J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., Vol. 10 (10):579 - 587, 2019

Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Performance Evaluation of a Small Machine for Chopping Fodder Beet

Hassan, M. A.*

Agric. Eng. Res. Inst.,ARC, Giza, Egypt.

Cross Mark

ABSTRACT

This research aims to evaluate small local prototype forage chopper machine performance during chopping fodder beet tubers. The independent variables including, four levels of fodder beet tubers moisture content of 81.6, 74.4, 66.2 and 57.9 % (w. b), four levels of cutter head speeds namely 18.8, 21.2, 23.50 and 25.8 m/s, and four levels of feed mechanism speeds of 0.41, 0.79, 1.13 and 1.45 m/min. During the execution of the present experiment the blade holders are inclined at 129° resulting in a cutting angle of the knives of 22°. The test results for modified forage chopper performance found that, the highest percentage of chopping length suitable silage (category of 3 - 6 cm) obtained at cutter head speed of 25.8m/s, feed mechanism speed of 0.41m/min and moisture content of 66.2%. The highest of actual capacity, machine efficiency recorded were 3.412Mg/h and 88.41%, respectively. Also, experiment recorded minimum of total losses, unit energy required and total losses cost of 7.65%, 0.767kW.h/Mg and 35.92 L.E/h, respectively. Too, minimum of criterion function cost was 134.71 L.E/h. Silage was made from the results suit chopping length, it found that the percentage of ammonia does not exceed 8%, the degree of PH was less than three. Also, silage was kept with leaves and legs in good condition. And the most suitable moisture content in the material used to be preserved is 65 - 70% (w. b). Moisture and all these indicators are proof that the silage is good and the interactions are done in a good way.

Keywords: Fodder beet tubers, Chopping length, Chopper efficiency, Total machine losses, Energy requirements and losses cost.

INTRODUCTION

The Beet *(Beta vulgaris*) belonging to family Amaranthaceous, is a biennial crop grown for its fleshy and swollen roots. It is a temperate crop being cultivated in many parts of the world for sugar, fodder and vegetable purpose. Also, it popularly called as sugar beet, fodder beet& beet root, respectively. Beet is successfully grown as a fodder crop and used as valuable source of green fodder for cattle in many developed countries (Niazi *et al.*, 2000). Fodder beet considered as one of the most important crops for farmers. In Egypt, the fodder beet yearly is grown with cultivated area about 9674 ha (23905feddan) and quantity of production was 244626 tons (FAOSTAT, 2014).Fodder beet contains high water and sugar; it increases milk productivity and is suitable forage for dairy cows. The fodder beet is used by mixing it with straw in European countries.(Aky ld z 1983) reported that the plant is suitable for making silage. In Egypt, the great shortage in animal feed stuffs and their distribution around the year are the main problems facing animal production. There is a shortage of fresh forage particularly during summer. Moreover, the cultivated area is very limited and is devoted to cultivation of strategic food crops such as wheat and faba beans during winter. On the other hand, the horizontal expansion of new reclaimed areas requires the cultivation of crops offering a source for satisfying income to the farmers (Kassab *et al.*, 2012). Decreasing of forage crops during summer seems to be a serious problem in the nutritional requirements of animal. Fodder beet is mainly grown for animal feed. All the components of the fodder beet crown, tubers and roots can be used for feed. It can be prepared in a variety of ways; chopped, dried, dehydrated, as silage to chopped feed. Also, it can be processed into pellets or used in silage. Silage process was hoped to participate in solving the serious problems of feed shortage of livestock. With either type, the mounting or shape of the knives is such that cutting occurs progressively from one end to the other to minimize peak moment requirements (Culpin, 1981). 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 cutter head housing. Power divided roughly as follows: 20 % in gathering and feeding, 40 % in the cutter head and 40 % for blowing.

Kholief *et al* (2001) develop and evaluate fodder beet chopping machine to obtain beet sizes suitable for small ruminants feeding and to avoid clogging during chopping process. 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 above 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. Khader (1997) concluded that the four movable knives could be used for producing animal fodder, silage or compost according to residues cutting length. The optimum operating condition

* **Corresponding author.**
E-mail address: mabdallah8@yahooo.com
DOI: 10.21608/JSSAE.2019.59499

was; (a) animal fodder (1.5 - 3cm) drum speed 29.05m/s and 1mm clearance, (b) silage (3 – 6 cm) and composting (6 - 12cm) drum speed 19.63m/s and 5mm clearance. The cutting efficiency values were 90, 95, 85 and 50% for cotton, maize, bean and rice, respectively, at the recommended cutting length. Abd el-Halim (1998) found that fodder beet tubers were transported in trailers to the experimental station and there after the tubers were spread over a layer of rice straw and were left for 2-3 days to be wilted to diminish the moisture content to about 65-70 %, before making silage. Limestone was added at the rate of 0.5% to raise the (Ca) content of the silage produced. Zhang *et al*.(2003) concluded that specific energy for the flail cutter/blower ranged from 2 to 4.7 kW.h/Mg at moisture content of 60-70% and 0.51 to 1.2 kW.h/Mg for flail speed, were highly correlated to specific energy. Hussein *et al*. (2004) found that the optimum parameters for chopping fodder beet tubers into silage, were cutting speed 23.55 m/s and knife clearance 1.5 mm at moisture content 60 % which gave less power required 8.85 kW, less specific energy 3.54 kW.h/Mg and highest values of out put 2.50 Mg/h, for fly wheel cutter heads. Przybyt *et al.* (2013) used the methodology for external assessment of the quality of fodder beet in testing fodder beet harvesters equipped with toppers. Based on this methodology, the quality of topping, damage tubers and loss of crop in the form of broken ends of tubers were determined. The last index indirectly proves damage to the beet tubers. The quality of topping and damage to beets was evaluated based on random five trails 100 tubers each, collected from the prism. Evaluation of the quality of topping consisted in qualification of tubers to one out of six categories: un-topped beet with leaves remains above 2 cm, un-topped with the leaves remains above 2 cm, over topped, correctly topped, under topped or angled topped. The final quality of the fermentation process of sugar-beet silage, results from an interaction of endogenous and exogenous technological factors, viz. of draying matter content, ambient temperature and temperature of ensiled sugar-beet pulp. Rate of filling, degree of pressing, duration of fermentation process and addition of chemical preservatives can also improve the final quality of silage. There are many researches in this field conducted like Braunsteiner *et al*., (1983) told that, this impaired pulp structure is caused partly by an increased temperature that is used for a certain period during the process of sugar extraction and partly by the course of the fermentation process itself, particularly due to activities of pectinolytic clostridia. 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. Papa and Grazia,(1987) concluded that the use of preservatives containing homofermentative lactic acid bacteria did not result in a marked reduction of fermentation losses. The improvement of the fermentation process was not very distinctive because the control silage was also good. However, he observed a marked improvement of silage stability after the use of the produt Biocool (with heterofermentative lactic acid bacteria)

