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MODIFYING OF A LOCAL THRESHER FOR CHOPPING CROP RESIDUES

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ABSTRACT

Field experiments conducted out to evaluate the performance of a modified thresher machine (El-shams thresher model) for chopping two types of crop residues namely rice straw and cotton stalks. The effect of two types of cutting knives (swinging and rotating knives), four cutting rotor speeds of 19.63, 23.56, 27.49 and 31.4m/s, and three stalk moisture contents of 10.45, 14.73 and 18.81%, d.b. for rice straw and 8.37, 11.27 and 15.65%, d.b. for cotton stalks on cutting length, cutting efficiency, productivity and total machine losses were taken the considerations. And also, an estimation of power, energy requirements, operating cost and criterion function cost were made. Results indicated that, cutting length <3cm was increased with increasing cutting rotor speed and decreasing stalks moisture content. The maximum value of machine cutting efficiency and machine productivity were 95.8, 94.2% and 1.15, 1.13ton/h for rice straw and cotton stalks, respectively. However the lowest value of energy requirement were 24.63 and 16.26kW.h/ton for rice straw and cotton stalks. Also, minimum values of criterion function cost was 74.68LE/ton and61.67LE/ton for cutting rice straw and cutting cotton stalks. The optimum operation conditions for cutting rice straw was at cutting rotor speed of 19.6m/s, stalks moisture content of 10.45%, and using swinging knives and for cutting cotton stalks was at cutting rotor speed of 27.5m/s, stalks moisture content of 8.37%, and using rotating knives.

Keywords: Rice straw, cotton stalks, cutting devices.

INTRODUCTION

Crop residues are considered the most critical problems facing the Egyptian farmers. In Egypt rice cultivation in the Nile Delta produces high amounts of rice straw as residue. About 2.8 million ton were left on the open fields for burning within a period of 30 days to get quickly rid of leftover debris. The harmful resulting emissions give a significant contribution to the air pollution called the “Black Cloud”. A suitable technology for the use of rice straw to reduce air pollution and gives a significant biomass as renewable energy is required in Egypt. Also cotton stalks in most cases, are burned in the field and cause some problems. While, with cutting this crop residues are taking advantage of them in animal feed, composting, biogas production, or other industries friendly to the environment. Egyptian farmers burn yearly about 2-3ton/fed of rice straw and 5.87 million ton of corn stalks respectively as a means for disposing it and to save time for preparing the land of the next crop (Helmy et al., 2003). El-Berry et al. (2001) reported that the quantity of crop residue in Egypt reached about 18.7-25 million ton/year and the national income might be increased by about 1.6 billion LE/year, if we try to recycle it. Many studies have been conducted to evaluate utilization of crop residues for such uses as animal feed, as a fuel, handicrafts, furniture, biogas, compost, pollution abatement and paper pulp with limited success (Lindsey and Hirt 1999 and Julien et al. 2001). Luis et al. (1993) found that the cutting lengths of residues between 1.27 to 7.62cm are recommended for composting the residues. Khader (1997) concluded that the four movable knives could be used for producing animal fodder, silage or compost according to residues cutting length. Where, the cutting length was affected by drum speed and clearance. The optimum operating condition was; (a) animal fodder (1.5-3cm) drum speed 29.05m/s and 1mm clearance, (b) silage (3–6cm) and composting (6-12cm) drum speed 19.63m/s and 5mm clearance. The cutting efficiency value were 90. 95, 85 and 50% for cotton, maize, bean and rice, respectively, at the recommended cutting length. Namikawa (1997) recommended that the optimum cutting speed must ranged between 15 to 30m/sec for the suitable hay shredding. He also mentioned that the speeds over than the optimum speed range caused a rapid increasing of specific energy consumption. Arif (1999) mentioned that the primary step in the operation of compost, processing is the mechanical treatment of the residual for size reduction, which can be accomplished by cutting or grinding the residual. The small pieces of the residual after being cut represent the form of agricultural residual, which are suitable for further steps of compost processing. He also added that the cut length of residual depends on the feeding drum, speed, moisture content and knives clearance. Mohamed et al. (2001) developed and evaluated a rice straw chopper. The results indicated that the productivity of the developed machines was 0.95ton/h at 31.4m/s rotor speed and the cutting lengths of (1-9cm). Tarek (2002) developed a crop residues chopper to improve its performance and productivity to be suitable for cutting rice straw, cotton stalk and maize stalk. The developed of the original machine is supplying a new pre-cutting device with different speed ratio to reduce the cutting time and increase the machine productivity. Lotfy (2003) concluded that, the feasibility of using a local stationary thresher for cutting and grinding farm crop residues (rice straw and maize stalks) with suitable particles size. El-Iraqi and El-Khawaga (2003) designed a cutting machine for rice straw and maize stalks. It was operated at five cutting speeds ranged (6.48–10.09m/s), three clearness between knives (1.5, 3 and 4.5mm) and three feeding rates (0.257, 0.514 and 0.771ton/h). Taieb (2005) carried out a field study through questionnaires to determine relative importance of different farm residues. The field study showed that cotton stalks, maize stalks and rice straw had the highest relative weight of residues and the most important and beneficial compared to other field crop residues. Sontakke et al. (2013) recommended that cutting farm residues in pieces less than 3cm improves its efficiency when used in feeding livestock. Ebaid (2006) used corn sheller for cutting cotton and corn stalks and mentioned that farmers can use the corn shellers in cutting crop residues. Omran (2008) evaluated and compared the performance of three shredders, (a) local manufacturing (LK), (LM) and (b) imported (IV) for shredding cotton, maize and rice residues at different rotor cutting speeds. The evaluation based on productivity, energy consumed, cutting length and total cost. So, the objective of the present research was to modify thresher machine for cutting crop residues and determine the technical and costal performance of modification thresher machine (El-shams) at different operating conditions.

MATERIALS AND METHODS

The experiments were carried out in Rice Mechanization Center, Meet El-Deeba, Kafer El- Sheikh governorate, Egypt, during season of 2014. New modification of local thresher machine for cutting crop residues and studying the effect of engineering parameters of machine on cutting process of rice straw and cotton stalks, was investigated. The optimum conditions for operation, energy requirements and operating cost were determined, as well.

Local thresher machine before modifying:

The general specifications of the local thresher machine(El-shams) are presented in Table 1.

Table1:The general specifications of the threshing machine before modifying.

No.	Item	Local thresher machine before modifying
1	Overall length, cm	320 without hitch, 415 with hitch
2	Overall width, cm	127
3	Overall height, cm	198
4	Mass, kg	1550
5	Source of power	Transmit from tractor through pulley and belt.
6	Type of the threshing drum	Spike tooth.
7	Length of the threshing drum, cm	118
8	Diameter of the threshing drum, cm	75
9	Knives tape pf flat dimensions	Total of 44 knives, (32.5cm) length, (10,6cm) bottom and top wide and (0.6cm) thick (knives) flats bolted to the central tube (10cm) diameter.
10	Input opining dimensions, cm	112x45
11	Output opening dimensions for straw, cm	50x35
12	Output opening dimensions for grain, cm	10x10
13	Hole diameter for curved sieve, cm	1.5
14	Eccentric stroke of the screen, cm	1.8-3.4
15	The distance between two plates, cm	10
16	The number of semi circular concave holes, per 10x10 cm²	12

Local thresher machine after modifying:

The general modification parts carried out on threshing drum as follows:

