DEVELOPMENT AND EVALUATION OF A FODDER BEET CHOPPING MACHINE

Kholief, R. M.; R. R. Abu-Shieshaa and A. El-keway
Agric. Eng. Res. Inst. (AEnRI), El-Giza, Egypt

ABSTR ACT

The objective of the present work is to develop and evaluate fodder beet chopping machine to obtain beet sizes suitable for small ruminants feeding and to avoid clogging during chopping process. Experiments were carried out at Sakha Agriculture Research Center during winter season of 2009 / 2010 using fodder beet crop (Monovert variety) to assess the effect of rotor speeds, beet feed rates and beet moisture content on chopper performance (machine productivity, chopping sizes, power requirement and energy consumed and chopping cost).

Results indicated that, the optimum operation condition was obtained at rotor speed of 350 rpm, beet feed rate of 9.9 Mg/h and beet moisture content of 84.15% (w.b). Whereas, the minimum values of energy consumed of 1.411 and 0.748 kW.h/Mg were obtained under these conditions for original and modified machine, respectively. Also, an acceptable beet sizes of 25 and 56 % for < 2 cm however, they were 23 and 21 % for > 2 – 4 cm for the two proposed machines. Meanwhile, machine productivity of 6.278 and 9.165 Mg/h were occurred under the same conditions. Moreover, the cost calculations indicated that the original chopping machine costs about 1.46 times the modified machine.

INTRODUCTION

Fodder beets are the highest yielding forage crop where any one can grow. The energy from rich fodder beets are complementing the use of grass or protein rich legumes in the diet of the cattle. In many countries fodder beets serve as the reliable winter storage of feed. In other countries fodder beets play an important role in supplying forage in dry periods late in the summer. It has a long growing season and is therefore retaining nitrogen very effectively for the benefit of the environment.

The great shortage in animal feed stuffs and their distribution around the year are the main problems facing animal production in Egypt. Many attempts have been made to introduce unconventional new forages, especially for the summer season when animals are under-fed. Fodder beet has several advantages and its cultivation may help in overcoming the problem of animal feeding .It could be sown in the new reclaimed sandy soils and its roots and leaves are acceptable for animal feeding besides its harvesting in June to August during the shortage of green forages in Egypt.

Fodder beets have very high digestibility and are in many areas able to produce considerably more feed than maize .The total energy will increase by mixing maize with fodder beets. Concentration of the roughage and high yielding dairy cows can cover a bigger part of their energy need through roughage; this makes the farmer more self sufficient and less dependent on bought in cereals and concentrates.

Fodder beet roots could be successfully used for feeding sheep (Gabra *et al.*, 1993), lactating dairy cows (Gabra *et al.*, 1992, Muller *et al.*, 1994, De Brabander *et al.*, 1995, Phipps *et al.*, 1995 and Deininger *et al.*, 1996) and fattening bulls (Fiems *et al.*, 1992).

Chopping fodder beet roots are the main point for feeding small ruminants in this connection, Gabra *et al.* (1993) reported that biting roots by sheep was slow, hard and negatively affected daily intake. They concluded that chopping roots at small pieces are suitable for the pointed mouth of sheep and may increase feed intake and feeding values.

Hashish (1981) mentioned that the desire for better quality silage has led to an over-increasing number of precision chop machines which are capable of providing a short cut material which in turn will have better clamp fermentation.

Ermrichev *et al.* (1989) described a transporting unite with a shredder for the preparation of roots and tuber for animal feed .Two sets of steel knives arranged alongside each other (9 blades) and consequently in a row (up to 36 blades) process 17.0-18.5 Mg/h of roots: a conveyor transports the material into an auger where the feed are steamed and mixed with further additives. The mixture is then transported into a feed distributor. The unite requires around 0.5 kW.h to prepare one megagram of feed.

Hashish *et al.* (1994) indicated that, the theoretical cut of 13 mm is usually considered fine enough for corn silage, longer cut (50 – 75 mm) are desirable for cured hay. With any crop, chopping into lengths shorter than necessary increase the energy requirements per megagram and may reduce the capacity of the chopper. Kholief (2001) pointed out that, the increase of drum speed from 14.52 to 22.31 m/s leads to increase the unit energy consumption of chopped fodder beet by 16.36, 12.74, 11.05 and 10.97 % at feed rates of 100.2, 130.2, 169.8 and 199.8 kg/h respectively by using fodder beet moisture content of 72.34 % (w.b.). Also, the same increase in drum speed increases the percentage of chopped fodder beet (size of 20 mm) from 48 to 55, 45 to 53, 43 to 50 and 40 to 47 % at the same above mentioned feed rate and fodder beet moisture content.

El-Awady *et al.* (1988) indicated that, the cutting force is greatly affected by the moisture content of plants and by increasing diameter of stalks. The cutting force decreased from 625 to 256.7 N by increasing the moisture content of stalk from 35 to 55 %, respectively for 9 mm diameter of cotton stalk. The cutting force decreases from 175 to 120 N by increasing the moisture content from 35.4 to 83.8 %, respectively for 4 mm diameter wheat straw in bundles of four straws. Decreasing cutting forces at higher moisture contents were due to visibility of the stalk tissues of plant stems.

Mohamed (1998) mentioned that the maximum force needed to cut the beet in the upper part was 540 N, the middle part 430 N and the root part was 188 N. Also, by increasing the beet diameter from 6 to 15.6 cm the hardness increased from 4.09 to 6.02 N/mm2. By increasing the sharpness from 0.0 to 1.0 mm, the cutting resistance increased from 11.11, to 166.67 N/mm2, respectively. The cutting power required ranged between 0.071 to 1.34 kW and the cutting energy ranged between 6.98 to 9.24 kW.h/fed. The relation of unit energy versus feed mechanism speed for chopping corn at various levels

of moisture content and cutterhead speed were estimated. It was evident that, the increment in feed mechanism speed from 0.41 to 1.45 m/min decreases the unit energy from 1.31 to 0.93, 1.56 to 1.13 and 2 to 1.4 kW.h/Mg at cutterhead speed of 20.73, 23.76 and 27.65 m/s, respectively. Also, it was decreased from 1.55 to 1.09, 1.63 to 1.17 and 1.69 to 1.19 kW.h/Mg at corn moisture content of 62.82, 48.16 and 40.22 %, respectively (Kholief *et al.*, 1998). Srivastava *et al.* (2003) estimated the power consumed in gathering, conveying and compressing the material to be cut, in chopping the material and in conveying it. Power losses in forage include bearing friction, friction of cut material on the cutterhead housing, power divided roughly as follows: 20 % in gathering and feeding, 40 % in the cutterhead and 40 % for blowing. The objective of the present study is to develop and evaluate fodder beet chopping machine to obtain beet sizes suitable for feeding small ruminants and to prevent clogging occurred during chopping operation.

MATERIALS AND METHODS

Materials:

The present study was devoted to develop and evaluate fodder beet chopping machine at Sakha Agriculture Research Center during winter season of 2009/2010 by using fodder beet (Beta vulgaris L.) Monovert variety.

