects on length of > 40 mm

Results of the second group of tests

Within the first group of tests, the developed mechanism was tested under six different drum rotational speed levels, three different straw moisture content levels (d.b.) and two threshing drum types, which were tested under the same drum speed, and straw moisture content levels. The obtained results concluded as follows:-

Effects of developed drum speed the cutting length categories

The interaction effects of both drum speed and straw moisture content on the percentages of the different cutting length categories are listed in table (2). While the individual effects of drum speed on these percentages are shown in Fig (5)

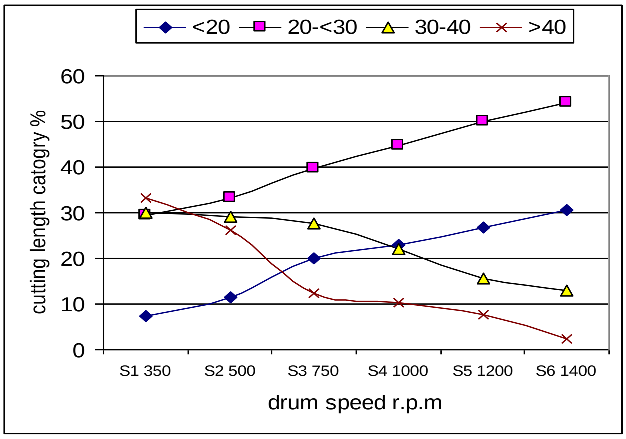

Fig (5) Effect of drum speed on the percentages of cutting length categories

From these data it can be noticed in general that increasing the drum speed leads to increase the percentages of cutting length category of < 20 mm, and demolishes the percentages of cutting length category of > 40 mm. Whereas, the percent of < 20 mm straw cutting length, increased from 5.5 to 27.1% as the drum speed increased from 350 to 1400 rpm.

The corresponding increase in the percent of 20-30 mm straw cutting length was from 26.3 to 50.6%. On the other side, the percent of > 40 mm straw cutting length was demolished by about 28% (from 35.5 to 6.9%).

That result trend revealed that revealed that desired cutting lengths from wheat straw, that suit animal feeding may be increased by about 46% as operating the developed drum at speed ranging from 1200 to 1400 rpm.

2 -Effect of straw moisture content

Data illustrated in table (2)) show the effects of straw moisture content parameter on the percentages of the chopped straw length categories. It can be seen that decreasing the moisture content increased, the percentages of straw lengths of <20, and 20--30 mm by about 6 %., While the percentages straw lengths of 30-40, and >40) mm., were decreased as the straw moisture content parameter decreased also by about 5-6%.

However, the maximum desired cutting lengths percentages, that suit animal feeding may be achieved at moisture content of 9.8 % . While the minimum percentages, achieved at moisture content of 15.1 % moisture content. It may be logical to state that operating the developed drum at low straw moisture content level will accomplished better chopping results.

The uniformity of chopped straw lengths CU ,(%)

The uniformity of chopped straw lengths (CU ,%) was estimated according the sequence equations from 1 to 4. Fig (6)) show the effects of drum speed parameter on the chopped straw lengths uniformity. While, Fig (6) illustrate the effects of straw moisture content parameter on straw chopping length uniformity.

Table (2)The interaction effects of drum speed and straw moisture content on the percentages of the different cutting length categories