- 44 cutting knives installed on threshing drum at the outer perimeter and distributed on four axes.
- Design and fabricate two types of rotary drums with 20cm internal diameter to which are attached four longitudes bars. The first type called swinging cutting knives as shown in Fig. 1. with 44 chopping knives L shaped fixed side connected to bars and the other side is free installed in four longitudinal bars. The distance equality with 12.5cm, the length of each 27.5cm and a compound on the tip of each other free knife movement have 10cm long and there was overlap between the knives of 2.5cm and thus the total diameter of the cylinder rotary equal to 75cm. The other type called rotating rotor, as shown in Fig. 2. It was an external diameter of 50cm and intra-distances between each of knives was 12.5cm.
- Installation of eleven stationary knives U-shape have the dimensions of 5x10cm at the entrance of cutting rotor and the other number eleven at the outlet of the cutting rotor to increase the effect of shear forces on used agricultural residues.
- Modifying and adjustment the concave cylinder containing rectangular openings with dimensions 3×8cm and so allow the passage of all parts chopped out of the machine.
- Replace the winnowing sieve by polished sieve to increase the suction effect

Experimental treatments:

The performance of two modified choppers are evaluated under the following treatments:

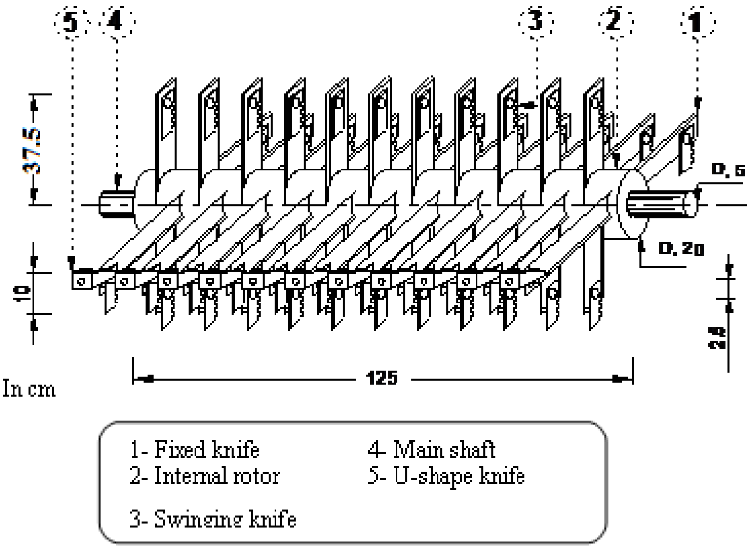
- Two types of crop residues namely: rice straw and cotton stalks:
- Three moisture contents of rice straw and cotton stalks namely (10.45, 14.73 and 18.81%, d.b.) and (8.37, 11.27 and 15.65%, d.b.), respectively:
- Four cutting rotor speeds of 19.63, 23.56, 27.49 and 31.4m/s, (500, 600, 700 and 800rpm), respectively.

Machine feed rate remained steady at level 1.2ton/h during the execution of the present experiment.

Measurements:

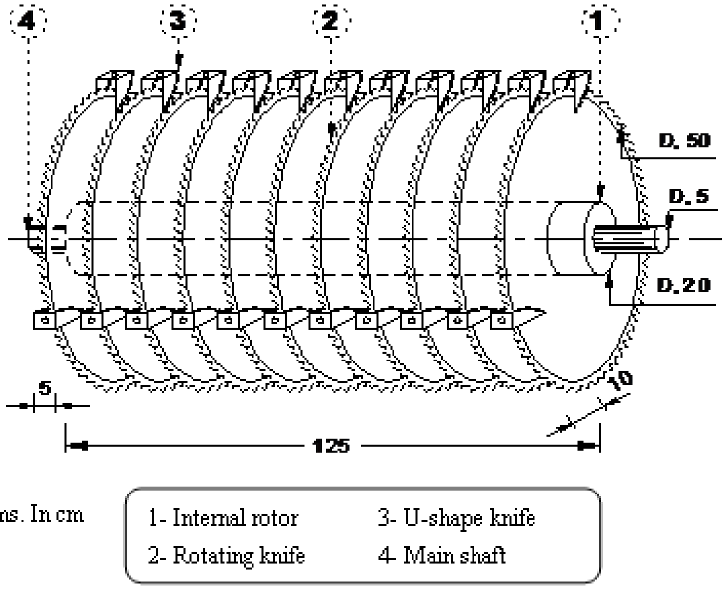
The rice straw and cotton stalks were collected in bundles before starting the cutting process. The speed of cutting rotor was measured and adjusted by tachometer. The chopped materials were dropped to the spout after cutting in threshing room through concave. Samples of cutting stalks were taken from each experiment to laboratory separated and classified into three classes using hand sieves as follows: first class >3cm, second class 3-6cm and third class <6cm (referred to *Luis et al. 1993*; *Church 1991*).

Moisture content: It was determined with using the oven method according to *ASHRAE, 1999* the following formula was used for determination:



Dims. In cm

Fig. 1: A geometrical drawing of the modifying cutting rotor with swinging knives.



Dims. In cm

Fig.2: A geometrical drawing of the modifying cutting rotor with rotating knives.

$$Moisture\,content = \frac{M_1 - M_2}{M_2} x100,\% \quad \text{……………………(1)}$$

Where:

M_1 moist mass, g, and

M_2 dry mass, g.

Machine productivity: It was calculated by using the following formula by ***Mady,1999***:

$$P = \frac{W\,x3600}{T}, ton/h \quad \text{……………………………(2)}$$

Where:

P productivity, ton/h;

W mass of the sample, ton, and

T time in sec.

length of cutting: It was assessed by taking a sample of 1kg from cut crop material into laboratory and separating into three class (>3cm, 3-6cm and <6cm). Each cutting length in the sample was weighed and calculated as a percentage from the total weight of the sample.

Cutting efficiency: Cutting efficiency was calculated by measuring the stem length before cutting and the size or length of particles after cutting. That according to the following equation ***(Elfatih et al., 2010):***

$$\eta_c = \frac{L_b - L_a}{L_b} x100,\% \quad \text{……………………………(3)}$$

Where:

η_c cutting efficiency, %;

L_b residual length before cutting, cm, and

L_a particles length after cutting, cm.

Total machine losses: machine losses were calculated as follow :

$$Total\,machine\,losses = \frac{M_{s1}}{M_d} x100,\% \quad \text{……………………… (4)}$$

Where:

M_{s1} mass of split portion of stalk losses in ground after cutting operation, kg; and

M_d total mass of stalks entering to machine for cutting, kg.

Energy requirements: Estimation of the required power is calculated as using the following formula (***Hunt, 1984***):

$$PR = \{FC\,x(1/3600)\,x\,\rho E\,x\,LCV\,x\,427\,x\,\eta_{thb}\,x\,\eta_m\,x(1/75)\,x(1/1.36)\}, kW \quad \text{…….(5)}$$

Where:

PR power required, *kW*;

FC the fuel consumption, l/h;

ρE	the density of fuel, kg/l (for gasoline, 0.72);
LCV	the lower calorific value of fuel, 11000kcal/kg;
η_{thb}	thermal efficiency of the engine, (for Otto engine, 25%);
427	thermo- mechanical equivalent, kg.m/kcal, and
η_m	mechanical efficiency of the engine (for Otto engine, 85%).

