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THE ENERGY MINIMIZATION AND THE COST REQUIREMENTS FOR THE POTATO RESIDUES REPROCESSING

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Abstract

Field crop residues have become an urgent problem for the Egyptian farmer. Total cultivated area with this crop in Egypt, 189,000 hectare and the estimated quantity of haulm potatoes is about 1,575 Tg with an average of 8.3 Mg/hectare of haulm potato. Varied techniques were used for cutting waste of field crop, and the mechanical shredder residue for handling and use of these wastes were analyzed in order to reduce the size of the waste molecules to fit the various aspects of its uses. To optimize the operating parameters of the performance of farm residues it was used the cutting machine and it was established the minimum cost, power and energy requirements for produce animal feed raw materials from potato haulme. The performance of the machine units was measured under the following parameters four levels of drum speed of 25.13, 30.14, 35.17 and 40.19 m/s (1,000, 1,200, 1,400, and 1,600 rpm), three feed rates of 600, 800, 1000 kg/h, two number of knives on the cutting cylinder from (68 to 48). The performance of the cutting machine unite was taking into consideration machinery productivity, percentages of softness degree, cutting efficiency, fuel consumption, power, energy, and cost analysis. The optimum results and parameters for cutting machine untie when using drum speed 1,600 rpm, 1,000 kg /h feeding rates, and 68 number of knives.0.985 Mg/h productivity, 19,123 kW power, 19,414 kW.h/Mg energy, 6,046 l/h fuel consumption, 99 % cutting efficiency, 85% percentages of softness degree, and 9,850 l.E/h cost analysis.

Key words*: cost, energy requirements, field crop, minimize, residues*

INTRODUCTION

Field crop residues are a problem still facing the Egyptian farms, especially after the harvesting of field crops. It is estimated of about 18-25 Tg per year. The estimated area of potatoes crop in Egypt about From grown potato crop through three lugs (Winter - Summer - Indigo) which produced about 2 Tg of potatoes haulm **(Central Administration for Agricultural Economics, Ministry of Agriculture and Land Reclamation, Egypt 2015).**

The quantities of crop residues in Egypt are estimated about 18.7 million ton/year, 53 % of which (9.91 million ton) are directly burned. Also they mentioned that burning of cotton residues (1.24 million ton/year) causes a loss of 532,000 equivalent ton of hydrocarbon fuel (1,806 million LE). (based on mean yield of 0.43 ton/fed).[1]

The different machine reciprocating mowers rotary mower, shredder and cutting machine some field crops. Machine performance was evaluated in storms of field capacity, cutting height, cutting energy and optioned cost. frame residues.[5]

Developing of the performance of cutting knives in crop residues shredder. The maximum percentage of < 2 cm cutting length of 94.0 % and 93.3 % were obtained at cutting peed of 1,500 rpm and moisture content of 30% and 22.0 % (w.b) for cotton stalks and rice straw respectively, the minimum value of useful power 1.10 KW and 1.0 KW were obtained at cutting speed of 900 rpm and moisture content of 30 % and 22.0 % for cotton stalk and rice straw respectively. The unit energy from (0.85& 1.50 kW.h/Mg) to (0.80 & 1.40 KW.h/Mg) with machine after modification at moisture content of 30.0 % and 22.0 % (w.b.) for cotton stalks and rice straw, respectively.[2]

A compatible unit to produce Rabbit feed pellets formula from black seed meal residues in one operation The compatible was

evaluated under operating parameters including four different retention time and four L/D ratio The optimum results compatible unit were die L/D ratio of 5.5:1, 3.5min of mixing retention time, and rollers teeth width of 10mm. give 427.87 kg/h production rate 37.96 kW.h/ton energy requirement.88.29% mixing efficiency, 0.671gm /cm^3 bulk density, 93.21% durability, 49.01N hardiness, and 566.36 LE/ton using residues formulation [3]

Minimize energy and costs in weeding and fertilizing processes for fiber crops in small farms. The experiment results reveled that the manufactured machine decreased energy and increased effective field capacity and efficiency under using speed 2.2 Kmlh at soil moisture content average 20%.[4]

The aims of this study were to remove the potatoes crop residues especially after harvesting and prepare, evaluate the performance of cutting machine to produce raw materials for animal feed and optimize the operating parameters to minimize cost, power and energy requirements

MATERIALS AND METHODS

The main experiments were carried out at the Experimental Farm of Agricultural Research Station, Gharbia Governorate during of 2013-2014 seasons to test and evaluate the performance of cutting machine of potatoes haulm under Egyptian conditions.

