Zagazig J. Agric. Res., Vol. 44 No. (6A) 2017 2281-2295

Agricultural Engineering

http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

CONSTRUCTION OF A LOCAL MACHINE FOR CHOPPING RESIDUES OF BANANA PLANTS

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Received: 22/08/2017 ; Accepted: 10/10/2017

ABSTRACT: The objectives of the present research were to construct and evaluate the performance of a developed machine for chopping residues of banana plants. Experiments were conducted to study some different operating parameters affecting the performance of chopping stem machine at four different cutting knives speeds of 16.74, 19.88, 23.02 and 26.16 m/sec. (800, 950, 1100 and 1250 rpm), four different feeding rates of 600, 700, 800 and 900 kg/hr., four different span times after harvesting and two cutting knives edge shape (sharp and serrated edge) taking into consideration calculating machine productivity, chopping efficiency, energy requirements and total costs. From the obtained results it was concluded that the proper values for banana stem machine productivity was 742 kg/hr., by using cutting knives speed of 26.16 m/sec. (1250 rpm), serrated knife edge under feeding rate of 800 kg/hr., and 6 days as a span time after harvesting.

Key words: Banana stem, chopping residues, machine.

INTRODUCTION

Banana is a tropical plant and considered as one of the most popular and favorite fruits in the world. Banana stem has no use after harvesting the fruit, which is used for manufacturing of pulp for the production of fiber, film and paper. Pulping is done to liberate the fibers from lignin and hemicelluloses, which can be accomplished chemically or mechanically or by combining these two type of treatments. They reported that, the pulping of banana pseudo-stem suggest that this material which is a waste product after fruits harvesting which can be used as potential source of cellulose to make high valued cellulose based products such as paper, fiber, *etc.* (Manish and Deepak, 2011).

In the fields of banana, when fruits are harvesting, the banana stem are cut off and let it down nearby fields because each banana plant cannot be used for the next harvest. There are three reasons of cutting of stems, the first reason is that banana stem are cut off when fruits are harvested, the second reason is due to diseases (that is because attack of fungi which are grown in result of waste banana stem) and female banana stem are also cut off after the maturity of male plant. So that a massive organic waste is produced because the banana stems cannot be used as an animal feed or other alternative. The waste is then causes of emission of toxic gases including CO_2 and also gives growth to the harmful fungi which attack on remaining banana trees (Intezar and Tarar, 2014).

From this point of view, the work of the present study was to manufacture a local machine to chop the wastes of banana stem.

Kepner *et al.* (1978) reported that the speed of the feed mechanism is determined by the number of knives on the cuterhead, the cutterhead speed, and the desired theoretical length of cut. Reducing the feed-mechanism speed to obtain a shorter cut, reduces the capacity of the feed mechanism. They added too that, the capacity of a field chopper may be limited by the capacity of the feed mechanism, by the amount of power available, by the ability

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of the cutterhead and impeller to chop and handle the material, or by other factors. The theoretical maximum capacity of the feed mechanism is a function of throat cross-sectional area.

El-Zahaby (1996) mentioned that there is a large amount of residues all over the Egyptian farms. So he made a complete survey of field crop residues in Egypt and suggested to use these residues as follows: using some field crop residues in production of thermal energy, using it for production of unconventional bricks which can be used for building farmer houses and using it in production of unconventional cattle feeding.

Khader (1997) developed a simple chopping system using field crop residues in small farm. He studied the effect of the following factors: (a) chopping- drum speed, (b) number of cutting-drum knives and (c) clearance between fixed and rotating knives on the cutting length and efficiency. The residues used were rice straw, cotton, maize and bean. He 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. And he studied the interaction effect between different speeds of cutter head and number of knives for cutting some field crop residues. Also, he found that by increasing number of knives and cutter head drum speed, the cutting length decreased. The optimum operating condition were: (a) Animal fodder 1.5 - 3 cm, drum speed of 1850 rpm and 1mm clearance and (b) Silage 3–6 cm and composting 6 - 12 cm, drum speed 1250 rpm and 5 mm clearance. The cutting efficiency value was 50% for rice straw, at recommended cutting length.

Sheng *et al.* (1999) used chopping machines for cutting crop residues to produce biomass briquettes under Egyptian conditions. Three chopping methods, the hammer-mill, helical knife and straight-knife choppers were used for chopping cotton stalks. Test results indicated that straight-knife choppers have higher chopping capacity, higher yield of small or fine particles and lower energy consumption than the other two choppers.

Tarek *et al.* (2001) stated that the rice crop residues could be used for making compost to improve soil properties, animal feeding, energy source (direct burning biogas generation) and in the field of industrial application. Therefore, straw chopping is necessary as a pre-treatment to incorporation into the soil or in other different uses. Where, the successful chopping reduces the length of straw avoiding long pieces of material fouling on cultivation and swing implement. It also eases the mixing process with soil active biological breakdown of the straw through the soil or making compost.

Younis *et al.* (2002) developed a crop residues chopper to improve its performance and productivity to be suitable for chopping rice straw. The development of the original machine is supplying a pre-cutting device to reduce the required chopping time and increase the machine productivity. They studied the rotor speed, cutting-length percentage and productivity to evaluate its performance. The results indicated that, productivity was 0.95 ton/hr., and cutting-length percentage of 1 - 9 cm reached 95% for the total amount of cutting residues at 2000 rpm rotor speed.

Younis *et al.* (2002) developed chopping machine and used it for cutting residues of rice, cotton and maize. They found that the productivity under the feeding roll speed cutting rotor speed ratio of 1:15 gave the best results in sympathy of cutting lengths. But the productivity was very low due to the decrease of feeding roll speed, the feeding roll speed to the cutting rotor speed ratio of 1:10 gave the best results in productivity due to the high speed of feeding roll.

Lotfy (2003) developed and evaluated a machine cutting and throwing agricultural residues. The performance of the chopper was evaluated by using the following parameters: number of cutting knives, the angle between them, different feeding speeds, different cutting speeds and different clearances between rotating knives and fixed knife for three types of crop residues (rice straw, cotton and corn stalks). The cutting length increased by increasing both cutting clearance and feeding speed and decreasing both number of cutter head knives and cutting speed. The machine capacity was doubled and cut length, energy requirement and operation cost were reduced to the half after modification.

Imbabi (2003) tested the performance of a cutting machine for crop residues. The results showed that the highest values of both cut length and machine productivity were obtained at cutting rotational speed of cutting knives 1500 rpm.

Omran (2008) evaluated the most widely used shredding machines (local shredder manufactured in Kader-Militry Factory, local shredder manufactured in Mabrouk–International Company and Vermeer made in USA) while working on the most important crops residues (rice straw, cotton and maize stalks). He recommended that the local shredder (Mabrok) was the most appropriate shredder to deal with rice, cotton and maize residues.

In order to add value to banana plantation, the pseudo stem could be processed into valuable products (Paper). Waste Banana stem is a very good source of cellulose. It contains 39.12% cellulose and 11.34% lignin. Cellulose can be easily separated from lignin without using toxic chemical during process. A huge mass residue is produced from banana plantation, all of which goes waste due to non-availability of suitable technology for its commercial utilization.

Al-Gezawe *et al.* (2016) developed, and evaluated the performance a fodder-bales chopper. The performance of the developed fodder bales chopper was evaluated in terms of average and percentage of cutting length, chopping efficiency, required power, energy requirements and operational cost. The maximum machine productivity values were (785.5 and 830.7 kg/ hr.), the maximum required power values were (20.86 and 22.64 kW), the maximum chopping efficiency values were (96.8 and 97.4%), the minimum average length of cut values were (2.6 and 1.54 cm). Minimum operating cost values were 19.1 and 21.5 LE/ton at wheat straw bale and rice straw bale, respectively by using combined knives with hammers at drum speed of 1040 rpm.