Hence, the energy requirements can be calculated as follows:

$$Energy\ requirements = \frac{Power\ required}{Machine\ productivity}, kW.h/ton \ldots\ldots\ldots(6)$$

Operating cost: The total cost need for operation was estimated by the following formula (***Hunt, 1984***):

$$Operating\ cost = \frac{Machine\ cost}{Yield\ output}, LE/ton \ldots\ldots\ldots(7)$$

Here, machine cost was determined by the following formula (***Hunt, 1984***):

$$C = p/h\left(1/a + i/2 + t + r\right) + \left(0.9\, w.s.\, f\right) + m/144, LE/h \ldots\ldots\ldots(8)$$

Where:

C	hourly cost, LE/h.	*0.9*	factor accounting for lubrication
p	price of machine, L.E.	*w*	engine power, hp
a	life expectancy of the machine, h.	*s*	specific fuel consumption, l/hp.h.
h	yearly working hours, h/year.	*f*	fuel price, L.E/l
i	interest rate/year.	*m*	monthly average wage, L.E.
t	taxes ratio	*144*	reasonable estimation of monthly working hours.
r	repairs and maintenance ratio		

And also:

$$Criterion\ function\ cost = (operating\ cost + losses\ cost), LE/ton \ldots(9)$$

RESULTS AND DISCUSSION

Primordial test:

primary experiment is carried out to determine the performance of thresher machine(El-shams)before modification for chopping rice straw and cotton stalks under different levels of experimental parameters. It is remarked that:

- Used thresher failed to chop rice straw due to the obstruct of the concave holes.
- long rice straw wrap around the main rotating shaft which cause thresher clogged.
- It is stopped the thresher at rotor speed of 37.3m/s because it was noticed high vibrations.
- With increasing cutting rotor speed to 37.3m/s, the unit clogged and belt slippage occurred due to over load with both of rice straw and cotton stalks.

Evaluate the performance of development thresher:

1-Cutting length categories:

Data in Figs. (3 and 4) show the effect of cutting rotor speed, knives type and different stalks moisture content for cutting both of rice straw and cotton stalks on cutting length categories. The results indicate that, with increasing of cutting rotor speed and decreasing stalks moisture content, (<3cm and 3-6cm) led to increase in cutting length categories while >6cm category was decreased. On the other hand, results show that, swinging knives recorded high percentage of <3cm category at cutting rice straw while rotating knives recorded high percentage of <3cm category at cutting cotton stalks. The highest percentage of cutting rice straw lengths of <3cm (56.89%) which is suitable for animal feed and the highest percentage of cutting rice straw lengths of 3-6cm (29.31%) also the minimum percentage of >6cm category(13.8%) obtained under rotor speed of 31.4m/s and moisture content of 10.45% and using swinging cutting knives. While, the highest percentage of cutting cotton stalks lengths <3cm (34.71%) and the highest percentage of cutting cotton stalks lengths of 3-6cm (44.62%) also the minimum percentage of >6cm category(20.67%) recorded under rotor speed of 31.4m/s and moisture content of 8.37% and using rotating cutting knives. So, swinging knives suit for cutting rice straw while rotating knives are fit for cutting cotton stalks.

2- Cutting efficiency:

Data presented in Fig. 5 illustrate that, cutting efficiency was increased with increasing of cutting rotor speed, and with decreasing stalks moisture content. Also, swinging knives recorder high value of cutting efficiency for cutting rice straw than rotating knives which are the best for cutting cotton stalks. The results, indicate that using swinging knives recorded maximum value of cutting efficiency for rice straw 95. 8% at rotor speed of 31.4m/s and moisture content of 10.45% .While using rotating knives to chop cotton stalks recorded maximum value of cutting efficiency for cotton stalks 94.2% with rotor speed of 31.4m/s and moisture content of 8.37% .these due to the rice straw has high elasticity so. It need more knives and more cutting cross-section area of cutting zone. This is available with free rotating knives.

3- Productivity:

The obtained results presented in Fig. 6 show that, increasing cutting rotor speed and decreasing stalks moisture content lead to increase of productivity, at using swinging knives and rotating knives, respectively. Through the results, the productivity was increased by using swinging knives to chop rice straw and using rotating knives to chop cotton stalks. Also, results noticed that, the higher productivity when cutting of rice straw is 1.15 ton/h recorded at rotor speed of 31.4m/s, moisture content of 10.45% and using swinging knive type. Whereas, the higher productivity for cutting cotton stalks is 1.13 ton/h recorded at rotor speed of 31.4m/s, moisture content of 8.37% and using rotating knive type.

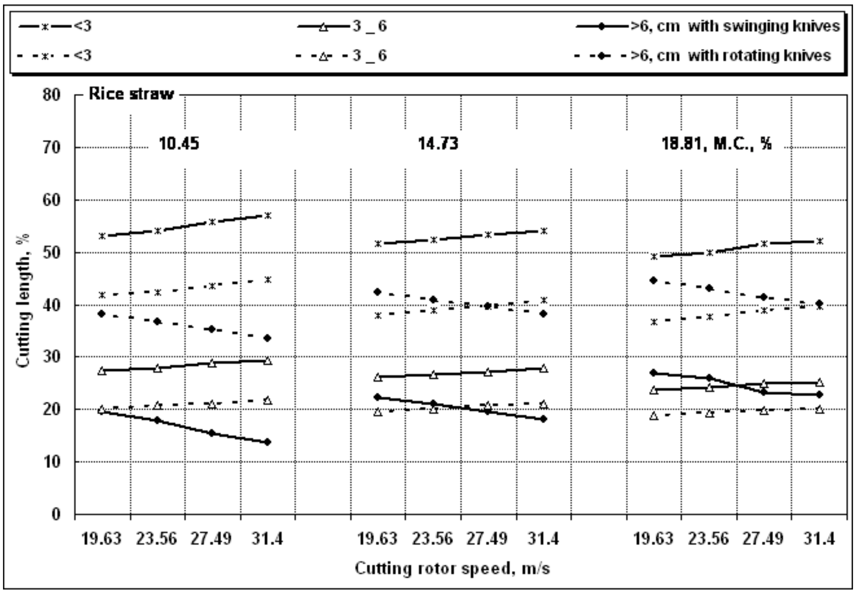


Fig. 3: Effect of cutting rotor speed and moisture content on rice straw cutting categories under both of swinging and rotating knives.

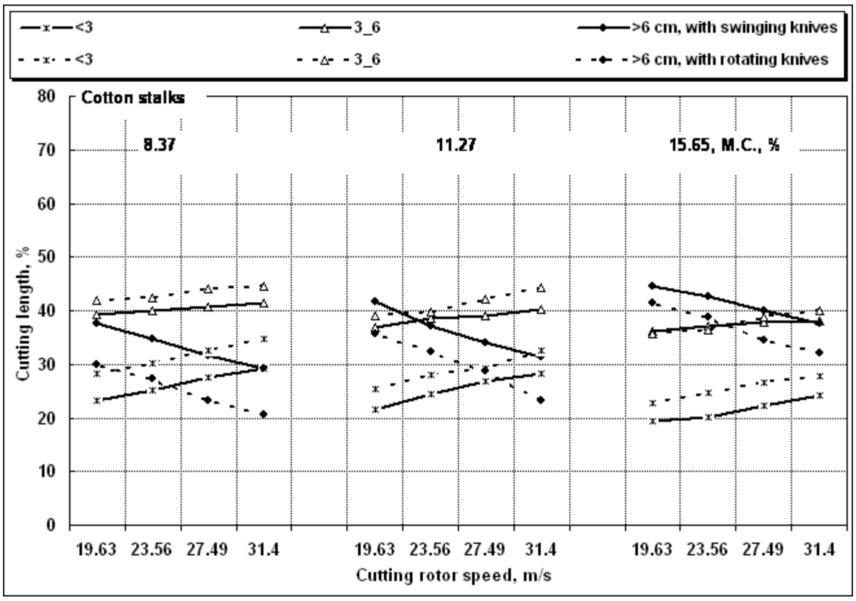


Fig. 4: Effect of cutting rotor speed and moisture content on cotton stalks cutting categories under both of swinging and rotating knives.