The aim of the research was to evaluate the performance of a small machine to chop the tubers fodder beet, to determine the optimum machine working conditions and to identify a product suitable for making a good silage

MATERIALS AND METHODS

A- **Chopping machine manufactured before adjustment:**

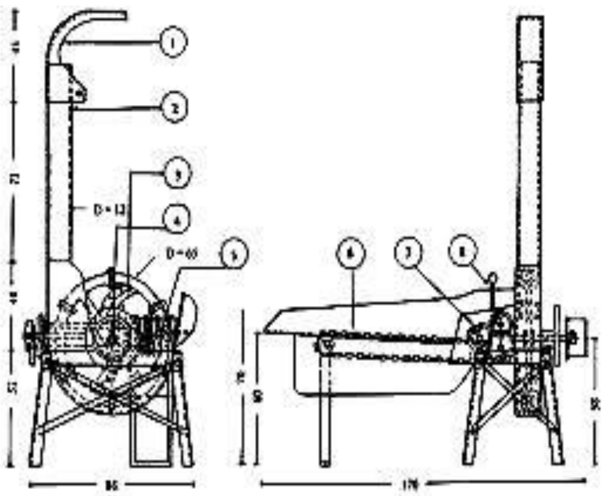
Field experiments were carried out during 2015-2016 at Rice Mechanization Center, Meet El-Dyba, Kafr El-Sheikh Governorate. The general components part of small forage chopper machine was used in the present study are shown in Fig. 1. It consists of:-

- Feeding mechanism with spring-loaded rolls to compress and hold the material for chopping.
- Chopping unit that including flywheel-type cutter head with four impeller blades around the periphery that throw or impel the chopped material up the discharge pipe and into the wagon.

Also, Fig. 2 illustrated schematic drawing of using forage chopper machine. Table 1 summarizes the technical specifications of the tested forage chopper machine.

1-Hopper **5-Power and transmission assembly**
2-Feed roll **6-Base and stand assembly.**
3-Outlate gate. **7- Wheel tires**
4-Cutter header

Fig. 1. Photography of used forage chopper machine.



1. Outlet 2. Feed extrusion tube
3. Chopping drum 4. An electric motor
5. Fixed knives 6. Mechanical feeding device

Fig. 2. Schematic drawing of using forage chopper machine.

Table 1. Technical specifications of used forage chopper machine.

Item	Specification
Overall length, cm	180
Overall width, cm	125
Overall height, cm	175
Net weight, kg	160
Width of roll, cm	18

The chopping machine was powered by an electric motor of 10 kW. The rotational speed of axe was measured using a multi range hand tachometer chronometrical type, readings were given in r.p.m. The proposed machine was used for chopping fodder beet Monovert variety; the physical properties are shown in Table 2.

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

No. of sample	physical properties			
	Mass, kg	Length, cm	Average diameter, cm	Volume, cm³
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

B- Chopping machine manufacturing:

The general adjustment parts on the cutting roller are as follows:

1- Portable small-scale multi-crop chipper machine was developed and constructed to slice different crops into choice sizes at no risk of injuries to fingers.(Fig.3)

2- Eight cutting blades mounted on a cutting roller in the perimeter and distributed on oblique axes at an angle of 129 degrees and the edge of these blades at a sharp angle of 22 degrees as shown in Fig.3.

Fig. 3. Anew chopping drum manufactured

3- The body is designed and made of the body of the roller drum with an inner diameter of 30 cm connected to eight longitudinal lines attached to the inclined cutting knives so, effective diameter is 50 cm. Each knife was 12.5 cm wide, and 10 cm long mounted on the edge of the drum. Another set of small knives with a width of 5 cm caused the pressure of the chopped parts and the body of the cutting roller.

4- Ten fixed U-shaped knives with dimensions of 5×10 cm installed at the cutting rotor inlet and outlet to increase the impact of shear forces on the agricultural material used.

5- Replace the sieve of the machine with a polished cavity to increase the effect of expelling chopped materials

6- And adjust the concave cylinder containing rectangular beams with dimensions of 3×8 cm, tapping the rapid passage of the chopped material and thus allow to cut into small parts.

Investigated variables:

The performance of used forage chopper was in the present study evaluated under the following treatments:

- Four levels of fodder beet tubers moisture content of 81.6, 74.4, 66.2 and 57.9 % (w.b).respectively.
- Four levels of cutter head speeds namely 18.8, 21.2, 23.50 and 25.8 m/s,
- Four levels of feed mechanism speeds of 0.41, 0.79, 1.13 and 1.45 m/min.

During the execution of the present experiment, the blade holders are inclined at 129° and the knives cutting angle of 22°.

Measurements:

The fodder beet tubers were collected and rotor cutting speed was measured and adjusted by tachometer. The chopped materials were dropped out machine after cutting at threshing room through concave. Samples of cutting material were taken from each experiment to laboratory which 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).

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

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

Where:

M_1 **moist mass, g, and**

M_2 **dry mass, g.**

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

$$P = \frac{W\ x3600}{T}, Mg/h \quad \textbf{............(2)}$$

Where:

P **machine capacity, Mg/h;**

W **mass of the sample, Mg, and**

T **time in sec.**

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

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

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 :

$$Total\ machine\ losses = \frac{M_{s1}}{M_d} x100, \% \ \ldots\ldots \textbf{(4)}$$

Where:

M_{s1} = mass of split portion of beet tuber losses in ground after cutting operation, kg;

M_d = total mass of beet tuber entering to machine for cutting, kg.