Original chopping machine:

An original chopping machine model VDC 900 Netherlands made was used in this study. The general specifications part present in Table 1 and components part are shown in Fig. 1. It consists of main hopper which contains two main shafts. The upper one drives both the cutting knifes and the auxiliary auger, however the lower shaft was used to drive the main auger to allow chopped beet to be through outside the machine.

Table 1: Some technical specifications of fodder beet chopper.

Items	Specifications
Model.	VDC 900, Netherlands make
Overall length, cm.	184
Overall width, cm.	155
Overall height, cm.	115
Net mass, kg.	App. 600
Capacity, m^3.	App. 1.4
Drive	PTO / hydromotor.
Discharge	Right
Rated power, kW.	20

Suggesting the problem:

1. During chopping process additional chopping have been done by the assisting of the main auger. At the same time the main auger produces axial force that pushes the chopped materials towards the discharge gate.
2. It was remarkable that, the big sizes of chopped materials were collected just before the discharge gate which, required higher pressure in order to cut and throughout.

1179

3. The higher the amount of big sizes chopped materials before the discharge gate the close the gate opening and subsequently an additional force will be produced and works against the axial force.
4. The two forces that, works against each other makes the flow of the chopped materials difficult and subsequently the big sizes of chopped beet will be escaped up into the lower zone pressure. Hence the quality and the quantity of chopped materials were reduced.
5. To overcome the problem facing the chopping process about one third of the main auger was covered with metal sheet (tunnel) to prevent closing the gate opening, minimizing the undesirable force and increasing the axial force.
6. There was an inclined surface at upper of the tunnel however; the motion of the auxiliary auger is reversed to avoid the collecting of chopped materials.

Modified machine:

The present work aims to modify some parts of the chopping machine to obtain beet sizes suitable for small ruminants feeding and to evaluate the machine performance under different operation conditions. The general modification parts carried out on the developed machine are sketched in Fig. 2. The machine operated by the PTO shaft of a 45 kW FIAT 55-6 DT tractor.

The proposed machine was used for chopping fodder beet Monovert variety; the physical properties are shown in Table 2 and Fig. 3. The root volume was measured by using water displacement method in order to obtain the actual volume. Tests were carried out by using four rotor speeds of 350, 400, 450 and 500 rpm, three different levels of beet moisture content of 75.36, 79.57 and 84.15 % (w.b) with four different feed rates of 5.10, 7.50 and 9.90 Mg/h.

Table 2: Some physical properties of fodder beet roots (Monovert variety).

No. of sample	physical properties			
	Mass, kg	Length, cm	Average diameter, cm	Volume, cm^3
1	3.15*	32.72	14.75	2971.7
2	2.95	29.51	15.56	2994.5
3	3.07	33.25	16.25	3065.2
4	3.24	31.60	14.57	2876.0
5	2.87	30.45	13.62	2752.5
Total	15.28	157.53	74.75	14659.9
Mean	3.06	31.51	14.95	2931.98

* Each reading indicated in the table is an average of ten samples.

Measurements:
Chopping sizes:

Chopping sizes of fodder beet tubers were measured by using crumb structure measuring device. It consisted of three sieves having different mesh sizes. The sieve diameter 20 cm and the mesh sizes are: 60, 40 and 20 mm, chopped fodder samples were randomly taken from product with three replicates. The sieves apparatus containing the chopped fodder samples is put into motion in a semi-circulating fashion for one minute. After sieving, the entire individual fraction were massed and converted as a percentage of total sample mass.
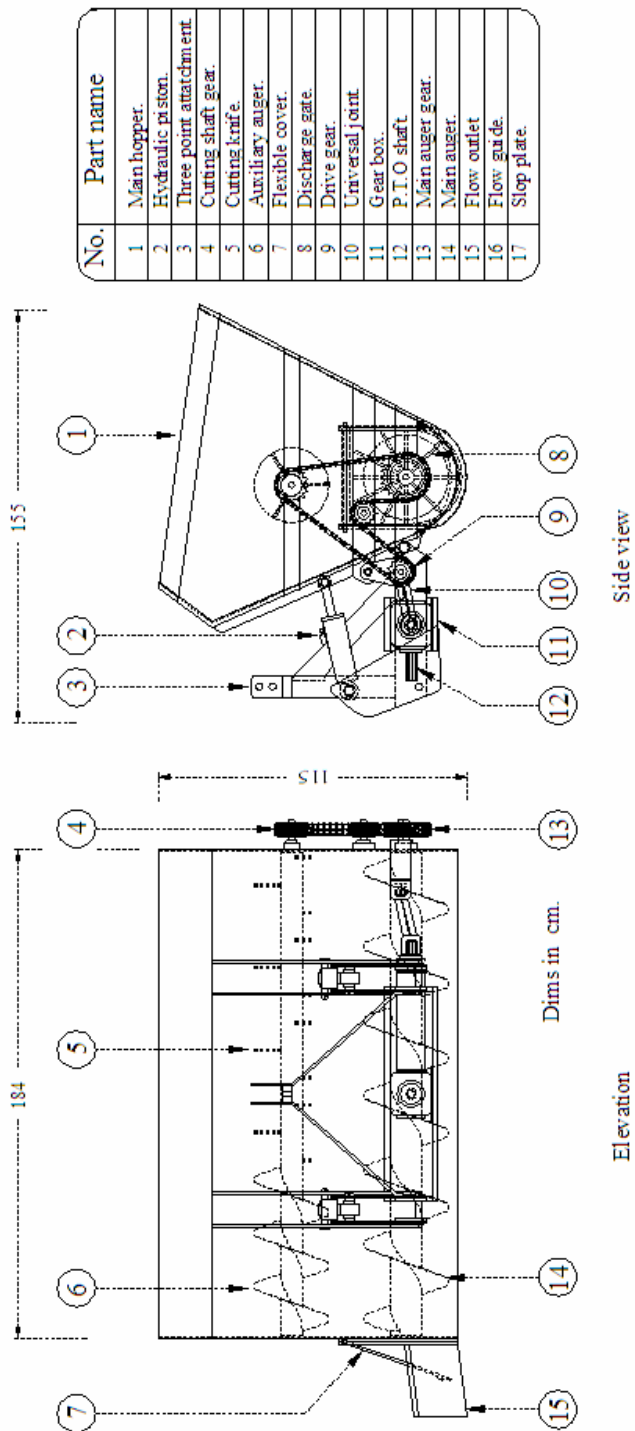
No.	Part name
1	Main hopper.
2	Hydraulic piston.
3	Three point attatchment.
4	Cutting shaft gear.
5	Cutting knife.
6	Auxiliary auger.
7	Flexible cover.
8	Discharge gate.
9	Drive gear.
10	Universal joint.
11	Gear box.
12	P.T.O shaft.
13	Main auger gear.
14	Main auger.
15	Flow outlet.
16	Flow guide.
17	Slop plate.