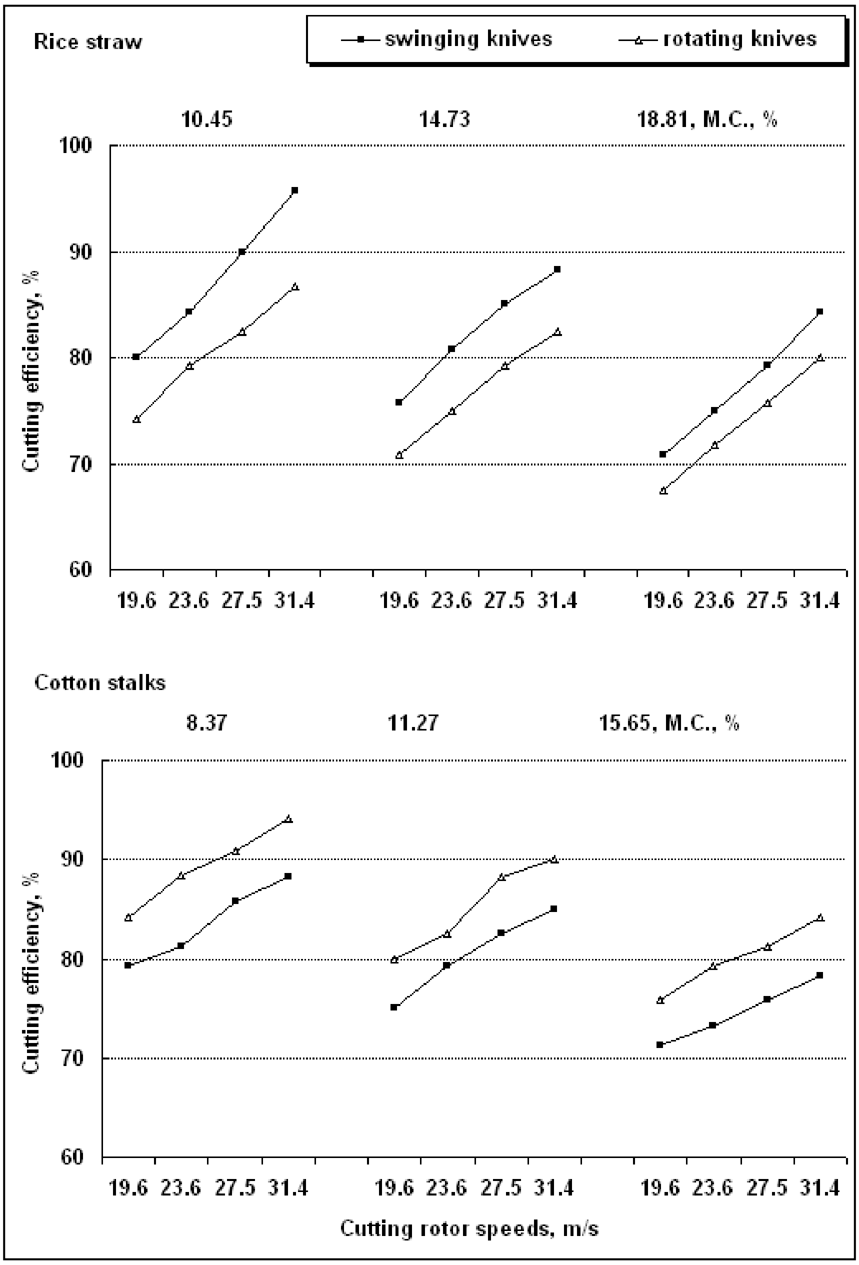


Fig. 5: Effect of cutting rotor speed and moisture content on rice straw and cotton stalks cutting efficiency under both of swinging and rotating knives.

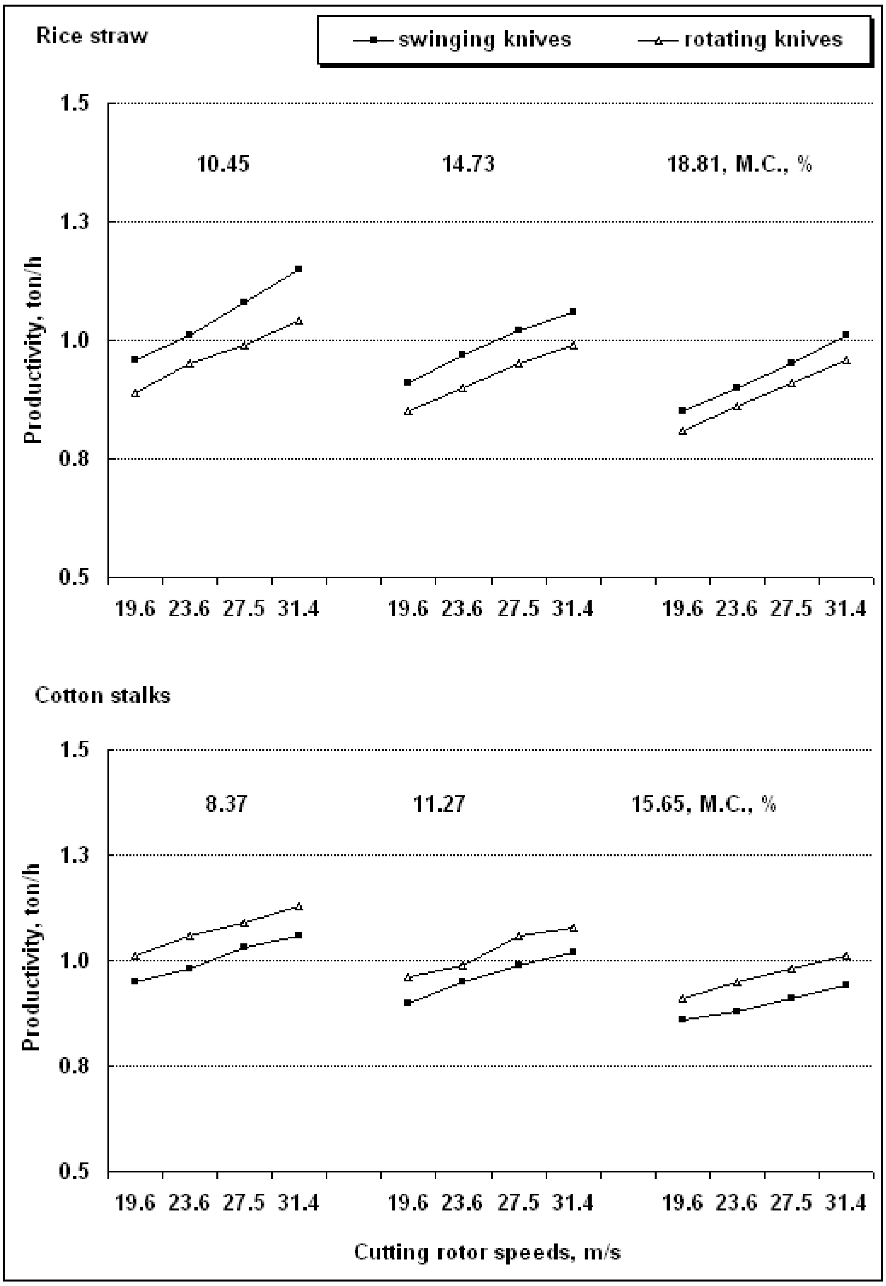


Fig. 6: Effect of cutting rotor speed and moisture content on rice straw and cotton stalks productivity under both of swinging and rotating knives.