So, the objectives of the present study may be summarized as follows:

1. Construct a developed machine for chopping residues of banana stem.
2. Evaluate the performance of the developed chopping machine under different operating parameters.

MATERIALS AND METHODS

A machine for chopping residues of banana plants was constructed and developed in a private workshop at Sharkia Governorate and was primarily tested in El-Kassasin Horticultural Res. Station, Ismailia Governorate, Egypt during seasons of 2015 and 2016.

Materials

Constructed chopping machine

The general view of the constructed chopping machine used for chopping residues of banana is shown in Fig. 1. It consists of the following parts:

Main frame

The main frame of the constructed chopping machine was made from iron sheet of 5mm thickness. The main frame was mounted on four stands and the dimensions of the constructed chopping machine were 90 cm length, 55 cm width and 115 cm height. Main frame is a base which carrying feeding unit, cutting unit and main electric motor.

Feeding hopper

The feeding hopper was constructed as a cylindrical shape from steel sheet of 2 mm thickness and 40 cm in length. It was fixed on the main frame which having a feeding gate of 25 cm diameter to guide the residue of banana stem towards the cutting mechanism.

Cutting drum

Elevation, plan and isometric of cutting drum are shown in Fig. 2, cutting drum is constructed from steel shaft which has 50 mm diameter and 650 mm length.

The cutting drum is suspended on the frame by two bearings. It is driven by pulley and belts attached with an electrical motor. Two iron flanges which having diameter and thickness of 40 cm and 12 mm, respectively were welded on the two sides of the cutting drum.

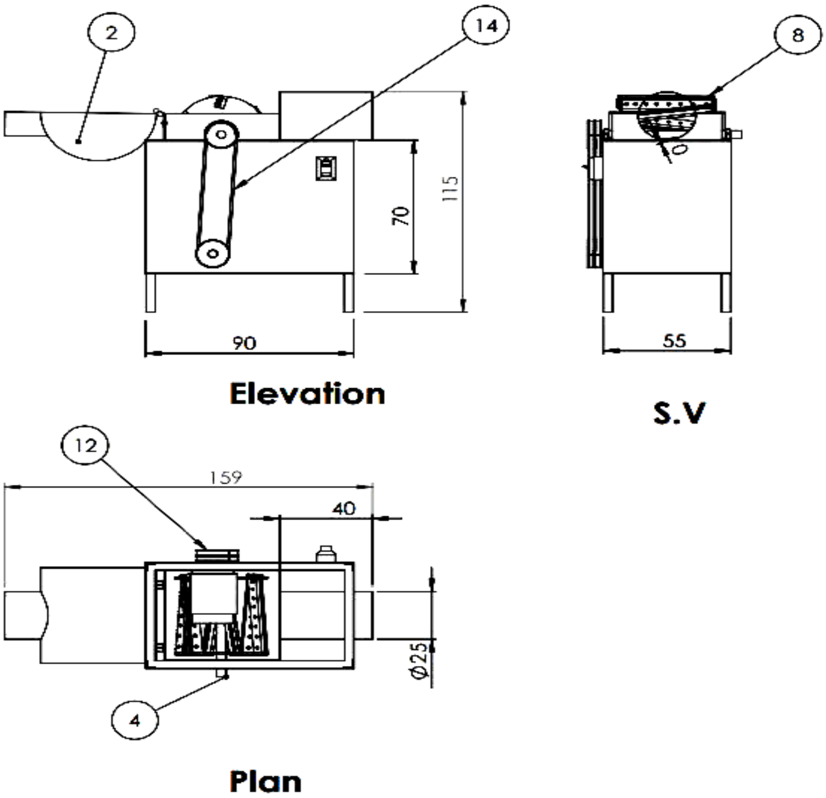

Fig.1. General view of the constructed chopping machine

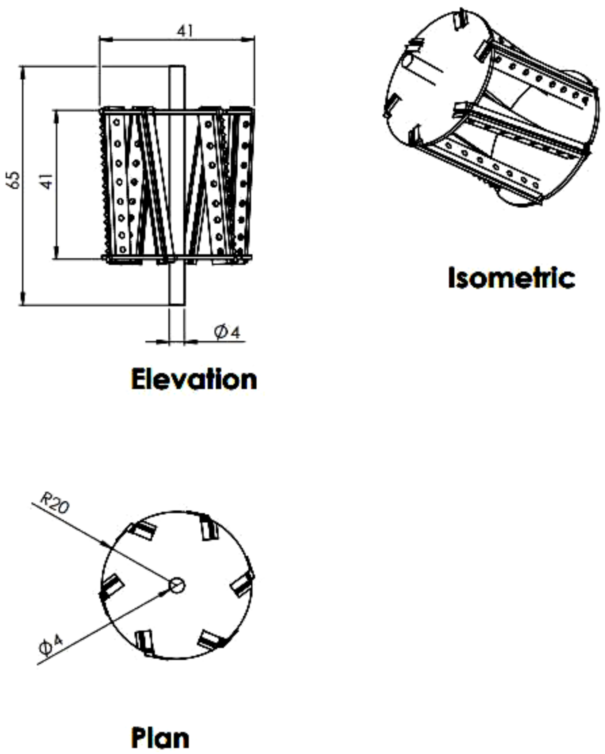

Fig. 2. Elevation, plane and isometric of cutting drum

There are six rectangular steel plates with 40 cm length, 6 cm width and 7 mm thickness. These steel plates were fixed inside the two flanges by welding.

The sharp edge and serrated knives are fixed in the previous steel plate by six bolts, the fixed metal bars and knives inclined angle is 14°, the slope angle was determined according to suitable clearance between fixed and rotating knives.

Cutting knives

Two type knives were used in the present study to cut the residues of banana stem. These types were six sharp and serrated knives edge. They made from steel sheet. The knives drum have lengths of 36 cm length ,7 cm width and 7 mm thicknes, as presented in Fig. 3.

Electric motor

An electrical motor of three phases (7.1 kW) was used as the power source to drive the cutting unit. There are four different pulley diameters and belts arrangement to transfer power from the motor to cutting unit to get the desirable cutting drum speeds of 16.74, 19.88, 23.02 and 26.16 m/sec. (800, 950, 1100 and 1250 rpm).

The electrical motor is equipped with a movable base using four bolts to be able to replace and change the tested pulleys.

Methods

The developed chopping machine was tested in El-Kassasin Horticultural Res. Station, Ismailia Governorate, during summer season of 2015 and 2016.

Experiments were conducted to study some operational parameters that affecting the performance of the developed chopping machine.

Experimental conditions

Tests were carried out to choose the studied-parameter ranges. The studied parameters were as follows:

1. Four different cutting knife speeds of 26.16, 23.02, 19.88 and 16.74 m/sec., (800, 950, 1100 and 1250 rpm).
2. Four feeding rates of 600, 700, 800 and 900 kg/hr.
3. Two types of cutting knives with sharp (SH.E) and serrated (SE.E) edge.
4. Four different banana stem moisture contents of 93, 91.4, 88 and 86% (MC).

Measurements

The theoretical chopper capacity Tt, in megagrams per hour may be expressed by using the following formula (Kepner, 1978) :

$$Tt = 6000 \times 10^{-9}\ D\ A\ L\ N\ R\ .$$

Where :

D = density of banana stem, kg/m³.