Potato Scientific Name**:** *Solanum Tuberosum***.**

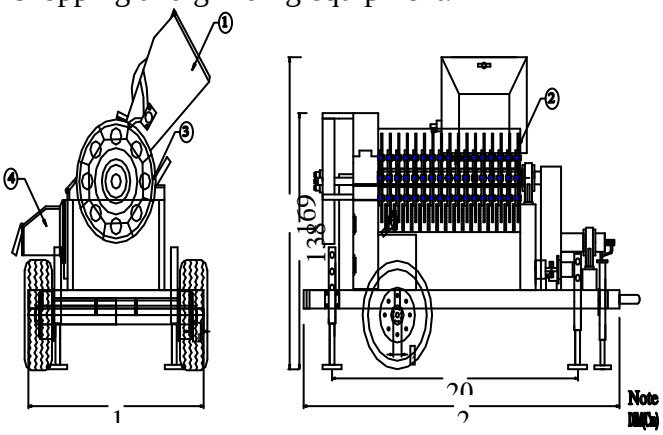
Haulm of potato: was used as raw materials to produces animal feed after drying and cutting as showing in Fig.1.

Fig. 1. Potato haulm Before and after drying from 24-12% moisture content(w.b)

Root Cross: Root cross graduated in groups arise in part on the bottom surface of the soil from the stalk these rooted in thirty stomata top of the soil.

Machine: Source of power using 35 hp.

Fig.2 illustrated the specific at mm and dimensions of the main components of chopping and grinding equipment.



1- Feeding orifice. 2- Knife. 3- Drum. 4- Excite gate.

Fig. 2. Side view and elevation view of chopping and grinding equipment.

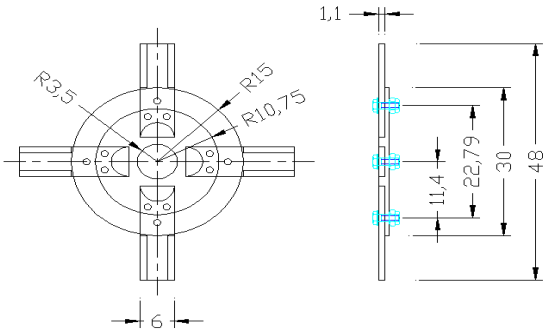


Fig. 3. The type of knives of chopping and grinding equipment.

The experiment was carried to evaluate the performance of cutting machine and optimize the operating parameters during cutting processes.

Experimental Procedures: The engineering variables were used:

- Drum speeds of 25.12, 30.14, 35.17, and 40.19 m/s (1,000, 1,200, 1,400 and 1,600 rpm).
- Feed rate of 600, 800, and 1,000 kg/h.
- Number of knives 48 and 68.

Measurements:

Evaluation of cutting machine performance taking into consideration the following

indicators.

-Percentage of Softness Degree:

Crop residues were used as a raw material for producing animal feed, the crop residues drayed by sun for 3 day. Before using to less the 23% moisture with 12%. Six sieves mechanical analysis of square openings of 1.4, 3, 3.35, 3.75, 7, and 10 mm.

-Determination of productivity (Mg/h):

Machine productivity was determined by the following equation:

$$\mathbf{M_p} = w_s/t \qquad kg/h$$

Where:

M_p : machine productivity , kg/h,

W_s : machine Raw materials out let, kg

T : time consumed to cutting samples, h.

-Cutting Efficiency (%):

Cutting efficiency were estimated using the following equation:

$$\zeta = w_s / w_t \times 100$$

Where :

ζ: cutting efficiency %.,

W_s : machine Raw materials out let, kg.

W_t: mass of input delivered to cutting unit kg .

Energy requirement (kW.h/kg):

Energy regalement may be calculated by using the following equation:

Energy=power consumed /productivity

-Cost Analysis:

Total Hourly cast (THC) may be calculated as following**:**

THC = (p/h) (l/a + l/2 + t + r) + (1.2 ×w ×s × f) + m/144 Where:

THC = Total Hourly cost, LE/h,

P = Purchase price of machine, LE,

h = Working hours per year, h/yr,

a = Expected machine life, years.

i = interest rate,(10%), t = taxes (3%)

r = repair and maintenance ratio (5%).

w = power, kW, f = fuel price, LE/l,

s = specific fuel consumption, l/kW.h,

m = operator monthly salary, LE, 1.2 is a factor to take care of oils, grease, etc.

144 = is operation hours per month.