4- Energy requirements:

Data in Fig. 7 illustrate that energy requirement decreased with increasing cutting rotor speed and decreasing stalks moisture content at using swinging rotating knives and rotating knives, respectively. It was found that, the lowest energy requirements value for cutting of rice straw was 24.63kW.h/ton recorded with rotor speed of 31.4m/s, moisture content of 10.45% and using swinging knives type while the lowest energy requirements value for cutting of cotton stalks is16.26kW.h/ton recorded with rotor speed of 19.63m/s, moisture content of 8.37% and using rotating knives type.

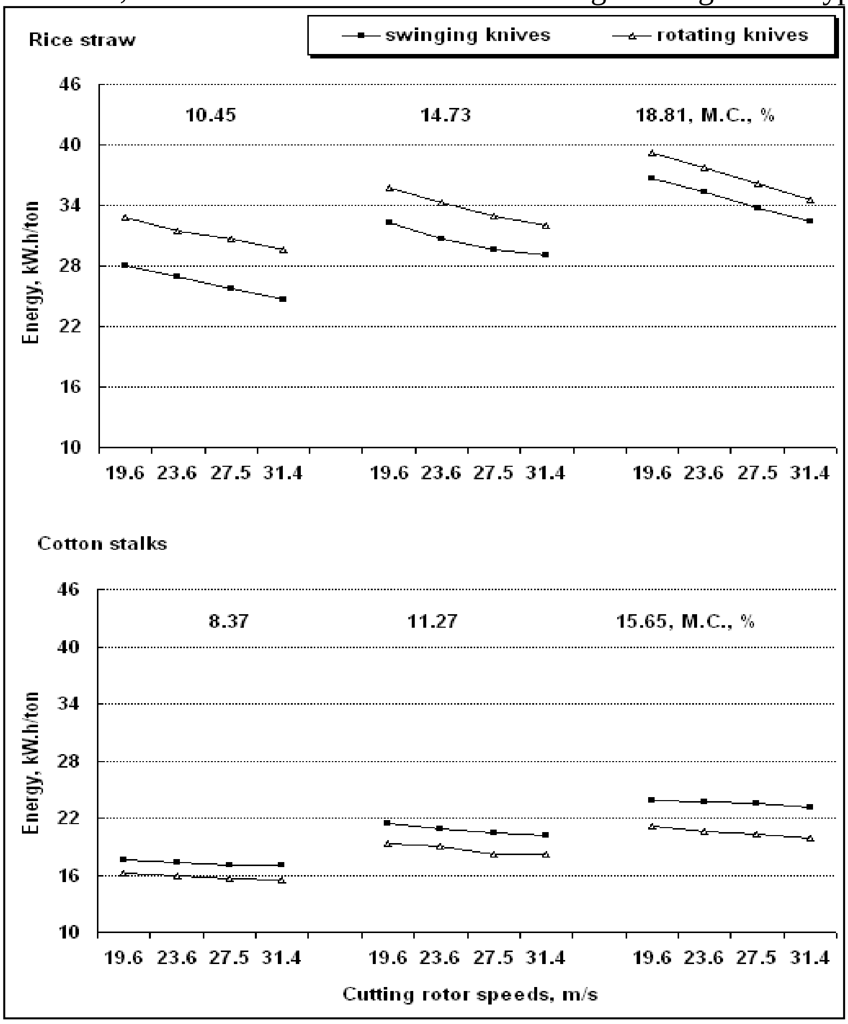


Fig. 7: Effect of cutting rotor speed and moisture on rice straw and cotton stalks energy requirements under both of swinging and rotating knives.

5- Total machine losses:

Total stalks losses are considered the efficacious indication during investigating the performance of the developed thresher. Results in Fig. 8 show that, total developed thresher losses were increased by increasing of cutting rotor speed or decreasing of stalks moisture content. Results show also that, total losses of rice straw are smaller with using rotating knives then of cotton stalks with using swinging knives. Considering, total losses are increased from 0.14 to 0.21ton/h and from 0.12 to 0.19ton/h at cutting rice straw and from o.153 to 0.237ton/h and from 0.11 to 0.202ton/h at cutting cotton stalks with increasing cutting rotor speed from 19.63 to 31.4m/s and stalks moisture content of 10.45%, d.b., for rice straw and 8.37% d.b., for cotton stalks with using swinging and rotating knives respectively. Also, total losses are increased from 0.1 to 0.14ton/h and from 0.06 to 0.12ton/h at cutting rice straw and from 0.132 to 0.153ton/h and from 0.08 to 0.11ton/h at cutting cotton stalks with decreasing stalks moisture content from 18.81 to 10.45% for rice straw and from 15.65 to 8.37% at cutting rotor speed of 19.63m/s with using swinging and rotating knives respectively.

6- Losses cost :

It is found that, losses cost is increased with increasing of rotor speed or decreasing of stalks moisture content (Fig. 9). So, the minimum losses cost value of 9.0LE/ton for rice straw and 15.0LE/ton for cotton stalks recorded under cutting rice straw rotor speed of 19.63m/s, stalks moisture content of 18.81%, d.b., swinging knives and rotor speed 19.63m/s, stalks moisture content of 15.65%, d.b., and using rotating knives for cutting cotton stalks.

7- Operating cost:

Fig. 10 illustrates that, operating cost is increased with increasing both of cutting rotor speed and stalks moisture content. Where for cutting rice straw, the lowest value of operating cost of 51.53LE/h recorded using swinging knives with cutting rotor speed of 19.63m/s and stalks moisture content of 10.45%, d.b. While, for cutting cotton stalks the lowest value of 42.29LE/h recorded using rotating knives with cutting rotor speed of 19.63m/s and stalks moisture content of 8.37%, d.b.

8- Unit cost and Criterion function cost:

From Figs.(11 and 12), it is noticed that, unit cost decreases with increasing cutting rotor speed or decreasing stalks moisture content. Also, using rotating knives in cutting rice straw and swinging knives in cutting cotton stalks recorded the lowest value of unit cost. So, the lowest value of unit cost of 47.1LE/ton recorded cutting rice straw under cutting rotor speed of 31.4m/s, cutting cotton stalks, the lowest value of unit cost of 38.77LE/ton records under cutting rotor speed of 31.4m/s, stalks moisture content of 8.37%, d.b., and using rotating knives.