Side view

Elevation

Dims in cm.

Fig. 1 : An elevation and side view for original chopping machine.

No.	Part name
1	Main hopper.
2	Hydraulic piston.
3	Three point attachment.
4	Cutting shaft gear.
5	Cutting knife.
6	Auxiliary auger.
7	Flexible cover.
8	Discharge gate.
9	Drive gear.
10	Universal joint.
11	Gear box.
12	P.T.O shaft.
13	Main auger gear.
14	Main auger.
15	Flow outlet.
16	Flow guide.
17	Stop plate.

Side view

Elevation

Dims in cm.
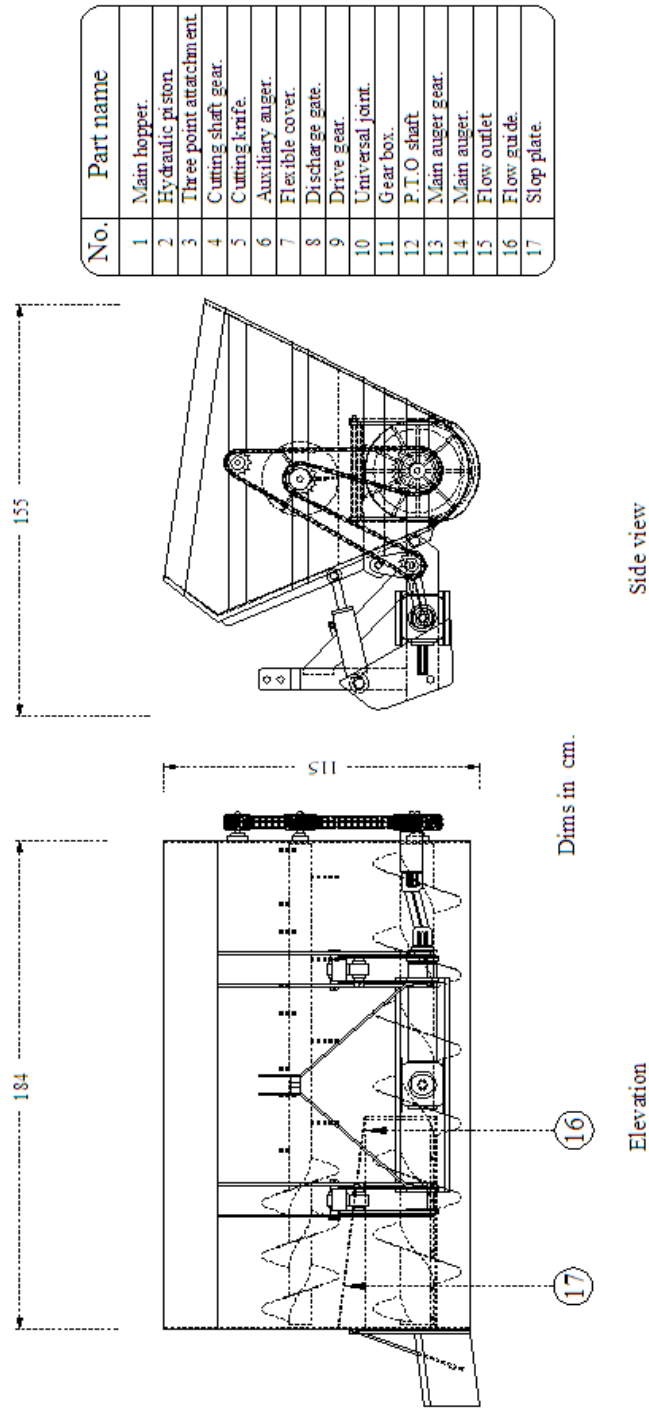
Fig. 2 : An elevation and side view for modified chopping machine.

P. No.	Description.
1	Vegetative growth (leaves).
2	Crown.
3	Neck
4	Cone-shaped taproot.
5	Narrow extended taproot end.
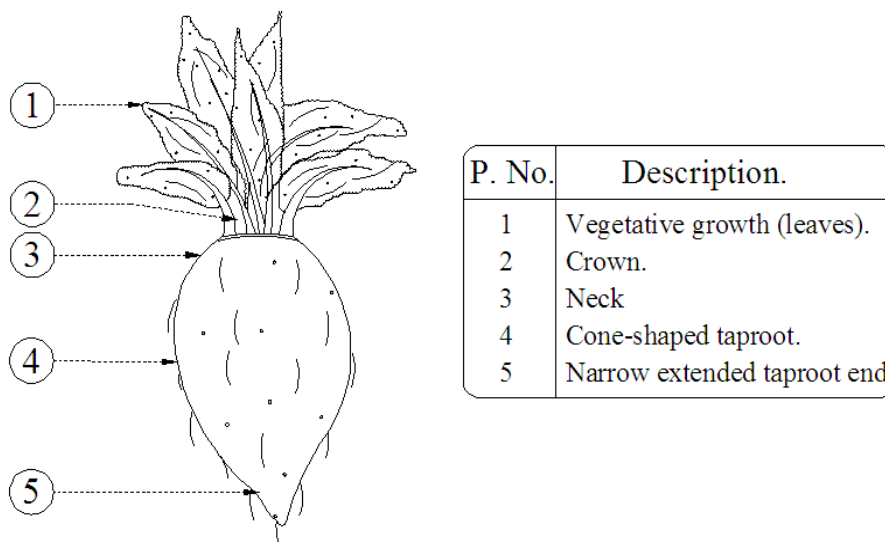
. Fig. 3: Fodder beet plant

Power requirement and energy consumed:

Strain gages are usually used to provide a more accurate measure of torque on a specific location. It's used to measure the torque on the main shaft of chopping machine. Strain gage type: (K-2) bounded metal-wire gages are classified as foil strain gage, 120 Ω. It contains two units every one consists of two cells connected by 90° each and supported at 45° on the shaft surface parallel to the axis, the other unit supported on the opposite side of the shaft make together 180°. The torque was measured twice without load and with load and the power requirement and energy consumed could be calculated from the following equations:

$$PR = T \times \omega/1000 \quad \text{....}\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(1)$$

Where:

$\quad\quad PR$ = power requirement, kW;

$\quad\quad T$ $\quad$ = Net torque, N. m;

$\quad\quad\quad$ = Torque with load – torque without load;

$\quad\quad \omega$ $\quad$ = Angular speed = 2 π. n / 60, red / sec;

$\quad\quad$ n $\quad$ = rotor speed, rpm.

$$consumed\ energy = PR/machine\ productivity, k\text{W.h/Mg} \ldots\ldots\ldots..(2)$$

Machine operation costs:

Total cost requirements of the chopping machine include fixed and operating costs. Declining balance method was used for estimating the depreciation (Hunt, 1983). In this method the depreciation amount is different for each year of the machine's life. This fact meets the actual use of any working machine. The unit operating cost could be estimated from the following formula:

Unit operation cost = chopping cost / productivity,LE/Mg $\quad$ ………………….(3)

RESULTS AND DISCUSSION

Chopping sizes:

Figures 4, 5 and 6 illustrate, the effect of rotor speeds, fodder beet feed rates and beet moisture contents on chopping sizes. The chopping sizes decreased by increasing the rotor speed, increasing the moisture content and decreasing fodder beet feed rates. It is clear that, the highest values of beet sizes < 2cm were 41 and 75 % takes place at rotor speed of 500 rpm, feed rate of 5.1 Mg/h and beet moisture content of 84.15 %for original and modified machine, respectively. Hence, the highest values of beet sizes were 30 and 25 % for the range of > 2-4 cm at rotor speed of 500 rpm, beet feed rates of 7.5 and 9.9 Mg/h and beet moisture content of 84.15 % for original and modified machine, respectively.