The power consumption (W) was calculated from the values of Ampere (I) and Volt (V). The amount of power required for operating the electric motor has been calculated according to Lockwood and Dunstan (1971):

Power consumption (W) = √ 3. I.V. Cos θ.η …. (5)

Where:

I = current strength, Amperes;
V = potential difference;
Cos θ = power factor, decimal (being equal 0.71) and η = mechanical efficiency of motor assumed 90%.

Hence, the energy requirements can be calculated as follows:

$$Energy\ requirements = \frac{Power\ required}{Machine\ capacity}, kW.h/Mg \ \cdots \textbf{(6)}$$

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

$$Operating\ cost = \frac{Machine\ cost}{Yield\ output}, LE/Mg \ \cdots\cdots \textbf{(7)}$$

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

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

Where:

_C :_ hourly cost, LE/h.
_P:_ price of machine, L.E.
_a:_ life expectancy of the machine, h.
_h:_ yearly working hours, h/year.
_i:_ interest rate/year.
_t:_ taxes ratio
_r:_ repairs and maintenance ratio
_0.9:_ factor accounting for lubrication
_w:_ engine power, hp
_s:_ specific fuel consumption, l/hp.h.
_f:_ fuel price, L.E/l
_m:_ monthly average wage, L.E.
_144:_ reasonable estimation of monthly working hours.

And also:

$$Criterion\ function\ cost = (operating\ cost + losses\ cost), LE/Mg \ \textbf{(9)}$$

RESULTS AND DISCUSSION

Performance evaluation of anew small local chopper machine for fodder beet tubers cutting:

Cutting length categories:

Results in Figs. 4 show the effect of cutter head speed and feed mechanism speed at different fodder beet tuber moisture content for cutting fodder beet tubers on cutting length categories.

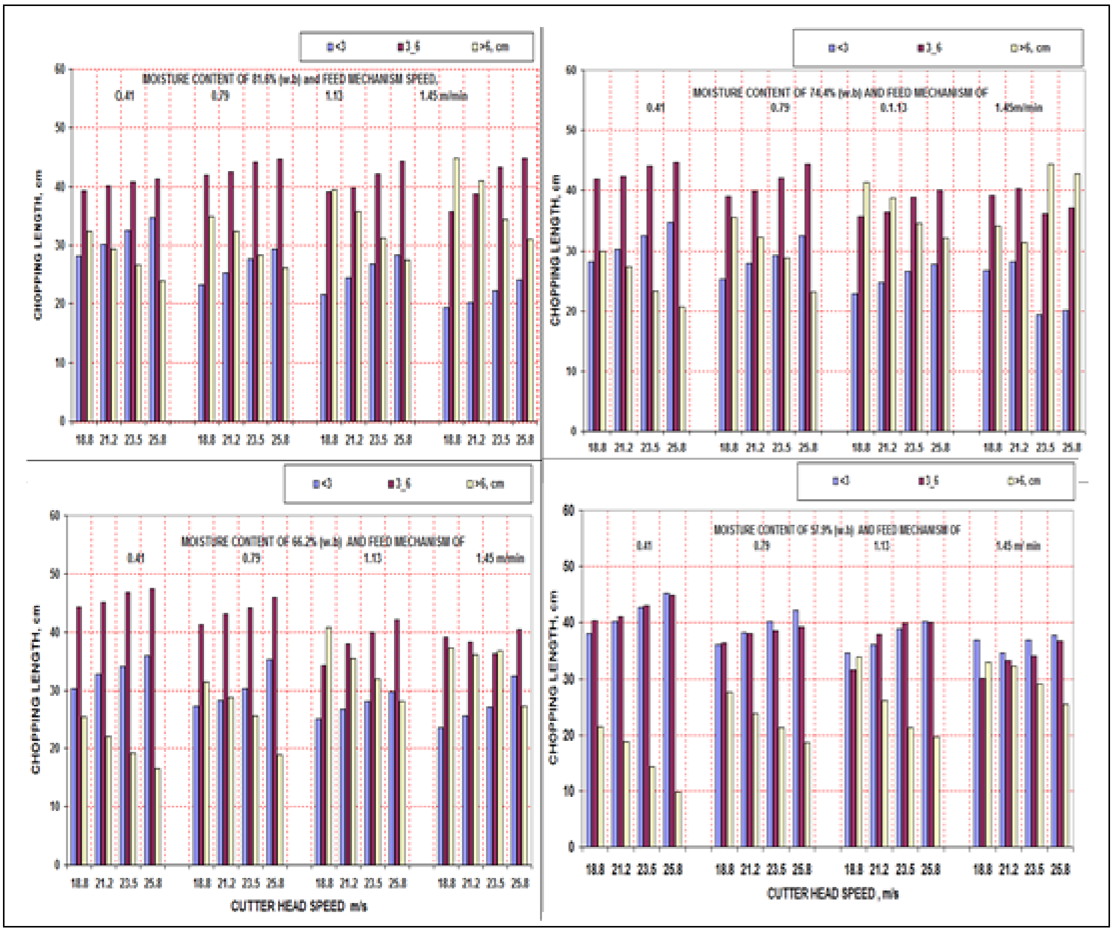


Fig. 4. Effects of tubers moisture content, cutter head speed and feed mechanism speed on chopping lengths of fodder beet tubers.

The results indicate that, increasing cutter head speed or decreasing both of fodder beet tubers moisture content and feed mechanism speed, < 3cm and 3-6cm categories led to increase while > 6cm category was decreased. As it has been known from many previous studies that the cut lengths 3-6 cm are suitable for the work of silage and get the best specifications, percentage of cutting fodder beet tubers lengths of 3 - 6 cm is the best level required. Results noticed that, the highest percentage of cutting fodder beet tubers lengths of <3cm recorded 42.23% at cutter head speed of 25.8m/s, feed mechanism speed of 0.79 m/min and moisture content of 57.9 % w. b. Also, the highest percentage of cutting fodder beet tubers lengths of 3-6 cm of 47.52 % recorded at cutter head speed of 25.8 m/s, feed mechanism speed of 0.41 m/min and moisture content of 66.2 %. And the highest percentage of > 6 cm category of 44.83 % obtained under cutter head speed of 18.8m/s, feed mechanism of 1.45 m/min and moisture content of 81.6 % w. b. While, the minimum percentage of cutting fodder beet tubers lengths < 3cm of 19.37 % recorded at cutter head speed of 18.8m/s, feed mechanism speed of 1.45 m/min and moisture content of 81.6 % w. b. And the minimum percentage of cutting fodder beet tubers lengths of 3-6 cm of 30.11 % recorded at cutter head speed of 18.8 m/s, feed mechanism speed of 1.45 m/min and moisture content of 57.9 % w. b. Also the minimum percentage of > 6cm category of 9.87 % recorded at cutter head speed of 25.8 m/s, feed mechanism speed of 0.41 m/min and moisture content of 57.9 % w. b.