Drum speed r.p.m	Moisture content	Cutting Length Categories, %					Total percent
		<20 mm	20-30 mm	suitable for animal feeding <30mm	30-40 mm	>40 mm	
S1 (350)	M1 (15.1%)	2.7	22.7	25.4	35.9	38.7	100
	M2 (13.27%)	5.3	25.7	31.0	33.5	35.5	100
	M3 (11.27)	6.4	27.5	33.9	31.4	34.7	100
	M4 (9.8%)	7.5	29.3	36.8	30.1	33.1	100
Av		5.5	26.3	31.8	32.7	35.5	100
S2 (500)	M1 (15.1%)	5.1	26.2	31.3	35.1	33.6	100
	M2 (13.27%)	7.3	28.8	36.1	31.6	32.3	100
	M3 (11.27)	9.5	31.2	40.7	30.9	28.4	100
	M4 (9.8%)	11.4	33.1	44.5	29.2	26.3	100
Av		8.3	29.8	38.2	31.7	30.2	100
S3 (750)	M1 (15.1%)	10.5	33.1	43.6	35.6	20.8	100
	M2 (13.27%)	14.5	35.0	49.5	30.9	19.6	100
	M3 (11.27)	16.6	37.1	53.7	29.5	16.8	100
	M4 (9.8%)	20.1	39.8	59.9	27.7	12.4	100
Av		15.4	36.3	51.7	30.9	17.4	100
S4 (1000)	M1 (15.1%)	17.1	39.6	56.7	27.9	15.4	100
	M2 (13.27%)	19.7	42.1	61.8	26.1	12.1	100
	M3 (11.27)	21.8	44.0	65.8	23.0	11.2	100
	M4 (9.8%)	22.9	44.8	67.7	22.1	10.2	100
Av		20.4	42.6	63.0	24.8	12.2	100
S5 (1200)	M1 (15.1%)	20.2	45.9	66.1	22.1	11.8	100
	M2 (13.27%)	24.0	47.4	71.4	18.6	10.0	100
	M3 (11.27)	25.8	48.9	74.7	16.3	9.0	100
	M4 (9.8%)	26.8	50.0	76.8	15.6	7.6	100
Av		24.2	48.1	72.3	18.2	9.6	100
S6 (1400)	M1 (15.1%)	23.8	47.5	71.3	18.3	10.4	100
	M2 (13.27%)	25.7	49.0	74.7	16.8	8.5	100
	M3 (11.27)	28.3	51.7	80.0	13.6	6.4	100
	M4 (9.8%)	30.7	54.0	84.7	12.9	2.4	100
Av		27.1	50.6	77.7	15.4	6.9	100

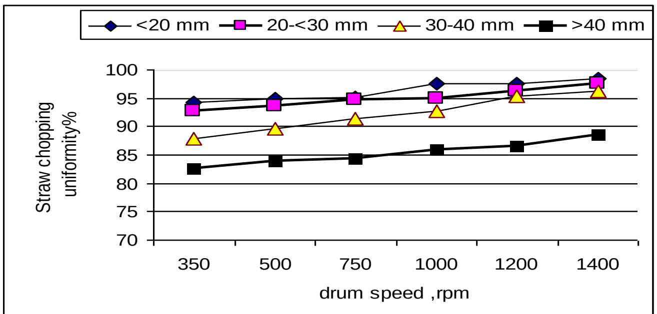

Fig (6)The staw chopping uniformity as affected by the developed drum speed

The obtained results indicated that the maximum uniformity percentages in cutting length of less than 20 ,and 20-30 mm were 87.80 and 92.00% These values were accomplished the highest drum speed levels of 1200 ,and 1400rpm. The corresponding uniformity percentages in cutting length categories of 30-40, and >40) mm were===, and ===respectively.

Meanwhile, the minimum uniformity percentages in cutting length of less than 20 , 20-30 30-40, and >40) mm were 87.80 and 92.00%. These values were found to be the lowest drum speed levels from 350 to 500 rpm and at the same moisture parameter levels respectively.

However, it may concluded that the proper straw chopping uniformity that accomplished the developed drum may be obtained at cutting speed of 1200 rpm feeding rate 1 kg/sec with 30/20 mm knife clearance.

On the other hand comparing the chopping performance of the developed thresher with that of the thresher before development at the same operating conditions, it can be concluded from figs 5,and (7) the following notations:-

1-The maximum percent of desired cutting lengths from wheat straw, that suit animal feeding was recorded as 84.7% for the developed drum as versus 69.9% for drum before development.

2-The cutting length uniformity of the chopped wheat straw was higher by about 20% in favor of developing the drum in comparison with the thresher before development.

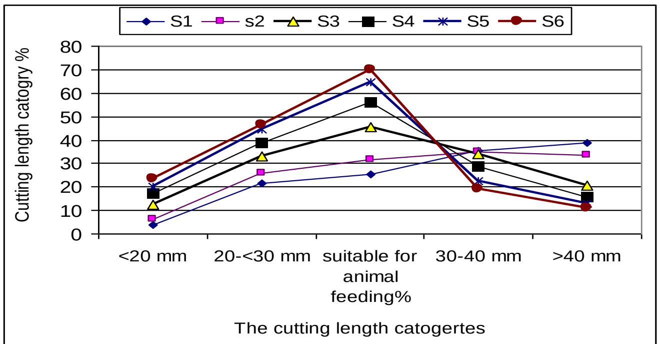

Fig (7) The straw chopping performance of the thresher befor development

SUMMAR AND CONCLUSIONS

The second important purpose of the threshing drums after separating the grain from plant is for cutting the straw to an acceptable length that is suitable for animal feeding. Thus the main objective of the present study is to design and test the straw chopping performance of a proper wheat straw threshing mechanism. That mechanism involved conical cutting rotor drum and its coinciding concave to change the theory of threshing from hammering to shearing, and to obtain the desired cutting wheat straw lengths, that suitable for animal feeding.