Meanwhile, the increase of rotor speeds decreases the beet sizes of > 4-6 cm for original and modified machine. Whereas, the minimum values were 8 and 6 % which takes place at rotor speed of 500 rpm, beet feed rate of 5.1 Mg/h and beet moisture contents of 84.15 and 79.57 % for original and modified machine, respectively. The obtained results showed that, the highest values of beet sizes >6 cm were 45 and 22 % at rotor speed of 350 rpm, beet feed rate of 9.9 Mg/h and beet moisture content of 75.36 % for original and modified machine, respectively.

From the previous mentioned results, it can be stated that, the modified machine was able to offer the best beet sizes suitable for feeding small ruminants.

Machine productivity:

Figure 7 shows the effect of feed rate, rotor speed and beet moisture content on machine productivity. It is conceivable that, the machine productivity was increased by increasing the feed rate, rotor speed and beet moisture content for both original and modified chopping machine. However, the machine productivity increases by 45.99% in case of using the modified machine in comparison with the original one at rotor speed of 350 rpm with feed rate of 9.9 Mg/h and beet moisture content of 84.15 %. Meanwhile, it was increases by 44.08 % at rotor speed of 500 rpm under the above mentioned conditions.. The same increase in rotor speed tends to increase machine productivity with all feeding rates and beet moisture contents.

Also, data presented in the same figure showed that, the increase of beet feed rate from 5.1 to 9.9 Mg/h `increases the machine productivity from 3.427 to 6.278 and from 4.87 to 9.165 Mg/h with rotor speed of 350 rpm and beet moisture content of 84.15 % for original and modified machine, respectively. The same trend was noticeable with the other rotor speeds and beet moisture contents for the machine before and after modification. This increase in the modified machine may be due to the obligated of passing chopped materials through the tunnel. However, the increase of beet moisture content from 75.36 to 84.15 % leads to increase the machine productivity from 3.175 to 3.427 and from 4.612 to 4.870 Mg/h with rotor speed of 350 rpm and beet feed rate of 5.1 Mg/h for original and modified chopping machine, respectively. The same trend was obtained from the other feed rates and rotor speeds.
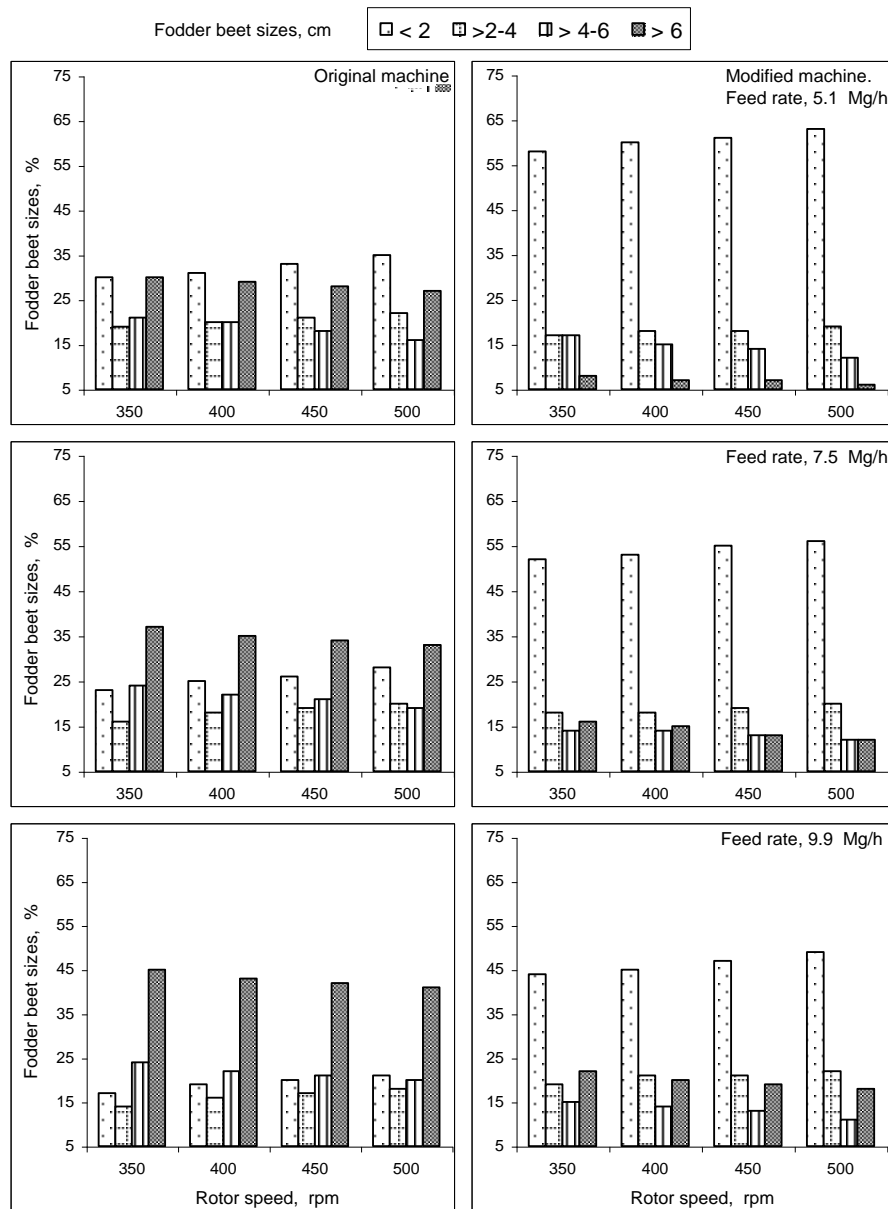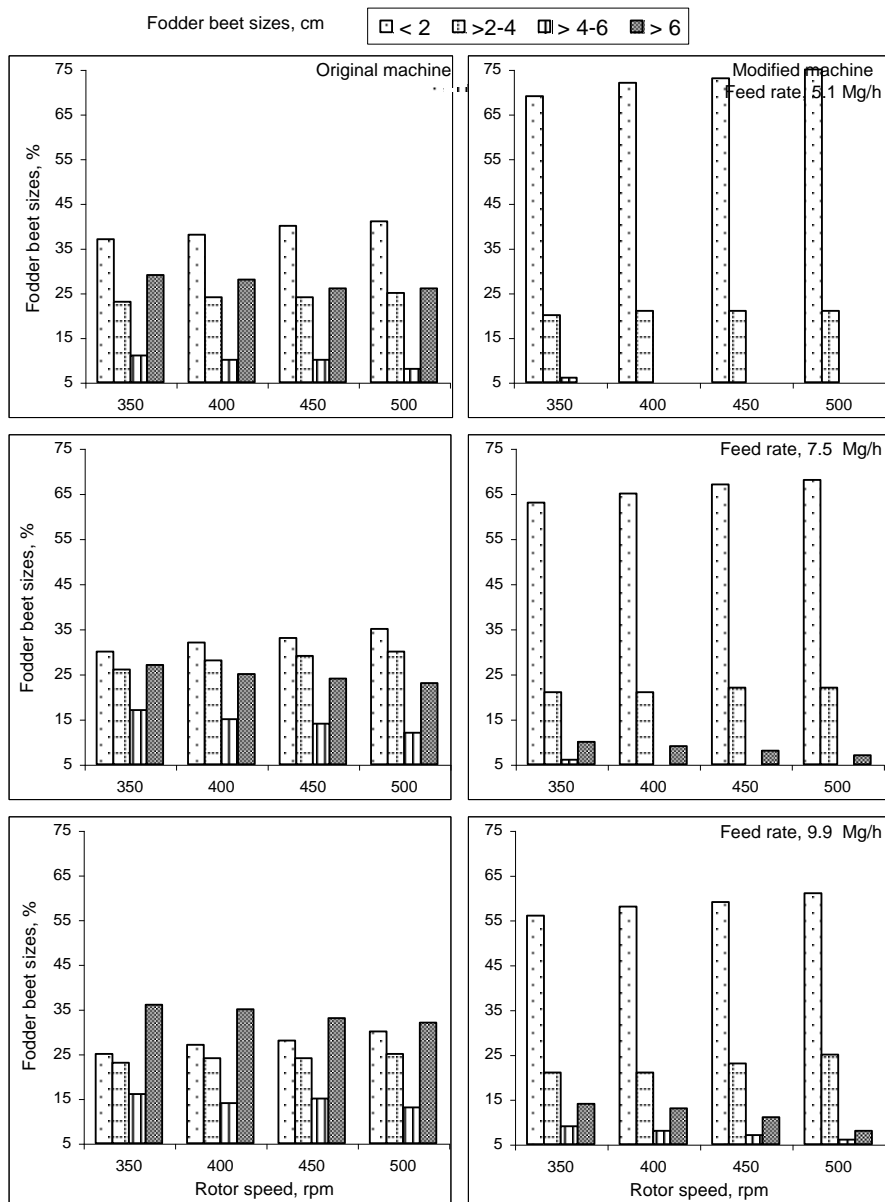
1184