A = throat area, cm².

L = theoretical length of cut, mm.

N = number of knives.

R = speed of cutterhead, rpm.

Machine productivity

Machine productivity was calculated by using the following equation:

$$D = \frac{Wp}{t} \times 3.6$$

Where :

D : productivity (ton/hr.).

Wp : residues of banana mass (kg).

T : consumed time (sec).

Chopping efficiency

Chopping efficiency of machine was calculated from the following formula:

$$CE\ \frac{Wp}{Wm} \times 100\%$$

Where :

CE : chopping efficiency (%).

Wp: residues mass (kg).

Wm: total mass of sample (kg)

Required power and specific energy

The electrical power requirement (kW) was calculated by using the clamp meter to measure the line current strength in Amperes (I) and potential difference values (v). The required power

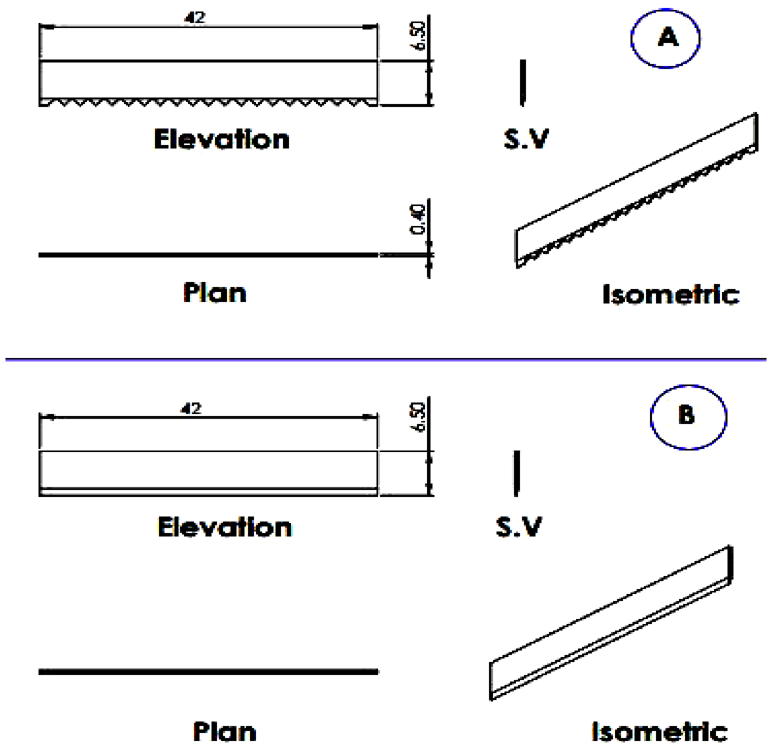

Fig. 3. Elevation, plan and side view of cutting knives

of developed machine with and without load (P) was calculated according to Kurt (1979) by using the following equation:

$P = \sqrt{3} \times I \times V \times \eta \times \cos\theta / 1000$

Where :

P : Power requirement for the cutting machine in kW,

I : Line current intensity in amperes,

V : Potential difference (Voltage) being equal to 380 V,

Cos θ : Power factor (being equal to 0.85),

$\sqrt{3}$: Coefficient current three phases (being equal 1.73) and

η : Mechanical efficiency assumed (95%).

The specific energy was calculated by using the following equation:

$$\text{Specific energy} = \frac{\text{Required power (kW)}}{\text{Productivity}\left(\frac{\text{Mg}}{\text{hr.}}\right)} \text{kW.} \frac{\text{hr.}}{\text{Mg}}$$

Estimating the costs of using the machine

Cost of operation was calculated according to equation given by Awady (1978) as follows :

C = p/hr. (1/a+i+ t/2 + r)+[(Ec) × (Ep)]+m/144

Where:

C: hourly cost, LE*/hr.

P: price of machine, LE.

hr.: yearly working hours (hr).

a: life expectancy of the machine, year.

i: interest rate/year .

t: taxes, (0.05) .

r: overheads and indirect cost ratio (0.03).

Ec: Electricity consumption kW.

Ep: Electricity price LE/kW hr .

m: Monthly wage and "144" are estimated monthly working hours. Notice that all units have to be consistent to result in LE/hr.

Production cost (LE/Mg) = Hourly cost (LE/hr.) / Machine productivity (Mg/hr.)

* One American dollar = 17.73 Egyptian pound (LE) according to prices of 2017.

RESULTS AND DISCUSSION

The obtained results will be discussed under the following items:

Effect of Chopping Drum Speed on Machine Productivity Under Different Feeding Rates Using Two Knife Shapes Under Different Moisture Contents

The effect of chopping drum speed on machine productivity at different feeding rates using two knife shapes and different banana stem moisture contents are shown in Figs. 4, 5, 6 and 7.

The increase of drum speed from 16.74 to 26.16 m/sec. (from 800 to 1250 rpm) led to an increase in chopping productivity from 493.5 to 555.1, from 508.6 to 638.3, from 527.21 to 631.5 and from 653.86 to 729.3 kg/hr. at feeding rates of 600, 700, 800 and 900 kg/hr., respectively in the case of using sharp edged knife (SH.E) while it increased from 503.68 to 560.7, from 510.3 to 640.2, from 540.46 to 645.6 and from 658.31 to 744.4 kg/hr., for serrated type (SE.E) under stem banana moisture content of 93%.

On the other side, the increase of feeding rate from 600 to 900 kg/hr., caused an increase in productivity percentage by (24.52, 28.48, 29.89 and 23.88%) for sharp edged knife (SH.E), and (23.48, 26.36, 28.55 and 24.67%) for serrated type (SE.E) at drum speeds of 26.16, 23.02, 19.88 and 16.74 m/sec. (800, 950, 1100 and 1250 rpm), respectively at the other M.C of banana stem of (91.4, 88 and 86%).

By looking for the effect of moisture contents (M.c %) on the productivity, in general the highest values of moisture content was accompanied with lowest values of productivity comparing to the lower ones of 493.5 and 503.68 kg/hr., under the same experimental conditions.

It is observed also that higher productivities can be achieved at the case of using serrated knife compared to sharp one.

From the all obtained results, it can be deduced that the highest productivities were recorded at 26.16 m/sec. (1250rpm) drum speed, 800 kg/hr., feeding rate for banana stem with MC of 88%, they were 742 kg/hr., for serrated edged knive (SE.E), and 717 kg/hr., for the sharp edged knive (SH.E) at 23.02 m/sec. (1100 rpm) drum speed, 900 kg/hr., feeding rate for the same MC of 88%.

While the minimum values were found at 16.74 m/sec. (800 rpm) drum speed, 600 kg/hr., feeding rate for banana stem at MC of 93%, they were 493.5 and 503.68 kg/hr., for sharp and serrated shapes, respectively.

Effect of Chopping Drum Speed on Chopping Efficiency at Different Feeding Rates by Using Two Knife Shapes at Different Stem Banana Moisture Contents

The relation between chopping efficiency and drum speed under the various experimental conditions was illustrated in Figs. 8, 9, 10 and 11 which showed that the chopping efficiency improved as the drum speed increased.

The increase of speed from 16.74 to 26.16 m/sec., (from 800 to 950 rpm) caused an increase in chopping efficiency from 68.13 to 71.36, from 69.85 to 71.6, from 70.01 to 72 and from 70.21 to 73.22% for sharp edged knife (SH.E), and from 69 to 72.5, from 69.56 to 73.35, from 70 to 74.6 and from 71.8 to 75.38% for serrated knife at feeding rates of 600, 700, 800 and 900 kg/hr., respectively under stem banana moisture content of 93%.