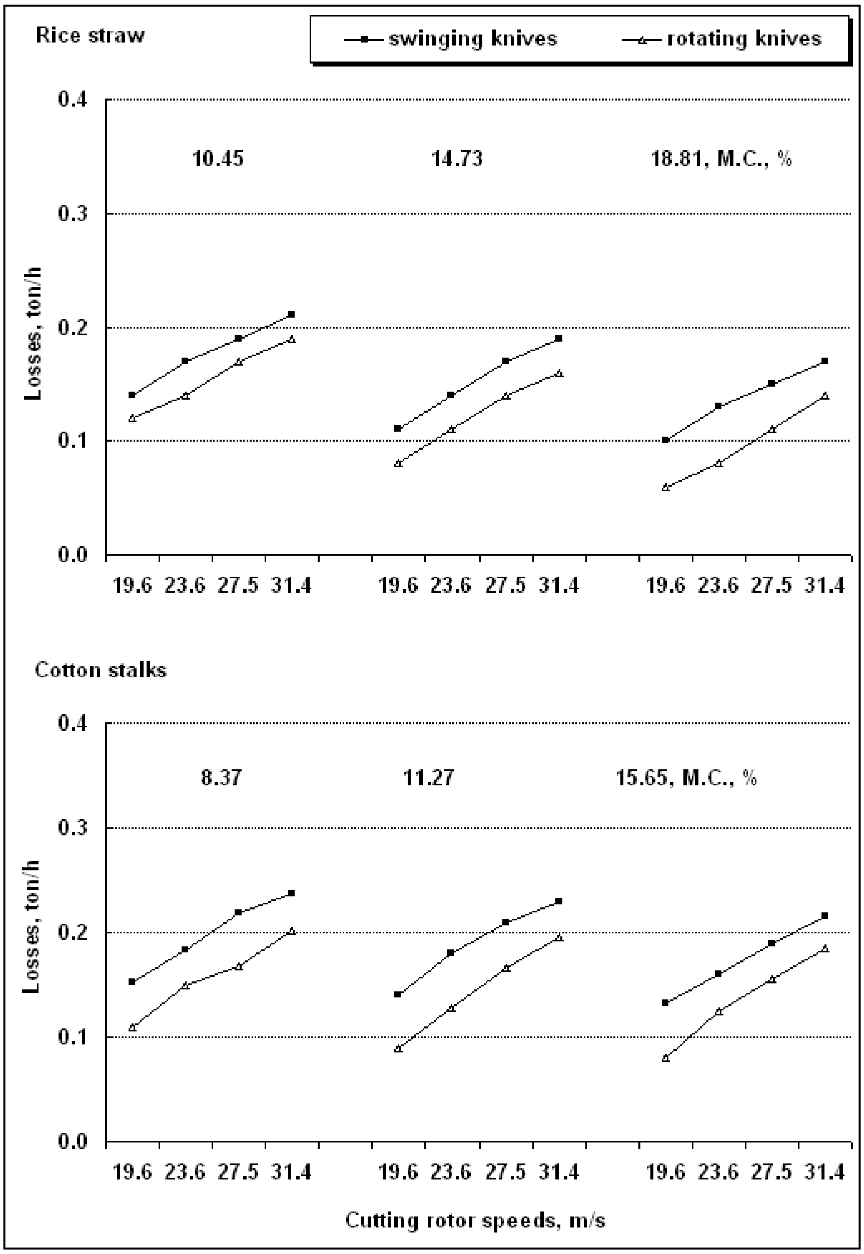


Fig. 8: Effect of cutting rotor speed and moisture on rice straw and cotton stalks losses under both of swinging and rotating knives.

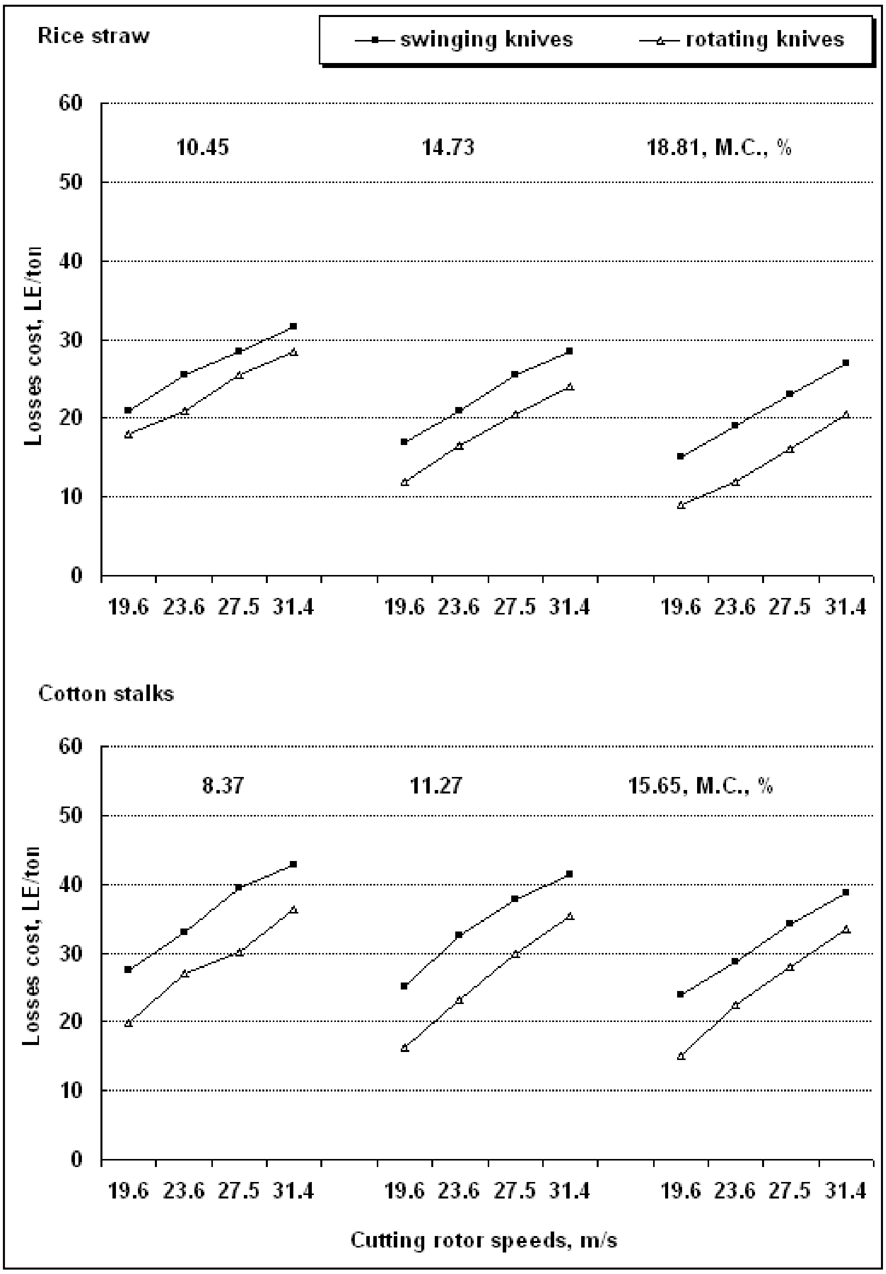


Fig. 9: Effect of cutting rotor speed and moisture on rice straw and cotton stalks losses cost under both of swinging and rotating knives.