Fig. 4: Effect of rotor speed and feed rate on fodder beet sizes for original and modified machines at beet moisture content of 75.36 %.

Fodder beet sizes, cm □ < 2 ⊞ >2-4 ◫ > 4-6 ▓ > 6
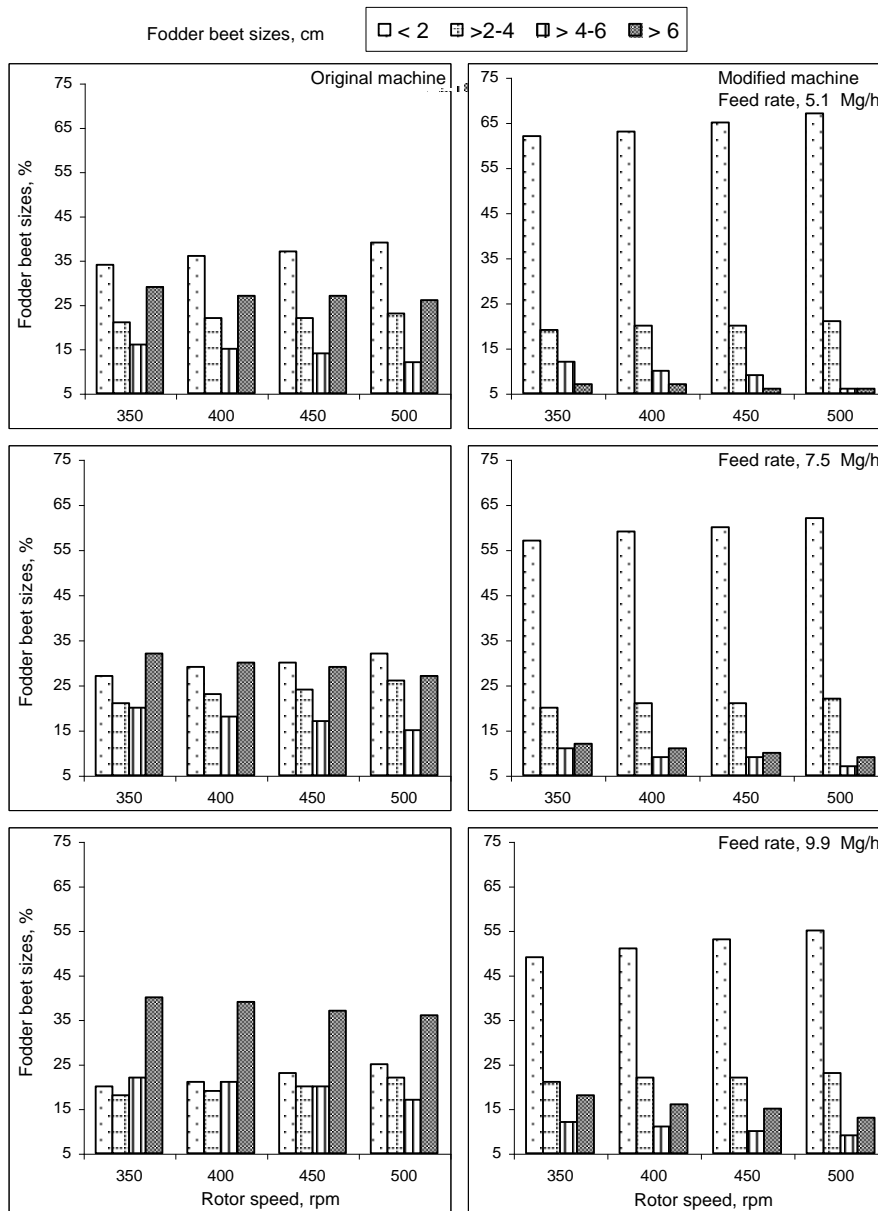
Fig. 5: Effect of rotor speed and feed rate on fodder beet sizes for original and modified machines at beet moisture content of 79.57 %.