The same trend was observed for the other moisture contents of 91.4, 88 and 86%. In addition to this trend, it was observed that there is no large significant variation in the values of chopping efficiency in the case of increasing feeding rate from 600 to 900 kg/hr., at the same drum speed for both of two knife shapes and all values of moisture content.

From the obtained results, it is cleared that the highest chopping efficiency of 91.11 and 91.33% were recorded at 900 kg/hr., feeding rate, 26.16 m/sec. (1250 rpm) drum speed and 86% stem moisture content for sharp and serrated edged knives, respectively.

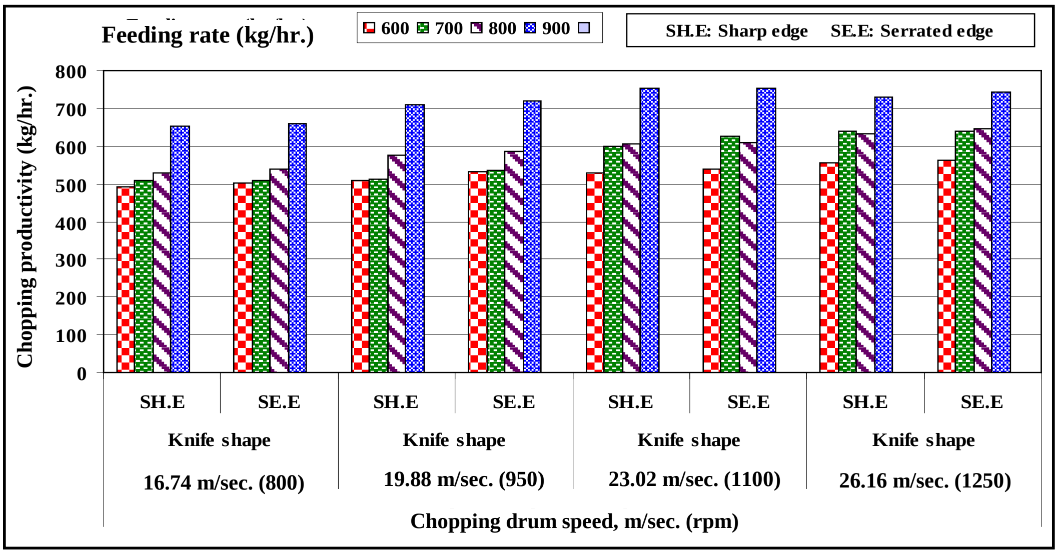

Fig. 4. Effect of study parameters on chopping productivity at banana stem MC of 93%

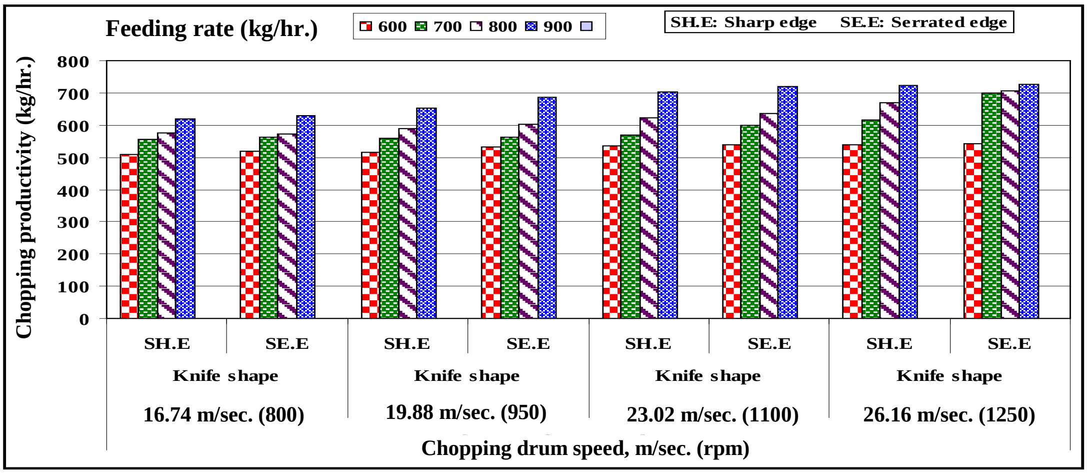

Fig. 5. Effect of study parameters on chopping productivity at banana stem MC of 91.4%

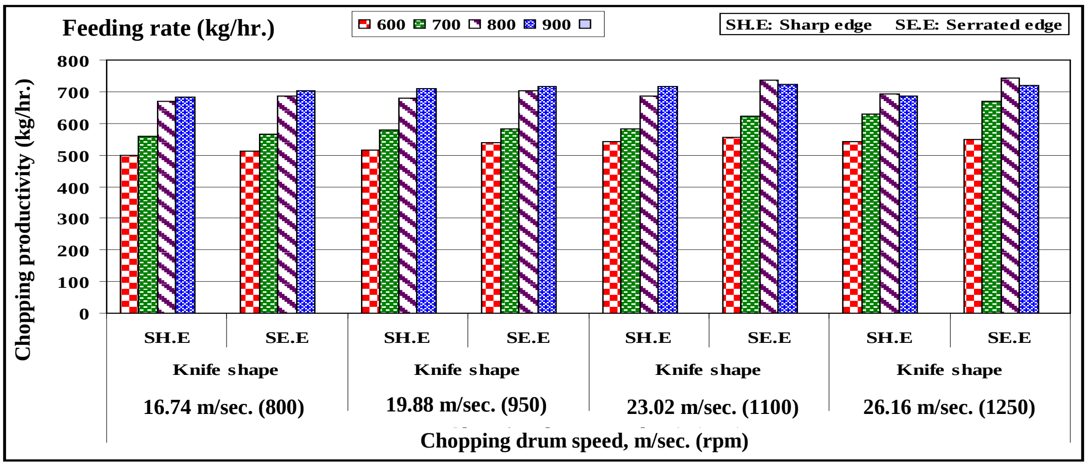

Fig. 6. Effect of study parameters on chopping productivity at banana stem MC of 88%

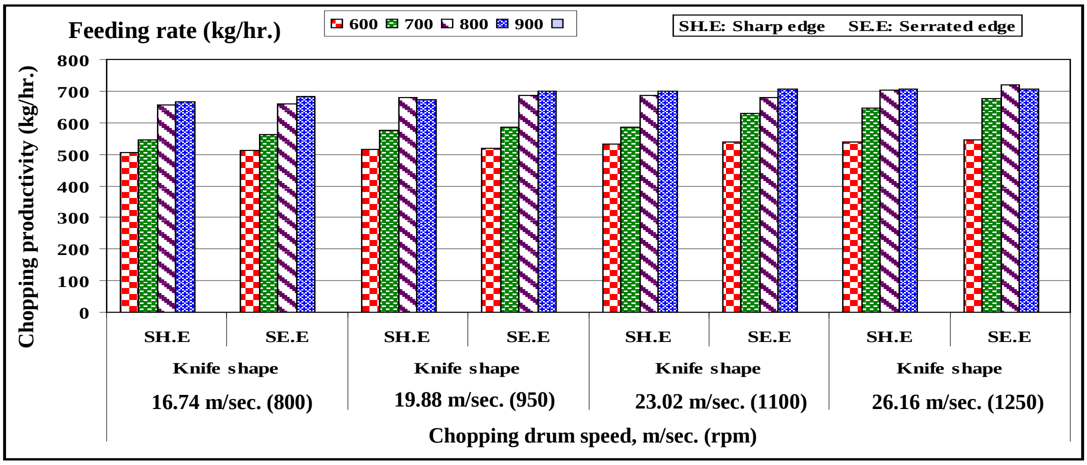

Fig. 7. Effect of study parameters on chopping productivity at banana stem MC of 86%