RESULTS AND DISCUSSIONS

Effect of drum speed, feeding rate and number of knifes on the percentage of softness degree:

The data illustrated in Fig. 4 indicated that increasing drum speed and feeding rate decreasing the percentage of softness degree. When reduced knifes about 48 and 600 kg/h feeding rate), and drum speed at 1,000 rpm,

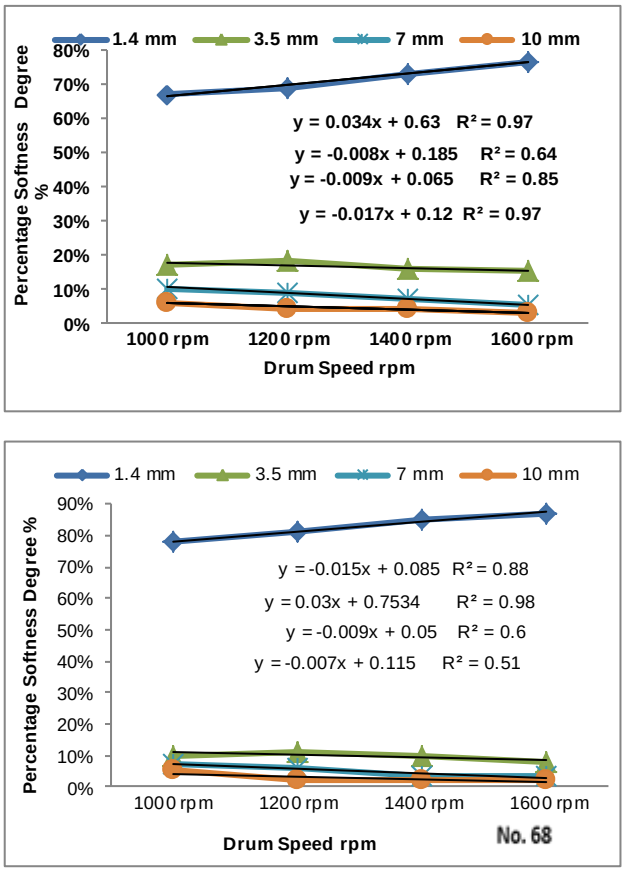


Fig. 4. Effect of drum speed and number of knifes (48 and 68 respectively) on the percentage of softness degree at constant feeding rate about 600 kg/h.

The percentage of softness degree was decreased from 67, 17, 10, and 6%, with hole of sieves 1.4, 3.5,7 and 10 mm, respectively. Linear regression analysis was performed to identify the relationship percentage of softness degree between drum speed, feeding rate and number of knifes. The results showed positive relations in percentage of softness degree with increasing drum speed, feeding rate and number of knifes.

Effect of drum speed, feeding rate and number of knifes on the machine productivity:

Data illustrated in Fig**.** 5. Results showed that the effect of drum speed on the productivity at 48 number of knifes and 600 kg/h feeding rate, by increasing the drum speed from 1,000 to 1,600 rpm, the machine productivity increased from 0.528 to 0.580 Mg/h, by

increasing the drum speed from 1000, 1200, 1,400 and 1,600 rpm, increase the machine productivity from 0.528, 0.552, 0.558, and 0.580 Mg/h, respectively. While the results showed that the effect of drum speed on the productivity at 68 number of knifes and 600 kg/h feeding rate, by increasing the drum speed from 1,000 to 1,600 rpm, the machine productivity increased from 0.552 to 0.570 Mg/h, by increasing the drum speed from 1000, 1200, 1400 and 1600 rpm, increase the machine productivity from 0.552, 0.558, 0.565, and 0.570 Mg/h, respectively.

Linear regression analysis was performed to identify the relationship productivity between drum speed, feeding rate and number of knives. The results showed positive relations in productivity with increasing drum speed, feeding rate and number of knifes.

Effect of drum speed, feeding rate and number of knifes on the machine cutting efficiency :

The data illustrated in Fig**.** 6 showed that the effect of drum speed on the cutting efficiency at 48 number of knifes and 600 kg/h feeding rate, by increasing the drum speed from 1,000 to 1,600 rpm, the machine cutting efficiency increased from 88 to 97 %, by increasing the drum speed from 1,000, 1,200, 1,400 and 1,600 rpm, increase the machine cutting efficiency from 88, 92, 93, and 97%, respectively. While the results showed that the effect of drum speed on the cutting efficiency at 68 number of knifes and 600 kg/h feeding such as feeding rate and number of knifes 48 to 68 respectively.

rate, by increasing the drum speed from 1,000 to 1,600 rpm, the machine cutting efficiency increased from 92 to 95 %, by increasing the drum speed from 1,000, 1,200, 1,400 and 1,600 rpm, increase the machine cutting efficiency from 92, 93, 94, and 95 %, respectively.