Actual machine capacity and machine efficiency:

From Fig. 5 results indicated that, actual machine capacity was increased with increasing both of cutter head speed and feed mechanism speed. While, it was increase with decreasing of moisture content levels at all experiment points**.** Results also noticed that, the maximum actual capacity value of 3.412 Mg/h recorded at moisture content of 57.9% w. b., cutter head speed of 25.8 m/s. and feed mechanism of 1.45 m/min. While, the minimum actual capacity value of 1.174 Mg/h recorded at moisture content of 81.6% w. b., cutter head speed of 18.80 m/s. and feed mechanism of 0.41 m/min respectively. On other hand, Fig.6 illustrated that modified forage chopper machine efficiency was increased with increasing of cutter head speed from 18.8 to 23.50 m/s, but it was decreased with cutter heads speed of 25.8 m/s. also, it was increased with increasing of feed mechanism speed at all experimental points. Also, it was increased with decreasing beet tubers moisture content. Generally, results noticed that the maximum modified forage chopper machine efficiency value of 88.41% recorded at moisture content of 57.9% w. b., cutter head speed of 25.8 m/s. and feed mechanism of 1.45 m/min. While, the minimum modified forage chopper machine efficiency value of 64.61% recorded at moisture content of 81.6% w. b., cutter head speed of 18.80 m/s. and feed mechanism of 0.41 m/min respectively.

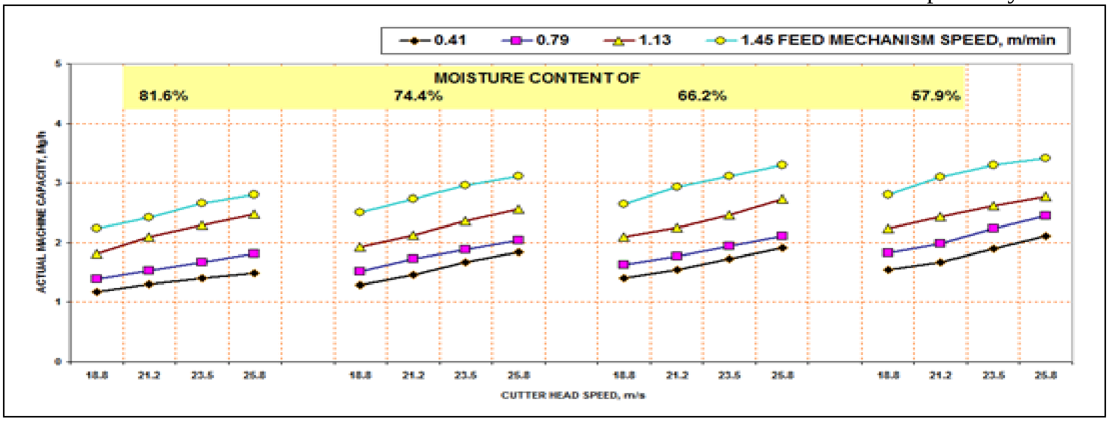


Fig. 5. Effects of tubers moisture content, cutter head speed and feed mechanism speed on actual machine capacity at chopping fodder beet tubers.

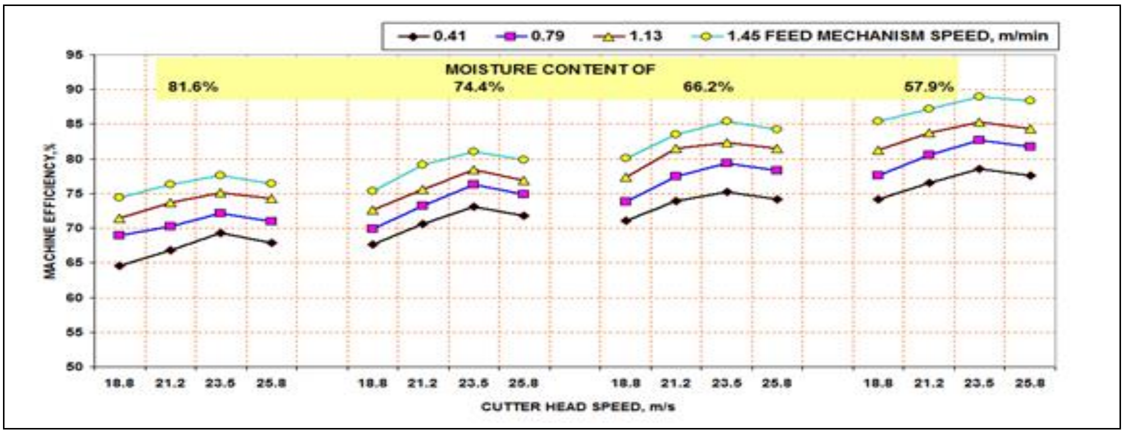


Fig. 6. Effects of tubers moisture content, cutter head speed and feed mechanism speed on machine efficiency at chopping fodder beet tubers.

Total beet tubers losses:

Total chopping losses are considered the efficacious indication during investigating the performance of small forage chopper machine. Results in Fig. 7 show that, total losses of modified forage chopper machine were increased by increasing both of cutter head speed and feed mechanism speed or decreasing of fodder beet tubers moisture content. So, results show that total losses increased from 7.65 to 10.34% at increase of feed mechanism speed from 0.41 to 1.45 m/min under cutter head speed of 18.8 m/s and moisture content of 81.6% w. b. Also, total losses are increased from 7.65 to 9.56% at increase of cutter head speed from 18.8 to 25.8m/s under feed mechanism speed of 0.41 m/min and moisture content of 81.6% w. b. Also, It was decreased from 7.65 to 11.43% at increase moisture content of 81.6 to 57.9% w. b. under cutter head speed of 18.8 m/s and feed mechanism speed of 0.41 m/min, respectively.