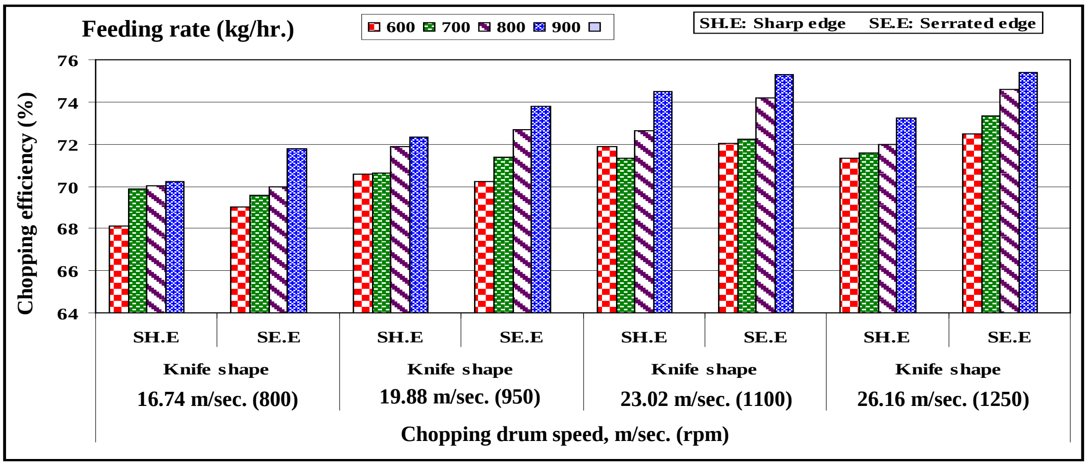

Fig. 8. Effect of study parameters on chopping efficiency at banana stem MC of 93%

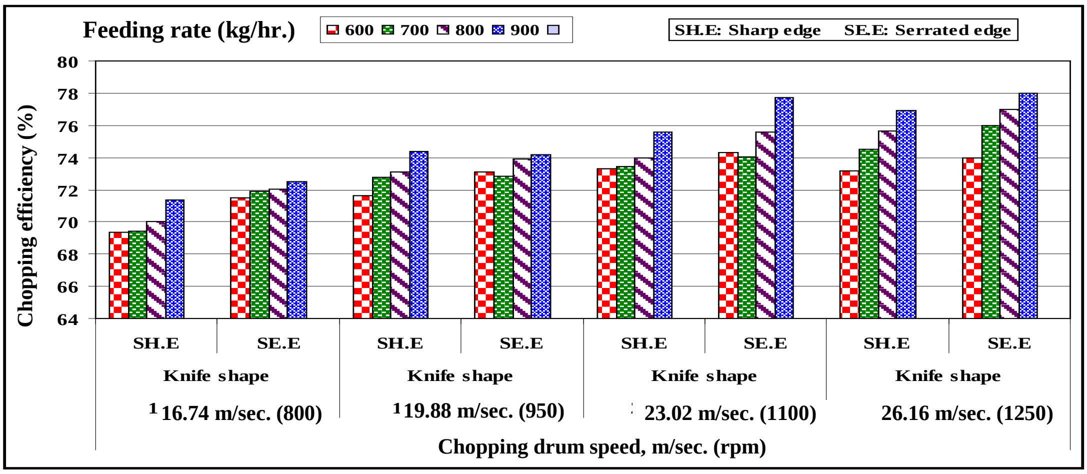

Fig. 9. Effect of study parameters on chopping efficiency at banana stem MC of 91.4%

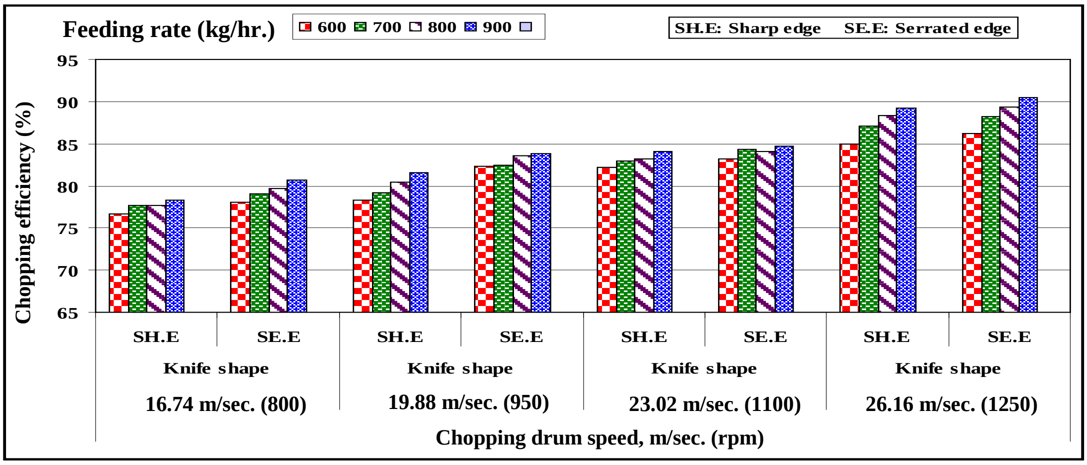

Fig. 10. Effect of study parameters on chopping efficiency at banana stem MC of 88%

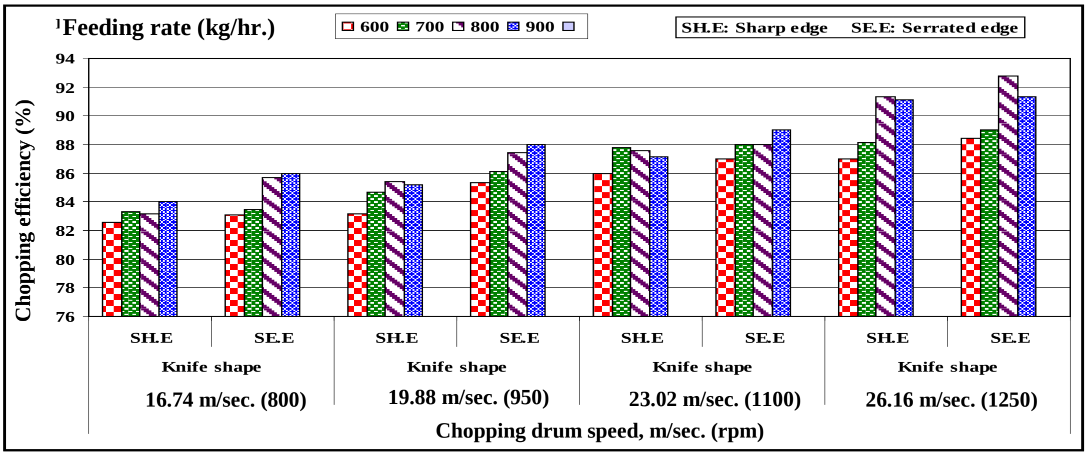

Fig. 11. Effect of study parameters on chopping efficiency at banana stem MC of 86%

Effect of Chopping Drum Speed on Required Power and Specific Energy at Different Feeding Rates by Using Two Knife Shapes at Different Banana Stem Moister Contents

The effect of chopping drum speed change from 16.74 to 19.88 m/sec. (from 800 to 950 rpm), from 19.88 to 23.02 m/sec. (from 950 to 1100 rpm) and from 23.02 to 26.16 m/sec. (from 1100 to 1250 rpm) on required power and specific energy at different feeding rates and by using two knife shapes is shown in Figs. 12, 13, 14, 15, 16, 17, 18 and 19.