Effect of drum speed, feeding rate and number of knifes on the machine energy requirements:

Results showed in Fig**.** 7 indicated that increasing drum speed and feeding rate increasing the machine energy requirement.

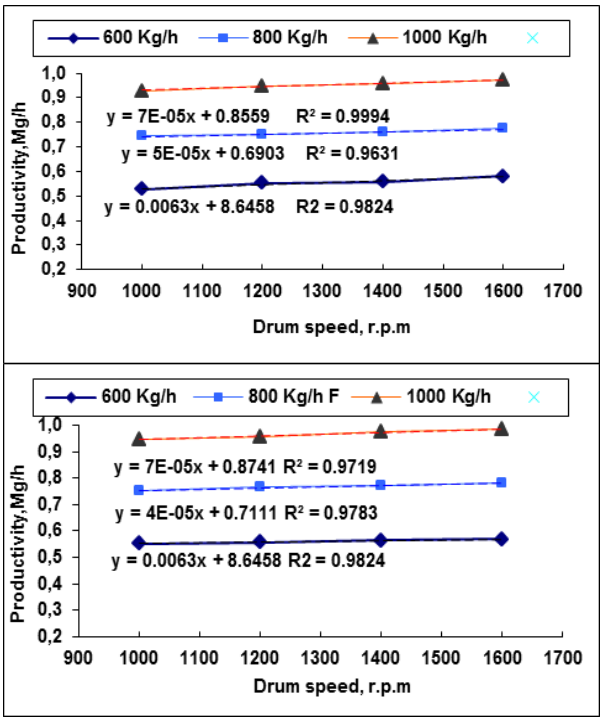


Fig**.** 5. The effect of drum speed on the productivity at 48 number of knifes and 600 kg/h feeding rate.

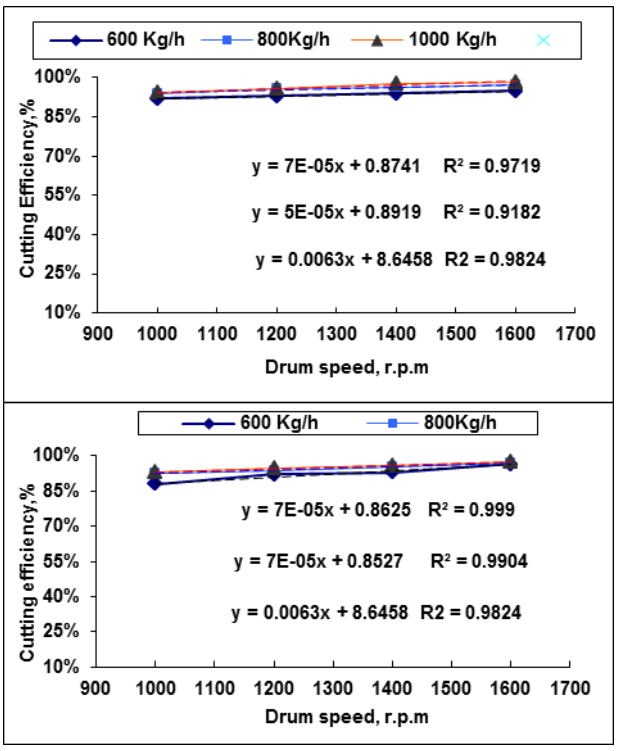


Fig. 6. The effect of drum speed on the machine cutting efficiency , feeding rate and number of knifes 48 to 68 respectively.

Results showed that the effect of drum speed on the energy requirement at 48 number of knifes and 600 kg/h feeding rate, by

increasing the drum speed from 1,000 to 1,600 rpm, the machine energy requirement increased from 26,177 to 31,360 kW.h/Mg, by increasing the drum speed from 1000, 1200, 1,400 and 1,600 rpm, increase the machine energy requirement from 26,177, 28,211, 30,188, and 31,360 kW.h/Mg, respectively.

While the results showed that the effect of drum speed energy requirement at 68 number of knifes and 600 kg/h feeding rate, by increasing the drum speed from 1,000 to 1,600 rpm, the machine energy requirement increased from 26,754 to 32,575 kW.h/Mg, by increasing the drum speed from 1,000, 1,200, 1,400 and 1,600 rpm, increase the machine energy requirement from 26,754, 29,442, 31,261, and 32,575 kW.h/Mg, respectively.