1186

Fodder beet sizes, cm   □ < 2   □ >2-4   ▥ > 4-6   ▦ > 6

Fig. 6: Effect of rotor speed and feed rate on fodder beet sizes for original and modified machines at beet moisture content of 84.15 %.
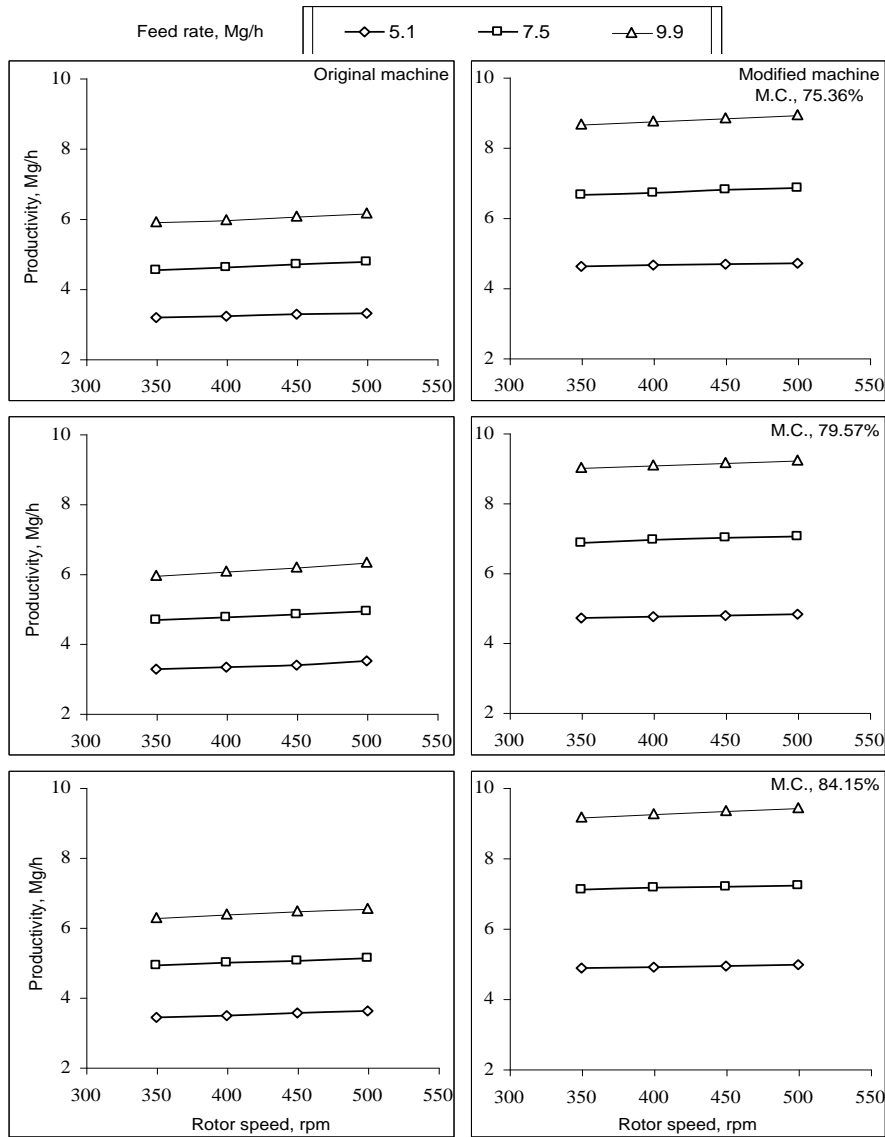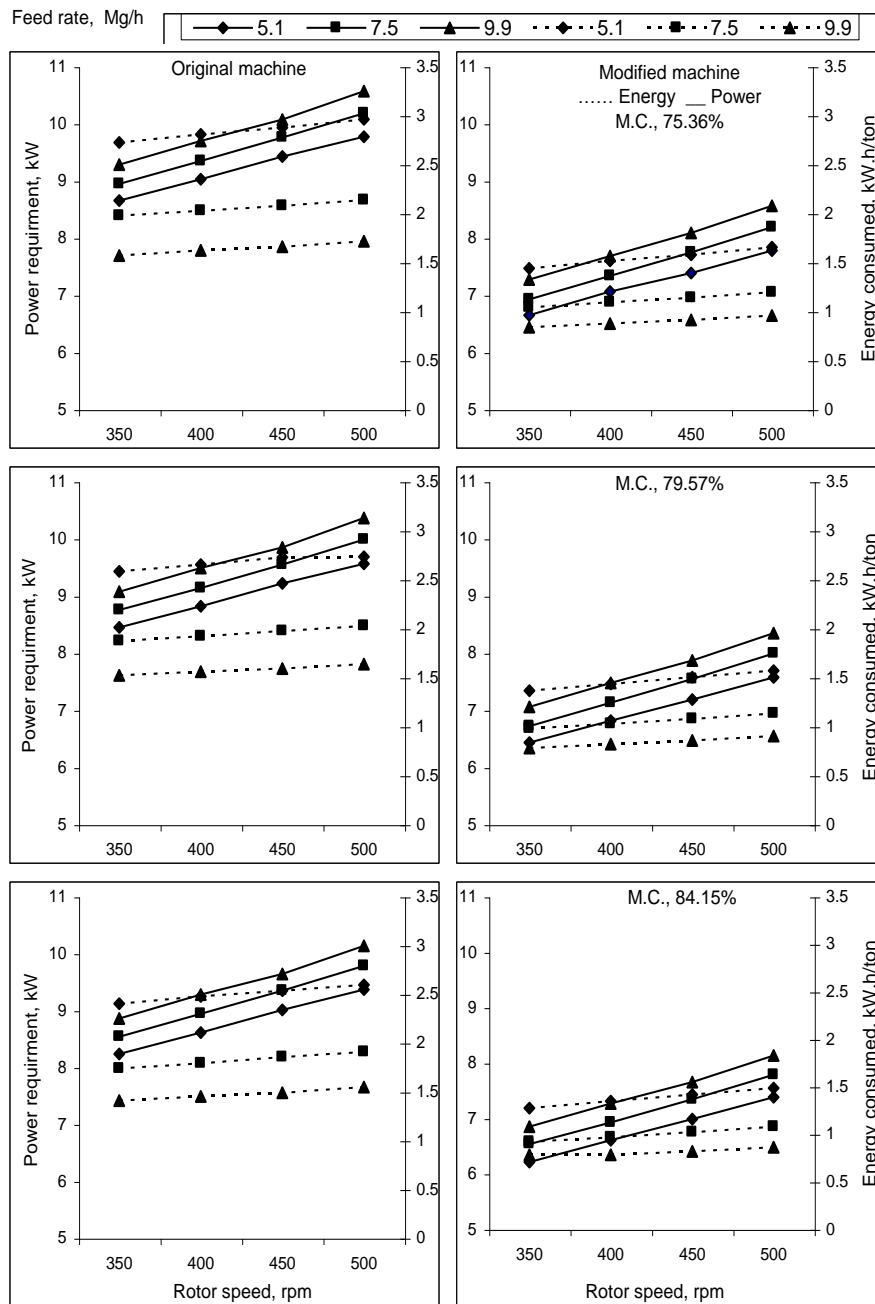
1187

Fig. 7: Effect of rotor speed, feed rate and beet moisture content on productivity for original and modified machines.