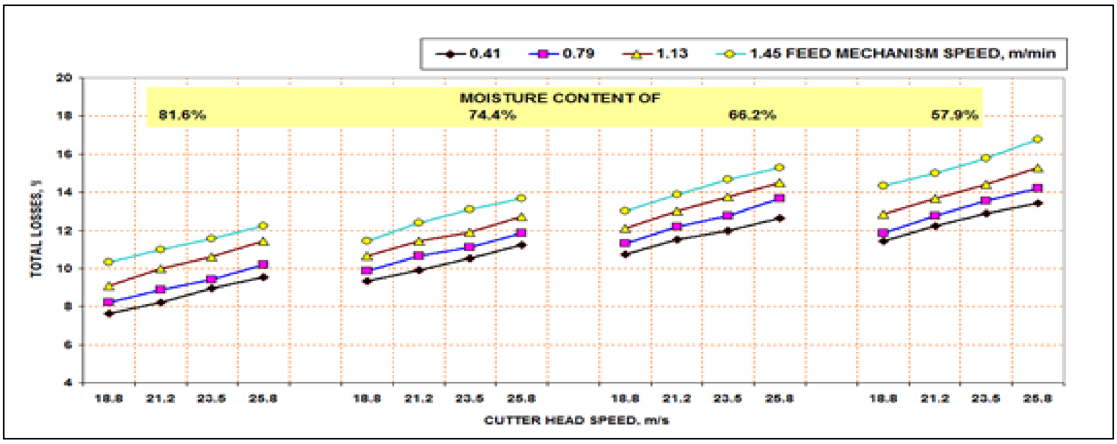


Fig.7. Effects of tubers moisture content, cutter head speed and feed mechanism speed on total losses at chopping fodder beet tubers.

Specific energy:

Fig. 8 illustrated that specific energy required was increase with increasing of cutter head speed. This results because several of the energy components are proportional to the square or cube of the speed (Kepner, *et al*., 1982). While, specific energy required was decreased with increasing of feed mechanism speed and with decreasing moisture content at all experimental levels. It was evident that, the increment in feed mechanism speed from 0.41 to 1.45 m/min decreases the specific energy from 1.211 to 0.767 kW.h/Mg at cutter head speed of 18.8 m/s and fodder beet tuber moisture content of 57.9%, respectively. Also, it was decreased from 1.604 to 1.211 kW.h/Mg at cutter head speed of 18.8 m/h and feed mechanism speed of 0.41m/min with decreasing moisture content from 81.6 to 57.9% w. b., respectively. Also, it was decreased from 1.604 to 1.114 kW.h/Mg at increase feed mechanism speed from 0.41 to 1.45 m/min with cutter head speed of 18.8 m/s and moisture content of 81.6% w. b., respectively. Results noticed also that, maximum of specific energy value of 2.661 kW.h/Mg, recorded at moisture content of 81.6% w.b, cutter head speed of 25.8 m/s, and feed mechanism speed of 0.41 m/min. While, minimum of specific energy value was 0.767 kW.h/Mg recorded tubers moisture content of 57.9% w. b, cutter head speed of 18.80 m/s. and feed mechanism of 1.45 m/min respectively.

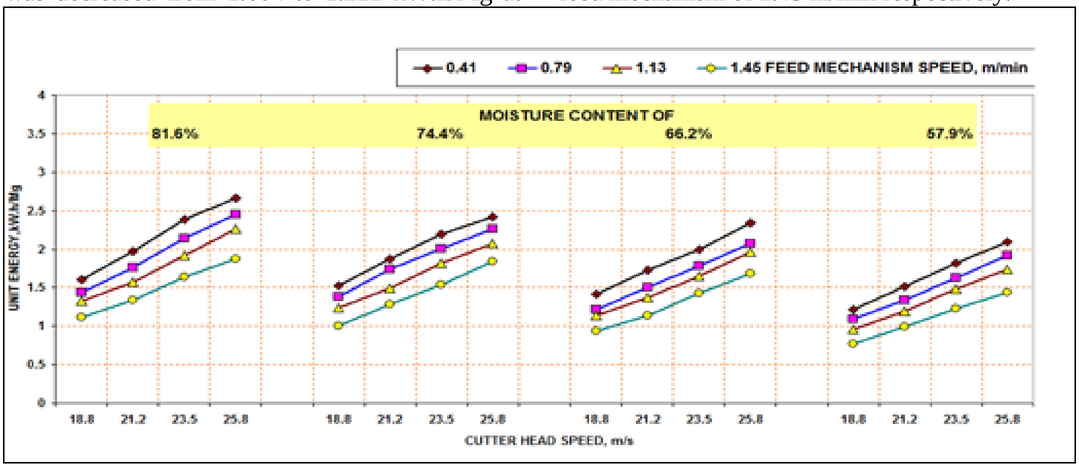


Fig. 8. Effects of tubers moisture content, cutter head speed and feed mechanism speed on specific energy at chopping fodder beet tubers.

Losses cost:

It is found that, losses cost is increased with increasing both of cutter head speed and feed mechanism speed and decreasing moisture content (Fig. 9). So, the minimum losses cost value of 35.92 LE/h recorded under cutter head speed of 18.8 m/s, feed mechanism speed of 0.41 m/min and tubers moisture content of 81.6 % w. b. While, maximum losses cost value was 235.58 L.E/h recorded under cutter head speed of 25.8 m/s, feed mechanism speed of 1.45m/min and fodder beet tubers moisture content of 57.9 % w. b.