Fig. 12 shows that by increasing chopping drum speed the required power increased. By increasing chopping drum speed from 16.74 to 19.88 m/sec. (from 800 to 950 rpm), from 19.88 to 23.02 m/sec. (from 950 to 1100 rpm), and from 23.02 to 26.16 m/sec. (from 1100 to 1250 rpm) the required power increased by (2.85, zero, and 0.56%) and (2.8, 1.11 and 2.96%) at feeding rate of 600 kg/hr., respectively.

Meanwhile, the specific energy decreased by (zero, 3.77 and 4.22%) and (2.47, 0.29 and 1.04%), respectively at feeding rate of 600 kg/hr., and MC of 93%.

The maximum value of required power of 4.11 kW was obtained by using chopping drum speed of 26.16 m/sec. (1250 rpm) feeding rate 900 kg/hr., and sharp edged hnife (SH.E).

Meanwhile, the minimum value of required power of 3.4 kW was obtained by using chopping drum speed of 16.74 m/sec. (800 rpm), feeding rate of 600 kg/hr., and sharp edged knife.

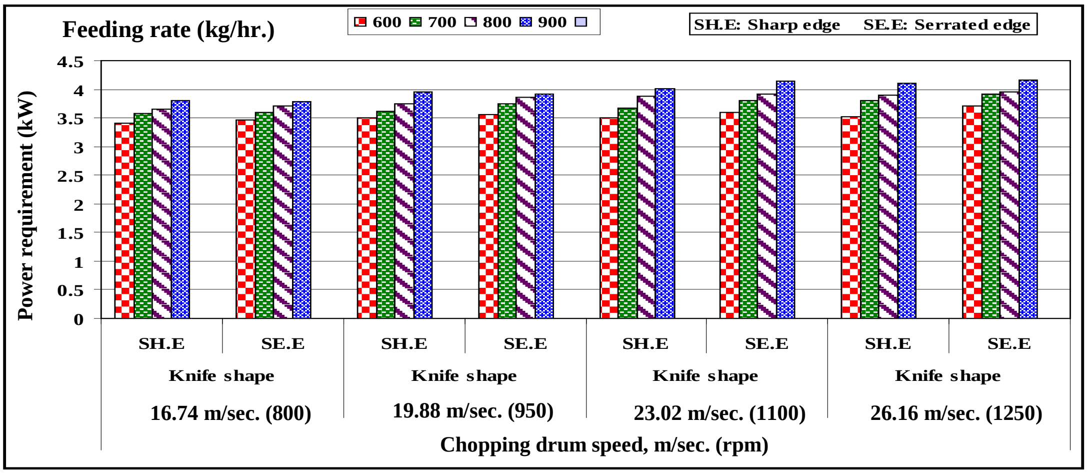

Fig. 12. Effect of study parameters on power requirement at banana stem MC of 93%

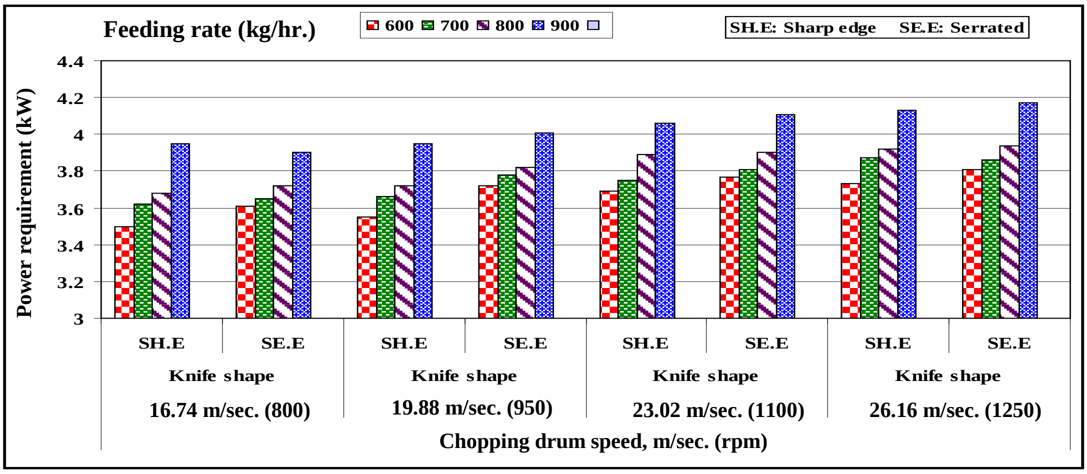

Fig. 13. Effect of study parameters on power requirement at banana stem MC of 91.4%

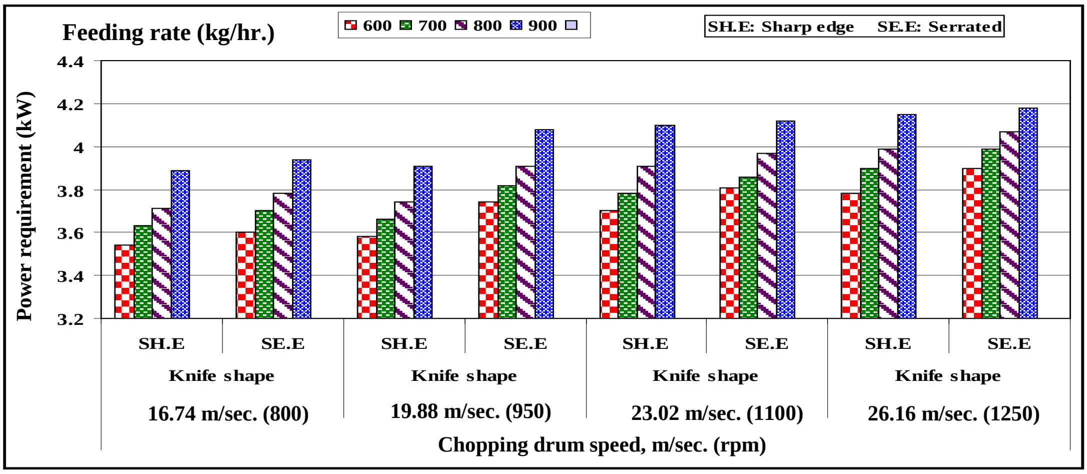

Fig. 14. Effect of study parameters on power requirement at banana stem MC of 88%

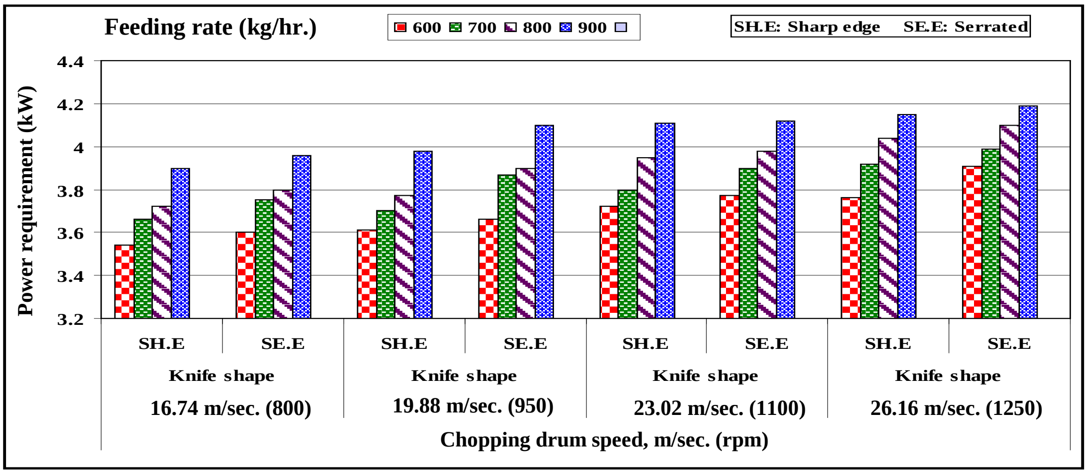

Fig. 15. Effect of study parameters on power requirement at banana stem MC of 86%