Linear regression analysis was performed to identify the relationship energy requirement between drum speed, feeding rate and number of knives. The results showed positive relations in energy requirement with increasing drum speed, feeding rate and number of knives.

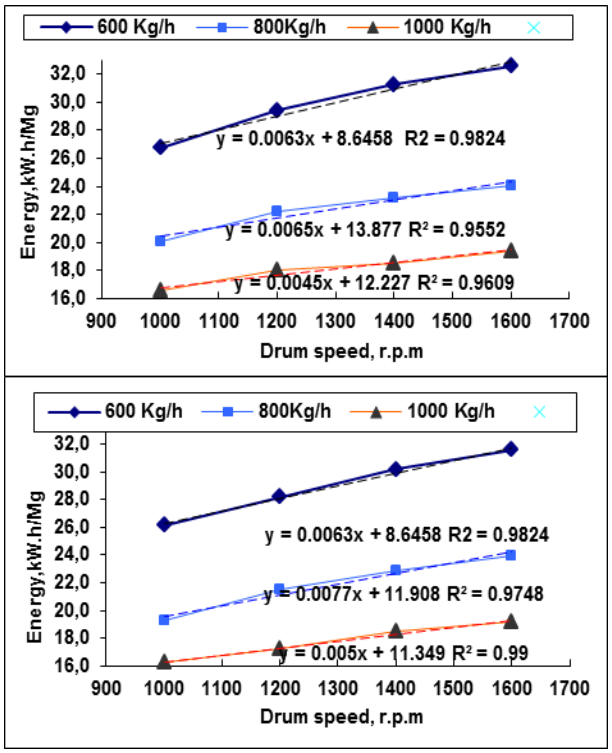


Fig. 7. The effect of drum speed on the machine energy requirement , feeding rate and number of knifes 48 to 68 respectively

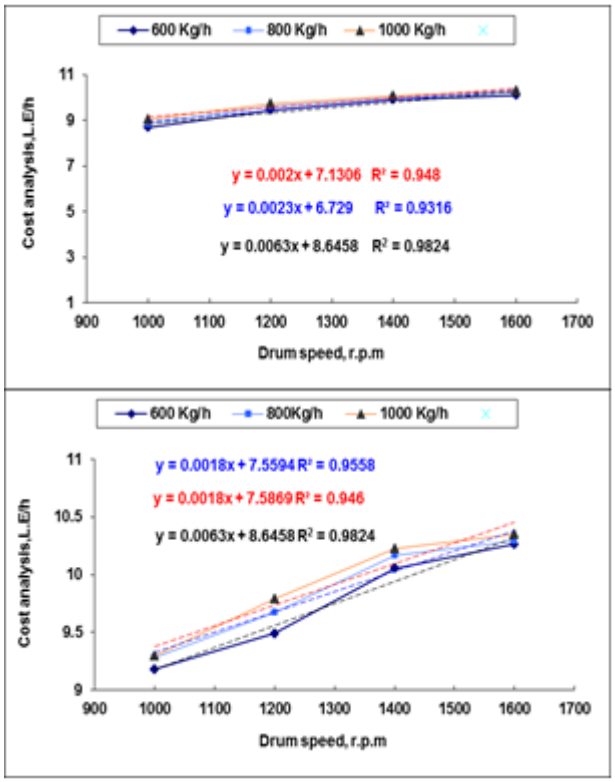


Fig. 8. The effect of drum speed on the machine cost analysis, feeding rate and number of knifes 48 to 68

Effect of drum speed, feeding rate and number of knifes on the machine cost analysis: Results from Fig**.** 8 showed that the effect of drum speed on the cost analysis at 48 number of knifes and 600 kg/h feeding rate, by increasing the drum speed from 1,000 to 1,600 rpm, the machine cost analysis increased from 8,696 to 10,109 L.E/h, by increasing the drum speed from 1,000, 1,200, 1,400 and 1,600 rpm, increase the machine cost analysis from 8,696, 9,453, 9,904, and 10,109 L.E/h, respectively. While the results showed that the effect of drum speed cost analysis at 68 number of knifes and 600 kg/h feeding rate, by increasing the drum speed from 1,000 to 1,600 rpm.

CONCLUSIONS

From this research, we can use the cutting machine after adjusted the machine performance to produce a raw materials from potato haulm as animal feed for different animal (rabets, dotes, crow and buffalo). The optimum data obtained leaded to minimize the cost and energy requirements.

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