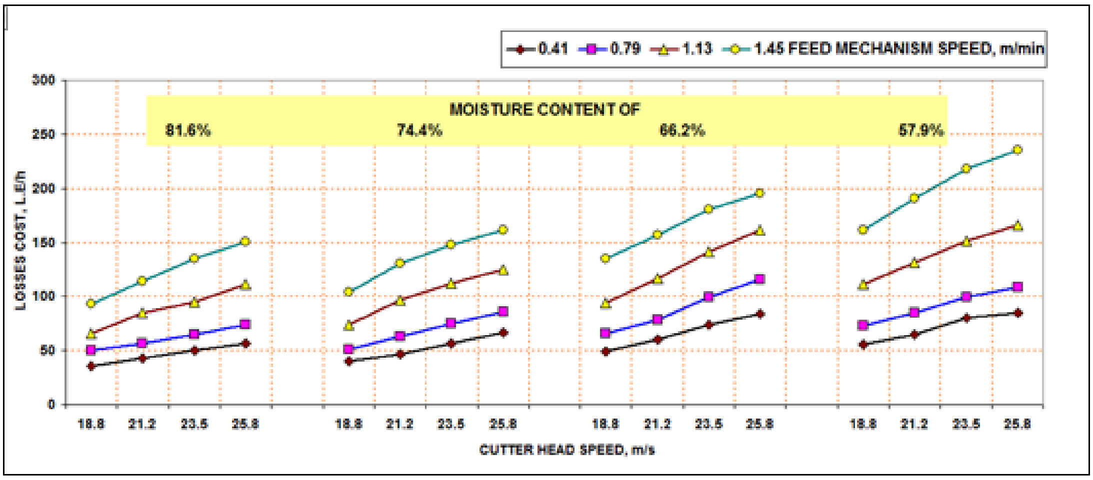


Fig. 9. Effects of tubers moisture content, cutter head speed and feed mechanism speed on losses cost at chopping fodder beet tubers.

Operating cost and Criterion function cost:

Fig. 10 illustrate that, operating cost is decreased with increasing both of cutter head speed and feed mechanism speed. Also, it was decreased with decreasing fodder beet tubers moisture content. Where the lowest value of operating cost was 73.82 L.E/h recorded using cutter head speed of 25.8 m/s, feed mechanism speed of 1.45 m/min and fodder beet tubers moisture content of 57.9 % w. b. While, maximum value of operating cost of 104.52 L.E/h recorded with cutter head speed of 18.80 m/s, feed mechanism speed of 0.41 m/min and tubers moisture content of 81.6 % w. b., respectively. On the other hand, Fig. 9 noticed also that, criterion function cost was increased with increasing both of cutter head speed and feed mechanism speed and it was increased with decreasing of fodder beet tubers moisture content. Results told that, the lowest value of criterion function cost of 134.71 LE/h records at cutter head speed of 18.8 m/s, feed mechanism speed of 0.41 m/min and tubers moisture content of 81.6% w. b. And maximum value of criterion function cost of 300.41L.E/h recorded with cutter head speed of 25.8m/s, feed mechanism speed of 1.45m/min and tubers moisture content of 57.9% w. b. Also through the intersection curves between criterion function cost and operating cost, it can determine the optimum point for the machine operation, which is then the least amount of criterion function cost and operating cost and through Fig.10. The optimum operation condition point for cutting fodder beet tubers at cutter head speed of 23.5 m/s, feed mechanism speed of 1.13m/min and fodder beet tubers moisture content of 74.4% w.b., respectively.

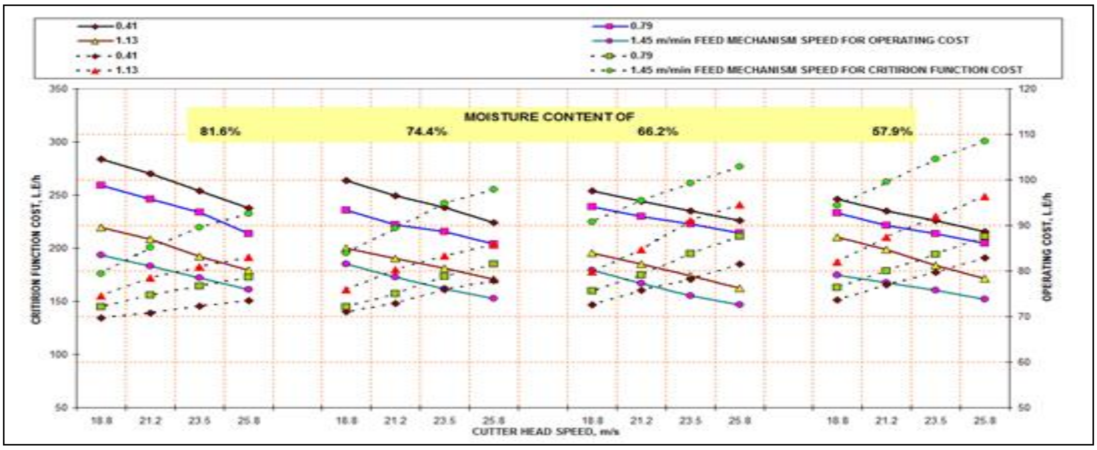


Fig. 10 . Effects of tubers moisture content, cutter head speed and feed mechanism speed on operating cost and criterion function cost at chopping fodder beet tubers.

Fodder beet silage:

For the possibility of evacuation of the ground and because the fodder beet is vulnerable to damage when storage. Keeping it in silage was a good technique. The following steps were followed:

A- Thrones are separated from the roots (lack of separation hinders the work of cutting machines later).

B- Fodder beet leaves for two weeks on a thick mattress of coarse materials (hay - firewood - straw) so as not to contaminate the soil and to absorb the resulting juicer.The place must be well ventilated shaded and left until the required humidity

C- Fodder beet cut with a modified mincing machine and mix beets chopped sticks and corn cobs minced by 150 kg / ton fodder beet, in order to increase the proportion of dry matter and to absorb the juice produced from fodder beet.

D- To increase the proportion of protein in the silage was added urea by 5 kg / ton fodder beet was dissolved in a quantity of water and spray the solution regularly on the fodder beet cut.

E- Due to the speed of fermentation of beet sugars was accelerating the completion of filling and cover the pile with plastic and then a good layer of soil (about 30 cm) and then pressed well.

F- It was making 3-2 slots in each wall of the pile open when necessary to drain excess juice when the proportion of moisture exceeds the appropriate limit. To be closed those openings after the full drainage of this juice

It has been possible to obtain good quality silage characterized by the following:

1- The percentage of ammonia is about 8% evidence that the silage is good and the reactions are done in a good way.
2- The degree of PH was in the range of 3.6 - 4 and is ideal for silage.
3- The quality of silage was judged by understanding the relationship between the ratio of lactic acid relative to other organic acids.
4- The color of the silage is close to the natural color of the material green or light brown, which gave an indication of the quality of silage
5- Silage was judged to be good by keeping the leaves and stems in good condition
6- There were slight traces of butyric acid and the smell of ammonia, which gave an indication of the quality of silage.