Power requirement and consumed energy:

The obtained results in Fig.8 illustrates the effect of rotor speed, beet feed rate and beet moisture content on power requirement and energy consumed. It can be stated that, the increase of rotor speed from 350 to 500 rpm tends to increase the power requirement from 9.287 to 10.570 and 7.276 to 8.565 kW for original and modified machine, respectively at beet feed rate of 5.1 Mg/h and beet moisture content of 75.36 %.

1188

Fig. 8: Effect of rotor speed, feed rate and beet moisture content on power requirement and energy consumed for original and modified machines.

However, the same increase in rotor speed increases the energy consumed from 1.573 to 1.718 and 0.840 to 0.959 kW.h/Mg at the same above mentioned conditions for both two tested machines. The same results were obtained with other beet feed rates and moisture contents.

In the same manner, the increase of beet feed rate from 5.1 to 9.9 Mg/h lead to increase the power requirement from 8.657 to 9.287 and 6.650 to 7.276 kW at rotor speed of 350 rpm and beet moisture content of 75.36 %. However, there were a reduction in energy consumed from 2.727 to1.573 and 1.442 to 0.840 kW.h/Mg for original and modified machine, respectively at the same above mentioned operation conditions. The same tendency was obtained with the other beet moisture contents. This trend may be due to the increase in machine productivity. On the other hand, the increase of beet moisture content from 75.36 to 84.15 % tends to decrease both power requirement and energy consumed for the two proposed machines. However, the power requirement decreases from 8.657 to 8.237 and 6.650 to 6.215 kW at rotor speed of 350 rpm, beet feed rate of 5.1 Mg/h. The same increase in beet moisture content decreases the energy consumed from 2.727 to 2.405 and 1.442 to 1.276 kW.h/Mg for original and modified machine, respectively. The same trend was noticeable with the other beet feed rates and rotor speeds.

The obtained results showed that, the minimum values of power requirement were 8.237 and 6.215 kW at rotor speed of 350 rpm, beet feed rate of 5.1 Mg/h and beet moisture content of 84.15 % for original and modified machine, respectively. However, the minimum values of energy consumed were 1.411 and 0.748 kW.h/Mg at rotor speed of 350 rpm, beet feed rate of 9.9 Mg/h and beet moisture content of 84.15 %for the above mentioned two machines.

Chopping cost:

Table 3 summarizes the effect of rotor speed on machine productivity, energy consumed and chopping cost. The increase of rotor speed from 350 to 500 rpm tends to increase the machine productivity and decreases the energy consumed for both two machines. On the other hand, the modified machine resulted a reduction of about 31.52% in comparison with original machine.

Table 3: Effect of rotor speed on machine productivity, energy consumed and chopping cost under the optimum conditions.

Moisture content, %	Feed rate, Mg/h	Rotor speed, rpm	Machine productivity, Mg/h		Energy consumed, kW.h/Mg		Chopping costs, LE./Mg	
			Original	Modified	Original	Modified	Original	Modified
84.15	9.90	350	6.278	9.165	1.411	0.748	4.950	3.390
		400	6.386	9.260	1.454	0.785	4.870	3.360
		450	6.472	9.345	1.490	0.820	4.810	3.330
		500	6.545	9.430	1.549	0.863	4.750	3.300

CONCLUSION

From the above results, it can be concluded that:

1. The minimum values of energy consumption reached 1.411 and 0.748 kW.h/Mg at rotor speed of 350 rpm, beet feed rate of 9.9 Mg/h and beet moisture content of 84.15 % for original and modified machine, respectively.
2. Modified machine gave the highest values of beet sizes < 2 cm and > 2-4 cm under all tested conditions.
3. Machine productivity of 6.278 and 9.165 Mg/h seems to be acceptable for both original and modified machine.
4. Developed machine indicated remark superiority under all conditions.
5. Chopping by using the original machine costs about 1.46 times the modified ones.
6. Chopping fodder beet roots at suitable sizes by using modified chopper may be share in solving the problem of limited consumption of such feeding by small ruminants.

Results of the present study under the above mentioned conditions encourage sowing fodder beet especially in new reclaimed lands to participate in solving the problem of green forage shortage in summer.

REFERENCES

De Brabander, D.L.; B. G. Cottyn and ch.v. Boucque (1995).Effect of pressed sugar beet pulp, fodder beets, potatoes and ensiled maize grain on milk yield and milk composition in dairy cows. P : 46 in book of abstracts of the 46 [th] annual meeting of the European Association for Animal production, Prague, Czech Republic wageningen Pres.

Deininger, A.; J. Beck; T. Jungbluth, M. Türk and G. Hörnig (1996). Mechanized feeding of ensiled beet mash to dairy cows. J. Agric. Eng. Res., 63: 45 - 51.

El-Awady, M. N.; M. M. Mostafa; A. M. El-Gindy and S. A. Sahar (1988). Design of an apparatus for measuring the resistance of plant stems for cutting. Misr J. Agric. Eng., 5 (3): 231 – 241.

Ermichev, A.; V. Bogatov and V. Broket (1989). Lines for preparing roots and tubers to be fed. Tekhnika-vsel'skom – khozyaistve. 5: 60.

Fiems, L. O.; B. G. Cottyn; J. M. Vanacker; C. V. Boucque; D. L. De Brabander and G. Vlaemynck (1992). Preservation, chemical composition and digestibility of mixed silages with maize and beet Revue de l'Agriculure, 45: 899- 908.

Gabra, M. A.; A. M. Khinizy and S. I. Hafez (1993). Feeding qualities and some mineral balances of fresh and stored fodder beet (Beta Vulgaris L.) leaves and roots in metabolism trials with sheep. J. Agric. Sci. Mansoura Univ., 18: 2897- 2906.

Gabra, M. A.; M. Moustafa; A. Abdel-Kabir and K. Etman (1992). Partial replacement of concentrates by fodder beet silage in metabolism trials with sheep and feeding trials with cows. J. Agric. Sci. Mansoura Univ., 17 : 3140-3148.

Hashish, A. E. (1981). A study for machine crushing and grinding crop residue. J. Approp. Tech. for Egypt. Ag. small scale Agric. Activist. Min. of Agric. USAID, No. 2 : 15 – 32.

Hashish, A. E.; M. A. Hassan and A. F. El-Mottalb (1994). Some factors affecting performance of chopping and crushing for field raw materials. Misr J. Agric. Eng., 11 (3): 669 – 682.

Hunt, D. (1983). Farm power and machinery management. Iowa State University, Ames 3rd ed.