The wheat straw cutting performance of the developed mechanism was deduced in terms of the percentages of cutting length categories, and the uniformity of cutting lengths**.** It was tested under the following parameters:- five different feed rate levels (:0.5, 1.0, 1.5, ,2.0, and 2.5 kg/sec), four different clearances levels {(20/10mm), (25/20mm), (30/20mm), and (35/25mm)}, six different drum speed levels (350,500, 750, 1000, 1200 ,and 1400 r.p.m.),four different moisture content levels (15.1, 13.27,11.27 and 9.8 %), and two threshing drum types, (the cylindrical ,and the developed double cone shape drums).

The obtained results concluded that the maximum percentages in wheat straw cutting length of less than 30 mm (84.7.3.%) was obtained at cutting speed of1200 rpm(45.7 m/s), feeding rate of 1 kg/sec and knife clearance of 30/20 mm. While, the minimum percentages in straw cutting length of less than 30 mm (50.3.00%) was obtained at cutting speed of350 rpm(11.45 m/s), feeding rate of 0.5 kg/sec and knife clearance of 35/25mm

In addition the maximum values (98.5%) of the uniformity of cutting lengths were obtained at cutting speed of1400 rpm at the same mentioned feeding rate ,and knife clearance levels.

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تقييم عملية تقطيع تبن القمح باستخدام درفيل مخروطي مطور

زكريا إبراهيم إسماعيل ، الشحات بركات البنا ، ماهر محمد إبراهيم و محمد عبد الحي شلبي
قسم الهندسة الزراعية - كلية الزراعة – جامعة المنصورة

للحصول علي أطوال تبن أكثر مناسبة لتغذية الماشية تم تطوير تصميم درفيل الدراس الموجود بماكينات الدراس المحلية خاصة التركية التصميم بدلاً من الدرفيل ذو الشكل الأسطواني إلي درفيل مخروطي الشكل. والدرفيل المطور عبارة عن مخروطين مندمجا التركيب بحيث تتقابل رأسي المخروطين في منتصف الدرفيل وتقع نهاية المخروطين في طرفي الدرفيل. وقد تم تقييم عملية تقطيع تبن القمح باستخدام آلة الدراس التركية بعد تركيب الدرفيل المطور بها ودراس محصول القمح علي ست سرعات لدرفيل الدراس وأربع نسب للرطوبة وعلي خمس معدلات تلقيم مختلفة .وقد أجريت التجارب في احد المزارع الخاصة بقرية تابعة للعامرية بمحافظة الإسكندرية .

وقد أظهرت النتائج المتحصل عليها ما يلي:

1-يصفه عامة أدى إحلال الدرفيل المطور ضمن تركيب آلة الدراس التركية مكان الدرفيل التقليدي الاسطواني تأثير واضح على تحسين أطوال تبن أكثر المناسبة لتغذية الماشية بمقدار 15% وتحسين انتظامية أطوال القطع بنسبة 20%
2-بزيادة سرعة الدرفيل المطور من الى350 إلى 1400لفة/دقيقة يزيد نسبة التبن ذي الطول اقل من 20مم وأيضاً تزيد نسبة طول قطع التبن من 20 إلي أقل من 30 مليمتر من (20.2) إلي (50.5) بينما تقل نسب التبن ذي الطول من 30 - 40 مليمتر وكذلك أكثر من 40 مليمتر من ينسب 15 إلي 29%.
3- بانخفاض نسب رطوبة القش من15الى 9.8% يتحسن أداء القطع للدرفيل المطور حيث يزيد نسبة التبن ذي الطول اقل من 30مم بمقدار13% بينما تقل نسب التبن ذي الطول من 30 إلي 40 مليمتر وكذلك أكثر من 40 مليمتر بمقدار7%
4-لم يلاحظ تأثير واضح بزيادة معدل التغذية من 2/1 كيلو جرام في الثانية إلي 2.5 كجم/ث على نسبة القطع المختبرة. وتوصى النتائج باستخدام معدل التغذية مقداره 1 كجم/ث.
5- يوصى باستخدام تصميمات درافيل الدراس ذات الشكل المخروطي واختبارها لدراس وتقطيع قش وعيدان محاصيل أخرى غير القمح.