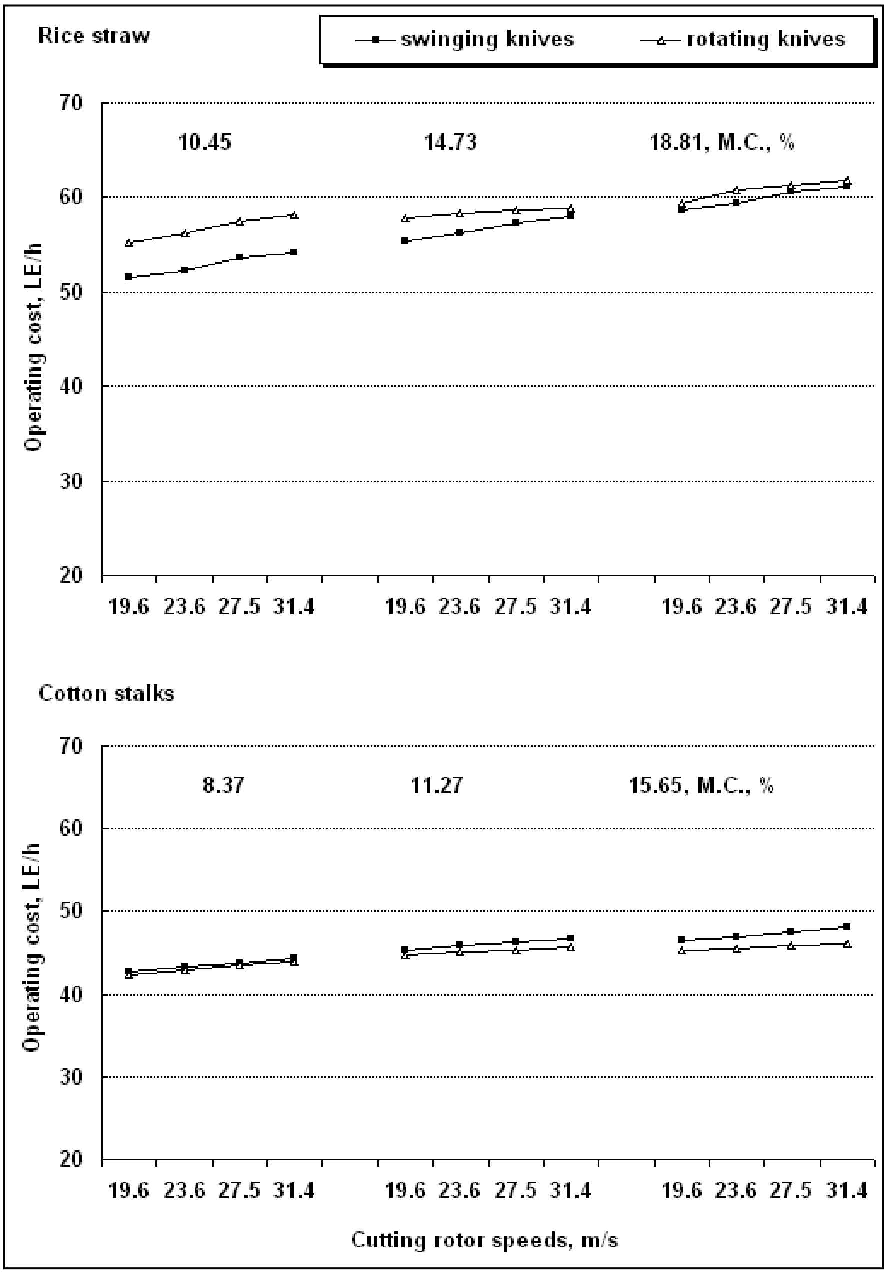


Fig. 10: Effect of cutting rotor speed and moisture on rice straw and cotton stalks operating cost under both of swinging and rotating knives.

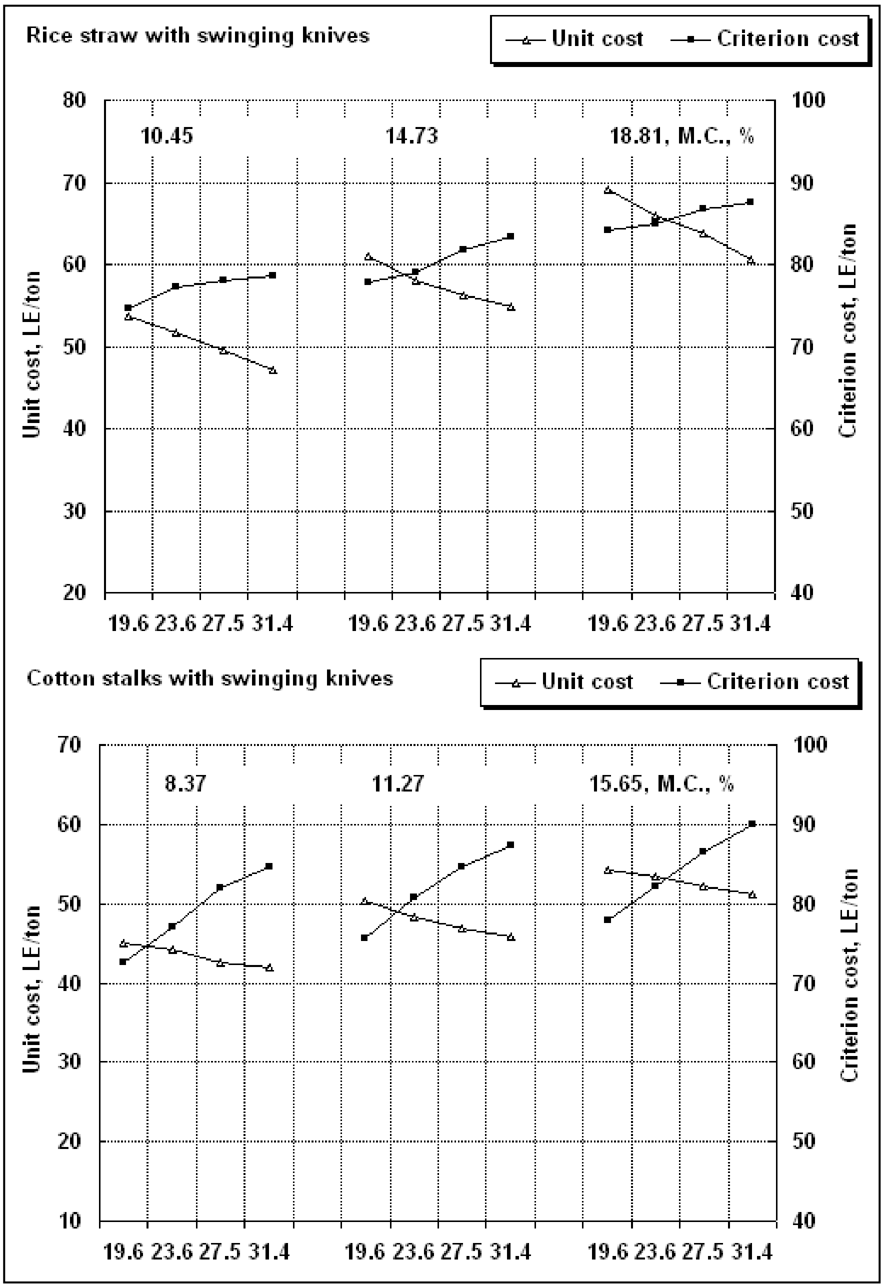


Fig. 11: Effect of cutting rotor speed and moisture content of rice straw and cotton stalks on unit and criterion function cost under swinging knives.