CONCLUSION

From the above results the following conclusions are derived:

1- The optimum conditions operation of modified forage chopper machine at determined as follows: at cutting fodder beet tubers was at cutter head speed of 23.5m/s, feed mechanism speed of 1.13m/min and tubers moisture content of 74.4% w. b. under using swinging knives.
2- The increments in cutter head and feed mechanism speeds tend to increase the actual capacity and efficiency of stationary chopper. The maximum values of actual capacity and efficiency were 3.412 Mg/h and 88.41% at fodder beet tubers moisture content of 57.9% w.b, feed mechanism speed of 1.45 m/min and cutter head speeds of 25.8 m/s, respectively.
3- The results illustrated that the maximum value of chopping length category 3-6 mm suit for silage was recorded at tubers moisture content of 66.2%, cutter head and feed mechanism speeds of 25.8m/s and 0.41 m/min, respectively.
4- From the energy point of view it can be stated that, the highest value of unit energy was 2.661kW.h/Mg at fodder beet tubers moisture content of 81.6% w.b, cutter head speed of 25.8m/s and feed mechanism speeds of 0.41 m/min, respectively. However, the lowest value was 0.767 kW.h/Mg recorded at tubers moisture content of 57.9% w.b, cutter head speed of 18.8 m/s and feed mechanism speeds of 1.45 m/min, respectively.
5- Minimum value of total losses was 7.65% and minimum value of losses cost was 35.92L.E/h recorded at tubers moisture content of 81.6% w.b., cutter head speed of 18.8m/s and feed mechanism of 0.41 m/min, respectively.
6- Minimum value of operating cost was 73.82L.E/h recorded at cutter head speed of 25.8m/s, feed mechanism speed of 1.45m/min and tubers moisture content of 57.9% w.b. While, minimum value of criterion function cost for cutting fodder beet tubers was 134.71 L.E/h, recorded at cutter head speed of 18.80m/s, feed mechanism speed of 0.41 m/min and tubers moisture content of 81.6% w.b.
7- Previous results noticed that, swinging knives suit for cutting fodder beet tubers for silage category 3-6 cm. Also, it is evident that, the ultimate analysis of the constituents of corn gave good quality silage for all treatments.

REFERENCES

Abdel-Halim,M.A.(1998). Studies on cattle production Nutritional Studies on the use of sugar beet by products in feeding lactating Cows. Mansoura Univ. Ph.D.

Aky ld z, A. R. 1983**.** Yemler Bilgisi ve Teknolojisi. Ankara Üniv. Zir.Fak. No: 868. Ankara.

ASHRAE (1999). ASHRAE handbook, heating, ventilating and air conditioning applications, inc. SI Edition.

Braunsteiner W., Kubadinow N., Hollaus F. (1983): Beiträge zur Aufklärung mikrobio- logischer und chemischer Zusammenhänge bei der Pressschnitzelsilierung. 2. Mitteilung: Untersuchungen über die Ursachen des Structurrverlustes silierter Pressschnitzel bei langerer Warmeeinwirkung. Zuckerindustrie, 108, 1138–1144.

Culpin, C. (1981). Farm machinery. Silage making and feeding. Crosby lokwood staples, London, 10 th ed. pp: 180-196.

Elfatih A.; E. M. Arif, and A. E. Atef (2010). Evaluate the Modified Chopper for Rice Straw Composting. Journal of Applied Sciences Research, 6(8): 1125-1131.

FAOSTAT. (2014). FAO Statistical Yearbook. Agricultural production.

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.

Hunt, D. (1984). Farm Power and Machinery Management. 8th ed., Iowa State Univ. Press, Ames., USA: 59-71.

Hussein, A.E. ;A.O EL-Ashhab and M.A.Ali (2004). Studying some mechanical factors affecting chopping sugar beet tubers into silage.Misr J.Ag.Eng.,21(3):900-914.

Kassab, O. M., S. A. Orabi, and A. A. Abo Ellil. 2012. Physiological response to potassium application in fodder beet plant grown under water stress. Australian Journal of Basic and Applied Sciences, 6 (13): 566-574.

Kepner, R.A.; R. Bainer and E.L. Barger, (1982). Principles of farm machinery third edition, third reprint, the AVI Publishing Company, Inc. USA.

Khader, S. S. (1997). Development af a simple chopper system using the field wastes in small farms. PhD Thesis, Agric. Eng. Dept., Fac. of Ag., Zagazig Univ.

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

Lockwood, F. B. and R. Dunstan (1971). Electric engineering principles. Meinemann Educational Books, L-td, London.

Luis, F. D.; G. M. savage; L. L. Eggerth and G. G. Clarence (1993). Composting and recycling municipal solid waste Lewis pup.,London p.: 121-175.

Mady, M. A. (1999). Developing a manual cutting machine suitable for mechanical cutting stalks. Misr J. Ag. Eng.,16(3): 449-459

Niazi, B. H., J. Rozema, R. A. Broekman and M. Salim. (2000). Dynamics of growth and water relations of fodder beet and sea beet in response to salinity. *J Agron Crop Sci.* 184:101-109.

Papa G.S.F., Grazia L. (1987): Pectolytic clostridia isolated from sugar beet pulp silages in Italy. J. Appl. Bacteriol., 63, 481–485.

Przybyt, J.; N. Mioduszewska; D. Wojcieszak; K. Durczak and E. Ozanska (2013). Method of external assessment of the quality of sugar beet r oots. Polish Society of Agricultural Engineering. 4(148). 113-125.

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.

Zhang,M.; M.L.Sword: D.R.Buckmaster,and G.R.Cuffman (2003). Design and Evaluation of A Corn Silage Harvester Using Shredding and Flail Cutting. Trans. ASAE, 46(6):1503-1511.