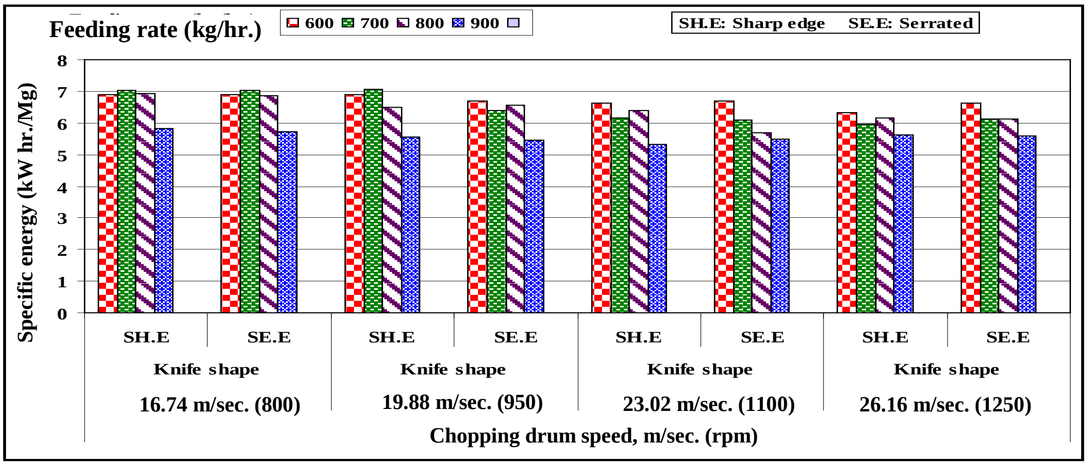

Fig. 16. Effect of study parameters on specific energy at banana stem MC of 93%

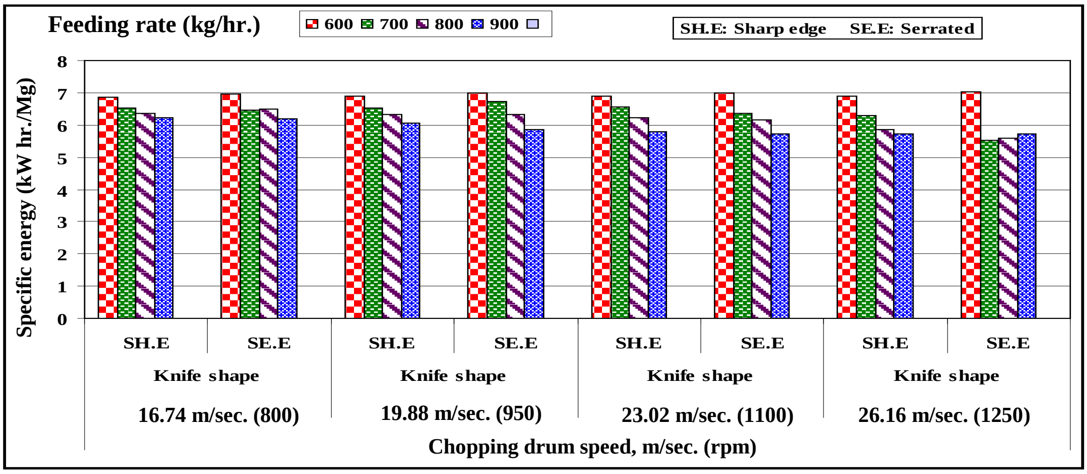

Fig. 17. Effect of study parameters on specific energy at banana stem MC of 91.4%

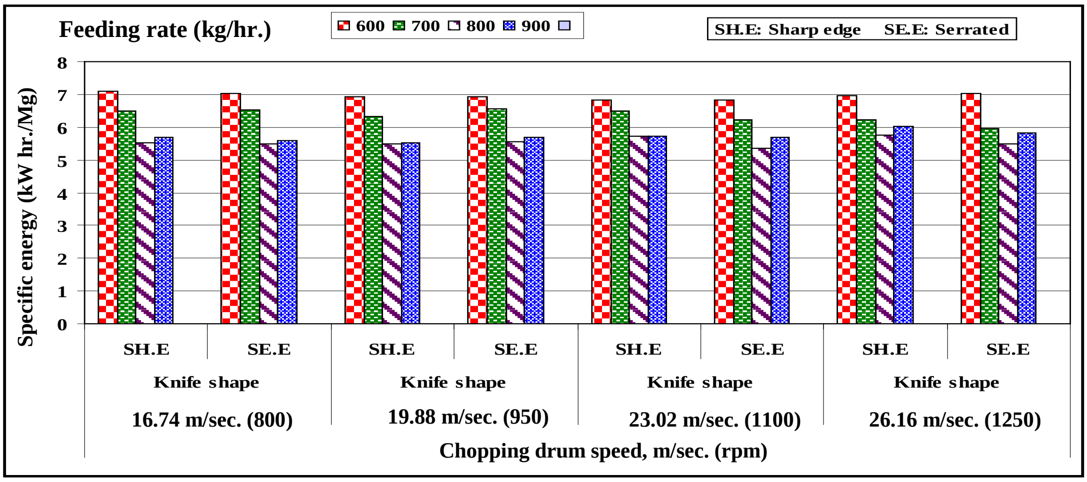

Fig. 18 : Effect of study parameters on specific energy at banana stem MC of 88%

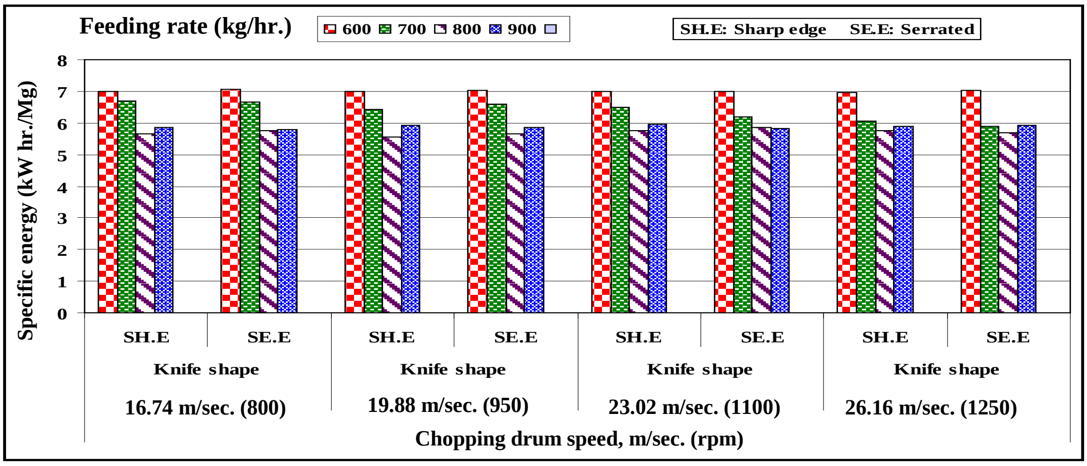

Fig. 19. Effect of study parameters on specific energy at banana stem MC of 86%

Also, Fig. 12 show that by increasing chopping drum speed from 16.74 m/sec., (800 rpm) to 26.16 m/sec., (1250 rpm) the required power increased by (1.41, 3.79 and 1.07 %) and (2.95, 1.32 and 1.05%) respectively at feeding rate of 600 kg/hr., and MC of 91.4%.