Kholief, R. M.(2001). Energy requirements of chopping operation for fodder beet. Misr J. Agric. Eng., 18 (3): 612– 628.

Kholief, R. M.; Z. M. Imara; R. R. Abou-Shieshaa and M. F. Youssef (1998). Chopping parameters affecting the performance of stationary chopper and silage quality. Misr J. Agric. Eng., 15 (3): 555 – 568.

Mohamed, A. (1998). Design and development of a sugar beet topper. Ph. D. thesis Agric. Mech. Dept. Faculty of Agriculture. Ain Shams Univ.

Muller, H. L.; F. Birkenmaier; F. Schwarz and M. Kirchgessner (1994). Energy utilization of fodder beets in lactaiting dairy cows. J. Anim. Physiol. Anim. Nutr., 71: 234- 246.

Phipps, H.; J. Sutton and B. Jones (1995). Forage mixtures for dairy cows: the effect on dry matter intake and milk production of incorporating either fermented or Uria-treated whole – crop wheat, brewer's grains, fodder beet or maize silage into diets based on grass silage. Anim. Sci., 61: 491 – 496.

Srivastava, A. K.; C.E. Goering and R.P. Rohrbach (2003). Engineering principles of agricultural machines. Hay and forage harvesting. Text book No. 6 published by the ASAE. Pamela Dover-Hansen editor.

تطوير وتقييم آلة لتقطيع بنجر العلف

رزق محمد خليف ، رفاعى رفاعى ابو شعيشع و عبد الفتاح القويعى
معهد بحوث بحوث الهندسة الزراعية – مركز البحوث الزراعية – الجيزة - مصر

يشكل نقص الأعلاف أساس الفجوة الغذائية فى مصر، ويستهلك الحيوان ما يوازى ٨.٥ مليار جنيه من الدخل القومى حيث يتعدى على ما هو مخصص للإنسان ومع ذلك يوجد عجز فى الثروة الحيوانية. ولزيادة الحاجة للإكتفاء الذاتى فى مجال البروتين الحيوانى، وإثراءً لخلق موارد لأعلاف غير تقليدية تزيد من حيث النوع والكم، كانت زراعة محصول بنجر العلف أحد أهم الحلول الفعالة للتغلب على مشكلة نقص العلف الصيفى. حيث أن متوسط إنتاجية الفدان الواحد من المادة الجافة لمحصول بنجر العلف والتى تمثل الغذاءالأساسى للحيوان يعادل إنتاج ٥ افدنة من الذرة من المواد الكربوهيدراتية، علاوة على إرتفاع نسبة البروتين فيه أكثر من الذرة والمذاق الحلو الذى يزيد من شهية الحيوان لهذا النوع من الأعلاف الغير تقليدية. هذا فضلاً ً عن إنتاجه فى شهر يونيو حيث قمة الإحتياج الى المواد النشوية اللازمة للأعلاف.

ولقد تناول البحث حلاً لمشكلة انسداد فتحات خروج بنجر العلف أثناء مروره عند نهاية البريمة الرئيسية لنقل وتفريغ الأجزاء المقطعة إلى خارج الآلة، حيث تقوم البريمة الرئيسية أثناء

التشغيل بدفع مواد العلف لإتمام عملية التقطيع والخروج. ولقد لوحظ تكدس القطع الكبيرة الحجم قبل فتحة الخروج والتي يتطلب لها ضغط اكبر حتى تأخذ مسارها للتقطيع والخروج. وينتج عن هذه القطع مشكلتين هما: أولا: أنها تتسبب في توليد قوى عكسية ناتجة عن انسداد فتحات الخروج ضد قوة دفع البريمة. وثانيا: تحرك هذه القطع إلى أعلى داخل الخزان حيث الهروب إلى منطقة الضغط المنخفض مما يؤدى إلى انخفاض معدل أداء الآلة وجودة المنتج ، ومن هنا كان التفكير في تغطية الثلث الأخير من البريمة أمام فتحة الخروج لتحديد مسار اجبارى لمواد العلف كي يتم تقطيعها وزيادة الضغط الواقع عليها حيث تتغلب قوة دفع البريمة على القوى الناتجة عن انسداد الفتحات و يتم تقطيع وخروج بنجر العلف بالأحجام المرغوب فيها،هذا فضلا عن تغيير اتجاه دوران عمود سكاكين التقطيع والبريمة الإضافية بحث تكون في عكس اتجاه دوران بريمة النقل مما يساعد على زيادة معدل الأداء وتحسين جودة المنتج.

ولقد تم دراسة تأثير كل من السرعة للآلة والمحتوى الرطوبى ومعدل التلقيم على كل من أحجام القطع والطاقة المستهلكة والإنتاجية وتكاليف عملية التقطيع لمحصول بنجر العلف صنف Monovert. وقد إشتملت الدراسة تأثير المتغيرات التالية على آداء عملية تقطيع بنجر العلف:

- المحتوى الرطوبى لبنجر العلف (٧٥.٣٦، ٧٩.٥٧، ٨٤.١٥ ٪ على أساس رطب).
- سرعة سكاكين التقطيع (٣٥٠، ٤٠٠، ٤٥٠، ٥٠٠ لفه/دقيقه).
- معدل تلقيم مواد العلف (٥.١، ٧.٥، ٩.٩ ميجاجرام/ساعة).

ويمكن تلخيص النتائج المتحصل عليها كما يلى:

١. تزداد إنتاجية الآلة المطورة بزيادة كل من سرعة دوران عمود التلقيم، معدل تلقيم ورطوبة بنجر العلف حيث بلغت ٦.٢٧٨ ، ٩.١٦٥ طن/ساعة للآلة قبل وبعد التطوير على الترتيب.

٢. أعطت الآلة المطورة أعلى نسبة تقطيع لأحجام القطع الأقل من ٢سم والأكبر من ٢-٤ سم تحت ظروف التشغيل المختلفة.

٣. تزداد الطاقة المستهلكة بزيادة سرعة دوران عمود التقطيع حيث كانت أقل قيم لها ١.٤١١ ، ٠.٧٤٨ كيلووات.ساعة/ميجاجرام عند سرعة دوران ٣٥٠ لفه/دقيقه، معدل تلقيم ٩.٩ ميجاجرام/ساعة ومحتوى رطوبى ٨٤.١٥ ٪، وذلك للآلة قبل وبعد التطوير على الترتيب.

٤. إنخفضت تكاليف بنجر العلف المقطع بالآلة المطورة بمقدار ٣١.٥٢ ٪ مقارنة بالآلة قبل التطوير.

٥. أعطت الآلة المطورة نتائج مرضية للغاية بالمشاركة فى حل مشكلة نقص العلف الصيفى من خلال تقطيع مناسب لبنجر العلف لتغذية المجترات.

قام بتحكيم البحث

كلية الزراعة – جامعة المنصورة	أ.د / ماهر محمد ابراهيم عبد العال
كلية الزراعة – جامعة الأسكندرية	أ.د / أحمد السيد أحمد