تقييم أداء آلة صغيرة لتقطيع درنات بنجر العلف

محمد عبد الله إبراهيم حسن
معهد بحوث الهندسة الزراعية ـ مركز البحوث الزراعية ـ الجيزة – مصر

نظرا لنقص الموارد العلفية في مصر خصوصا في فصل الصيف فانة يجب حفظ و تحويل بعض محاصيل الاعلاف و بعض المخلفات الزراعية الى صورة تصلح كعلف للحيوان أو إعادة استخدامها كسماد عضوي وذلك عن طريق فرمها أو تقطيعها إلى أجزاء صغيرة ثم حفظها في صورة سيلاج لإعادة استخدامها في تغذية الحيوان خلال فصل الصيف يعتبر السيلاج أحد طرق حفظ الأعلاف تحت ظروف لا هوائية في بداية مرحلة التخزين . ذلك كان الهدف من الدراسة هو تطوير آلة فرم صغيرة بتصميم و تصنيع درفيل لفرم درنات بنجر العلف كان يتكون من اسطوانة معدنية بقطر50 سم مركب على محيطها الخارجي عدد ثمانية سكاكين تقطيع بوضع مائل بزاوية 129° و هذه السكاكين كان لها شفرات حادة بزاوية ميل 22°و كانت السكاكين بعرض5. 12سم و طول10سم وقد تم تثبيت عوارض على محيط الاسطوانة لتثبيت السكاكين عليها .وايضا تم تثبيت عدد شفرات على شكل حرف Uعند مدخل و مخرج اسطوانة الفرم. وتم استبدال غربال الالة بتجويف مصقول لزيادة طرد المواد المفرومة لخارج الالة . وتم تركيب عوارض صغيرة في اتجاه خروج المواد المفرومة بأبعاد 8X3سم على التجويف المصقول لزيادة فعل الفرم والتقطيع و توجيهه المادة المفرومة لخارج الالة . وذلك للاستفادة من الالة في فرم بنجر العلف و الاستفادة منهما في صناعة الأعلاف غير التقليدية و بعض الصناعات الأخرى. وكانت المعاملات التجريبية للدراسة على النحو التالي:المحتوى الرطوبى للدرنات: يتم إجراء الدراسة عند اربعة مستويات رطوبية كانت 81،6 , 74،4 , 66،2 , 57،9 % على التوالي وعلى أساس رطب.سرعة دوران اسطوانة التقطيع: يتم إجراء الدراسة عند أربعة سرعات هي 18،8 , 21،2 , 23،5 , 25،8 م/ث.سرعة جهاز التلقيم : حيث يتم إجراء الدراسة عند اربعة سرعات هي 0،41 , 0،79 , 1،13 , 1،45 م/ د .وكذلك دراسة مدى تأثير تلك العوامل على الصفات التالية: النسب المئوية لأطوال القطع ,% ، كفاءة التقطيع,% ، السعة, ميجاجرام/ساعة. ، تقدير الطاقة المستهلكة ، نسبة فاقد التقطيع, % ، تكاليف التشغيل, جنية/ساعة ، تقدير الدالة المعيارية للتكاليف , جنية/ساعة ويمكن تلخيص النتائج المتحصل عليها كما يلي:- الظروف المثلى لتشغيل ماكينة تقطيع بنجر العلف المطورة كانت على النحو التالي: عند قطع الدرنات باستخدام سرعة دوران اسطوانة التقطيع 23.5 م / ث ، وسرعة جهاز التلقيم و التغذية 1.13 م / دقيقة ومحتوى رطوبة الدرنات 74.4٪ (على اساس رطب) تحت استخدام السكاكين المائلة حادة الشفرات بزاوية 22°. ادت الزيادة في سرعة دوران اسطوانة التقطيع وسرعة جهاز التلقيم إلى زيادة السعة الانتاجية وكفاءة الفرم للألة .و كانت القيم القصوى للسعة والكفاءة الفعلية هي 3.412 ميجا جرام/ ساعة و 88.41٪ عند محتوى رطوبى لدرنات بنجر العلف 57.9٪ (على اساس رطب)، وسرعة جهاز التلقيم 1.45 م / دقيقة وسرعة دوران اسطوانة التقطيع 25.8 م / ث ، على الترتيب . أظهرت النتائج أن القيمة القصوى لفئة طول التقطيع 3-6 سم المناسب لعمل السيلاج تم تسجيلها في محتوى رطوبة الدرنات بنسبة 66.2 ٪ (على اساس رطب) وسرعة دوران اسطوانة التقطيع 25.8 م / ث وسرعة جهاز التلقيم 0.79 م / دقيقة ، على التوالي . أعلى قيمة لوحدة الطاقة كانت 2.661 كيلو وات. ساعة/ ميجا جرام في محتوى رطوبى لدرنات بنجر العلف بنسبة 81.6 ٪ (على اساس رطب) وسرعة دوران اسطوانة التقطيع 25.8 م/ث وسرعة جهاز التلقيم 0.41 م / دقيقة، على التوالي. ومع ذلك، فأن أدنى قيمة لوحدة الطاقة كانت 0.767 كيلو وات . ساعة/ميجا جرام سجلت عند محتوى رطوبى للدرنات 57.9 ٪ (على اساس رطب) ، وسرعة دوران اسطوانة التقطيع 18.8 م / ث وسرعة جهاز التلقيم 1.45 م / دقيقة ، على الترتيب. كانت اقل قيمة للفاقد الكلي 7.65٪ واقل قيمة لتكاليف الفقد 35.92 جنية / ساعة سجلت عند محتوى رطوبى للدرنات 81.6٪ (على اساس رطب) وسرعة دوران اسطوانة التقطيع 18.8 م / ث وسرعة جهاز التلقيم 0.41 م / دقيقة ، على الترتيب. كانت القيمة الاقل لتكاليف التشغيل 73.82جنية /ساعة عند وسرعة دوران اسطوانة التقطيع 25.8 م/ث وسرعة جهاز التلقيم 1.45م/د ومحتوى رطوبة الدرنات بنسبة 57.9 ٪ (على اساس رطب). في حين أن الحد الأدنى لقيمة تكلفة الدالة المعيارية لتكاليف فرم درنات بنجر العلف كان 134.71 جنية /ساعة وذلك عند وسرعة دوران اسطوانة التقطيع 18.80 م / ث ، وسرعة جهاز التلقيم 0.41 م / دقيقة و محتوى رطوبة الدرنات 81.6٪ بالوزن الرطب. لاحظت النتائج السابقة أن سكاكين المائلة حادة الشفرات تناسب تقطيع و فرم درنات بنجر العلف للفئة الطول 3-6 سم. التى تناسب اجراء عمل السيلاج عالي الجودة . و قد تم عمل سيلاج من نتائج الفرم بعد الخلط بنسبة من الذرة المفرومة لرفع معدل النشويات و البروتين و قد كان واضحا من التحليل النهائي لمكونات سيلاج خليط الذرة و بنجر العلف أعطى سيلاج عالي الجودة لجميع المعالجات.