Meanwhile, the specific energy decreased by (0.58, 0.29 and 0.29%) and (0.14, 0.28 and 0.42%) under feeding rate 600 kg/hr., respectively. The maximum value of required power of 4.17 kW was obtained by using chopping drum speed of 26.16 m/sec. (1250 rpm), feeding rate of 900 kg/hr., and using serrated knife edge (SE.E). Meanwhile, the minimum value of required power of 3.5 kW was obtained by using chopping drum speed of 16.74 m/sec. (800 rpm), feeding rate of 600 kg/ hr., and using sharp edged knife (SH.E) at MC of 91.4%.

Fig. 14 also shows that by increasing chopping drum speed from 16.74 to 19.88 m/ sec. (from 800 to 950 rpm), from 19.88 to 23.02 m/sec. (from 950 to 1100 rpm) and from 23.02 to 26.16 m/sec. (from 1100 to 1250 rpm) the required power increased by (1.11, 3.24 and 2.11%) and (3.74, 1.83 and 2.31%) respectively at feeding rate of 600 kg/hr. and M.C of 88%.

Meanwhile, the specific energy decreased by (2.25, 1.29 and 1.86%) and (1.42, 1.44 and 2.84%) respectively at feeding rate of 600 kg/hr., the maximum value of required power of 4.18 kW was obtained by using chopping drum speed of 26.16 m/sec. (1250 rpm), feeding rate of 900 kg/hr., and using serrated knife edge (SE.E). Meanwhile, the minimum value of required power of 3.54 kW was obtained by using chopping drum speed of 16.74 m/sec. (800 rpm), feeding rate of 600 kg/hr., and using sharp edged knife (SH.E) and MC of 88%.

In the other hand Fig. 15 shows that by increasing chopping drum speed, the required power increased. By increasing chopping drum speed from16.74 to 19.88 m/sec. (from 800 to 950 rpm), from 19.88 to 23.02 m/sec. (from 950 to 1100 rpm), and from 23.02 to 26.16 m/sec. (from 1100 to 1250rpm) the required power percentage increased by (1.94, 2.95 and 1.06%) and (1.64, 2.91 and 3.58%), respectively at feeding rate of 600 kg/hr., and stem MC of 86%.

Meanwhile, the specific energy percentage decreased by (0.14, 0.42 and 0.43%) and (0.28, 0.56 and 0.42%) respectively at feeding rate of 600 kg/hr. The maximum value of required power of 4.19 kW was obtained by using chopping drum speed of 26.16 m/sec. (1250 rpm), feeding rate of 900 kg/hr., and knife serrated edge (SE.E).

Meanwhile, the minimum value of required power of 3.54 kW was obtained by using chopping drum speed of 16.74 m/sec. (800 rpm), feeding rate of 600 kg/hr., and using sharp edged knife (SH.E) at stem M.C of 86%.

Cost Estimation of the Developed Machine for Chopping Banana Stem

The operation costs of the developed machine for chopping banana stem were calculated according to equation of Awady (1978), the operation and production costs were calculated according to prices of year 2016/ 2017. The value were 14.53 LE/Mg and 19.58 LE/Mg.

Conclusion

According to the obtained results, it is recommended to operate the developed machine for chopping banana stem using feeding rate of 800 kg/hr., 26.16 m/sec. (1250 rpm) drum speed, 86% banana stem moisture content and serrated edged knife (SE.E).

The proper value of specific energy was 5.94 kW hr./Mg, and the hearly and production costs were 14.53 LE/hr., and 19.58 LE/Mg.

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تصنيـــع آلــــة محلـيــــة لفــــــرم مخلــفــــــات نبـــاتـــــات المــــــــوز

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نظرا لزيادة المخلفات الزراعية الناتجة بعد حصاد محصول الموز فى مصر حيث بلغت المساحة المزروعة حوالي٦٧٨٨١ فدان عام (٢٠١٦م) تنتج حوالي ١.٠٩٦ تيرا جرام من المخلفات سنويا (طبقاً لإحصائيات وزارة الزراعة المصرية عام ٢٠١٦م) مما يؤدى إلى زيادة التلوث البيئى وانتشار القوارض الضارة بين المزارع، كان من الضرورة بمكان تطوير و تصنيع آلة محلية تقوم بفرم أمهات الموز بعد الحصاد بأقل طاقة مستهلكة وبأقل تكاليف للفرم وبأقل فاقد ممكن والاستفادة من هذه المخلفات في صناعة السماد العضوى (compost) كمصدر للكربوهيدرات ولاحتوائه على الكثير من العناصر الغذائية المفيدة للتربة، لذا تم تصنيع آلة لتناسب فرم أمهات الموز التي يتم التخلص منها بعد الحصاد في إحدى الورش المحلية الخاصة، وأجريت العديد من التجارب العملية باستخدام الآلة خلال موسمى ٢٠١٥ و ٢٠١٦ في محطة بحوث البساتين بالقصاصين محافظة الإسماعيلية وكانت أهداف الدراسة: تصنيع وتقييم أداء آلة الفرم المطورة من خلال دراسة تأثير استخدام أربعة مستويات لسرعة وحدة الفرم وهى ١٦.٧٤ ، ١٩.٨٨ ، ٢٣.٠٢، ٢٦.١٦ م/ث (٨٠٠ ، ٩٥٠ ، ١١٠٠ ، ١٢٥٠ لفة/الدقيقة)، أربعة معدلات تلقيم مختلفة (٩٠٠، ٨٠٠، ٧٠٠، ٦٠٠ كجم/الساعة)، نوعين من سكاكين القطع الأولى ذات حافة حادة والثانية مشرشرة وأربعة نسب رطوبة مختلفة وهى ٩٣ ، ٩١.٤ ، ٨٨ ، ٨٦%، وقد تم حساب بعض مؤشرات الكفاءة مثل الإنتاجية، كفاءة الفرم، الطاقة المستهلكة والتكاليف، وأوضحت النتائج المتحصل عليها أن أفضل قيم أثناء التشغيل كانت كالتالي: أعلى إنتاجية للآلة المصنعة في فرم الموز كانت ٧٤٢، ٧١٧ كجم/ساعة عند سرعة درفيل ٢٦.١٦ م/ث (١٢٥٠ لفة/الدقيقة) ومعدل تغذية ٨٠٠ كجم/ساعة باستخدام سكينتي القطع ذات الحافة الحادة والمشرشرة على التوالى عند نسبة رطوبة ٨٨ %، مما تقدم توصى الدراسة عملياً بما يلي: تشغيل الآلة المصنعة لتعظيم الفائدة من مخلفات الموز وإعادة استخدامه مرة ثانية في صورة أسمدة عضوية للتربة عند سرعة درفيل٢٦.١٦ م/ث (١٢٥٠ لفة/دقيقة) ومعدل تغذية٨٠٠ كجم/ساعة واستخدام سكينة القطع ذات الحافة المشرشرة حيث كانت تكلفة فرم الطن ١٩.٥٨ جنيهاً/طن.

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