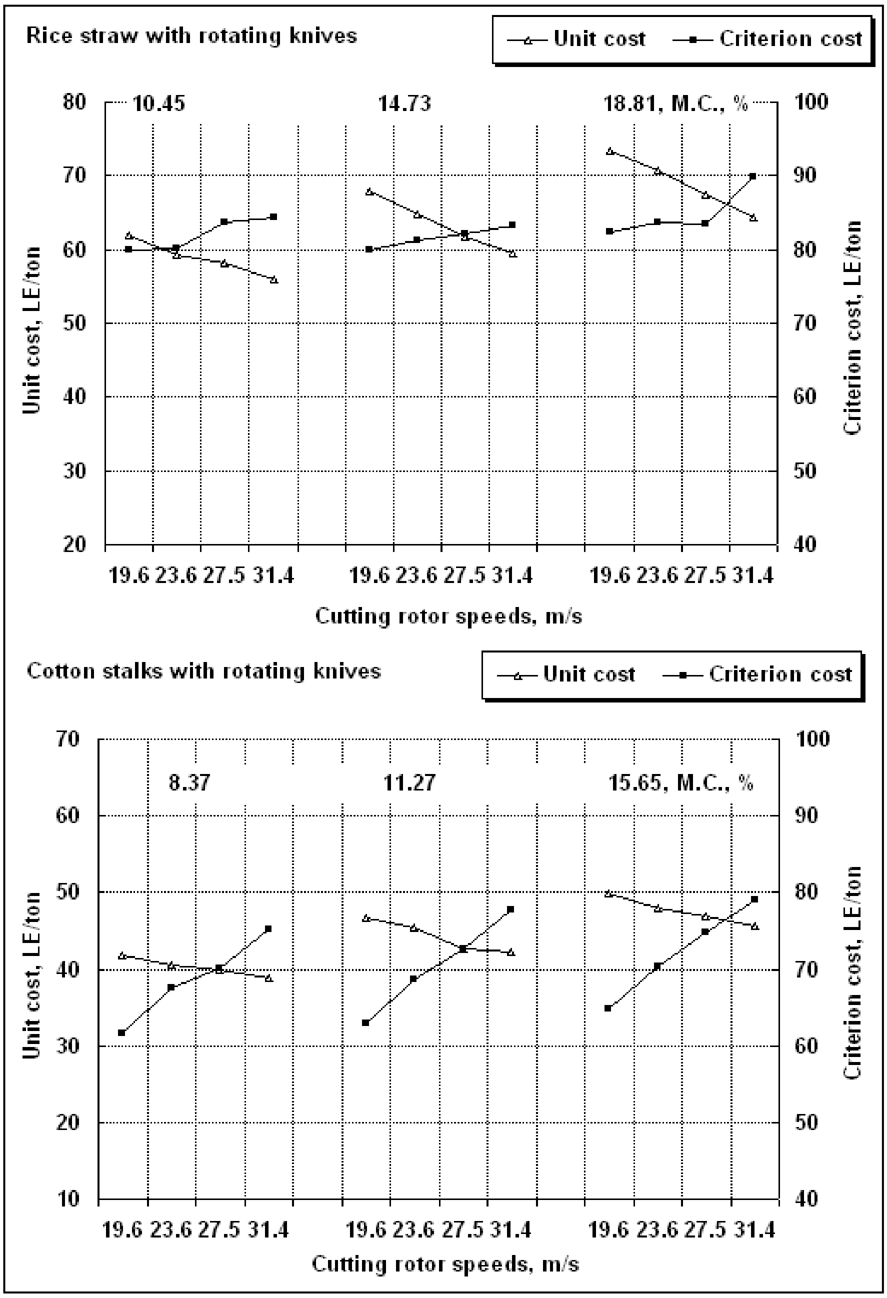


Fig. 12: Effect of cutting rotor speed and moisture content of rice straw and cotton stalks on unit and criterion function cost under rotating knives.

On the other hand, the lowest value of criterion function cost for rice straw cutting of 74.68LE/ton records at rotor speed of 19.68m/s, moisture content of 10.45% and using swinging rotor knives. And 61.67LE/ton for cutting cotton stalks with rotor speed of 19.63m/s, moisture content of 8.37% and using rotating rotor knives. Also through the intersection curves between criterion function cost and unit cost, it can determine the optimum point for the machine operation, which is then the least amount of criterion function cost and unit cost and through Figs.11 and 12 the optimum operation condition point for cutting rice straw was at cutting rotor speed of 19.6m/s, stalks moisture content of 10.45%, and using swinging knives and for cutting cotton stalks was at cutting rotor speed of 27.5m/s, stalks moisture content of 8.27%, and using rotating knives.

CONCLUSION

The characteristics conclusion could be summarized as follows:

- The optimum conditions operation of development thresher at determined as follows: at cutting rice straw was at cutting rotor speed of 19.63m/s, stalks moisture content of 10.45% and using swinging knives. While at cutting cotton stalks was at cutting rotor speed of 27.5m/s, stalks moisture content of 8.27%, and using rotating knives.
- The maximum of rice straw cutting efficiency and machine productivity of 95.8% and 1.15ton/h recorded at rotor speed of 31.4m/s, moisture content of 10.45% respectively using swinging knives. While the maximum of cotton stalks cutting efficiency and machine productivity of 94.2% and 1.13ton/h recorded at rotor speed of 31.4m/s, moisture content of 8.37% and using rotating knives.
- Minimum value of unit cost for cutting rice straw was 47.1LE/ton recorded at rotor speed of 31.4m/s, moisture content of 10.45% and using swinging knives. While, it was 38.77LE/ton at cutting cotton stalks recorded at rotor speed of 31.4m/s, moisture content of 8.37% and using rotating knives.
- Minimum value of criterion function cost for cutting rice straw was 74.68LE/ton recorded at rotor speed of 19.63m/s, moisture content of 10.45% and using swinging knives. While for cutting cotton stalks, it was 61.67LE/ton recorded at rotor speed of 19.63m/s, moisture content of 8.37% and using rotating knives.
- Previous results noticed that, swinging knives suit for cutting rice straw which was running smoothly at cutting sticks while rotating knives suit for cutting cotton stalks where it was needed large shear forces and elastic modulus to cut.

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تطوير آلة دراس ثابتة لفرم مخلفات المحاصيل

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الهدف من الدراسة هو تطوير آلة دراس ثابتة بتصميم و تصنيع درفيلين أحدهما ذات سكاكين متأرجحة بعدد 44 سكينة موزعة على محيط الدرفيل على أربعة محاور و الأخر ذات سكاكين ثابتة منشارية بعدد 11 سكينة موزعة على محيط الدرفيل و كل درفيل منهما يدور داخل غرفة الفرم و يزود محيطها الداخلي بعدد 22 سكينة ثابتة على شكل حرف U و ذلك لفرم مخلفات الأرز و القطن و الاستفادة منهما في صناعة الأعلاف غير التقليدية و بعض الصناعات الأخرى. وكانت المعاملات التجريبية للدراسة على النحو التالي:

- نوع المخلفات الزراعية المستخدمة: حيث يتم إجراء التجارب على قش الأرز و حطب القطن.
- المحتوى الرطوبى للأعواد: يتم إجراء الدراسة عند ثلاثة مستويات رطوبية كانت 10,45 , 14,73, 18,81% لقش الأرز و 8,37 , 11,27 و 15,65% لأعواد حطب القطن على التوالي وعلى أساس جاف.
- سرعة دوران اسطوانة التقطيع: يتم إجراء الدراسة عند أربعة سرعات هي 19,63, 23,56 , 27,49 و31.4م/ث.
- نوع سلاح سكاكين القطع: حيث يتم إجراء الدراسة باستخدام نوعين من الأسلحة : النوع المتأرجح والنوع الدوراني.

وكذلك دراسة مدى تأثير تلك العوامل على الصفات التالية:

- النسب المئوية لأطوال القطع ,%
- كفاءة التقطيع,%
- الإنتاجية, ميجاجرام/ساعة
- تقدير الطاقة المستهلكة
- احتياجات القدرة اللازمة , كيلوواتزساعة/طن
- تكاليف التشغيل, جنية/ساعة
- تقدير الدالة المعيارية للتكاليف , جنية/طن

وأوضحت النتائج الآتي:

- أعلى كفاءة تقطيع لقش الأرز كانت 95.8% بينما كانت 94.2% عند تقطيع حطب القطن.
- أعلى إنتاجية للآلة بعد التعديل عند تقطيع قش الأرز كانت 1.15طن/ساعة بينما كانت 1,13طن/ساعة عند تقطيع حطب القطن.
- أعلى دالة معيارية لتكاليف الآلة عند تقطيع قش الأرز كانت 74,86جنية/طن بينما كانت 61,67جنية/طن عند تقطيع حطب القطن.
- كانت الظروف المثلي لتشغيل الآلة عند تقطيع قش الأرز عند سرعة اسطوانة تقطيع 19,6م/ث , محتوى رطوبى 10,45% و استخدام اسطوانة تقطيع ذات الأسلحة المتأرجحة.بينما كانت الظروف المثلي لتشغيل الآلة عند تقطيع حطب القطن عند سرعة اسطوانة تقطيع 27,5م/ث , محتوى رطوبى 8.37% واستخدام اسطوانة تقطيع ذات الأسلحة الدورانيه.
- من خلال النتائج السابقة أتضح أن اسطوانة التقطيع ذات الأسلحة المتأرجحة كانت تناسب تقطيع قش الأرز بينما كانت اسطوانة التقطيع ذات الأسلحة الدورانية تناسب تقطيع أعواد حطب القطن.