

Study of Techno-Economic of Corn Sheller Type MPJ-01-TEP-2014 Design of Study Program Agricultural Engineering, University of Andalas

Mislaini[#], Santosa[#], Widyawati^{*}

[#] Department of Agricultural Engineering, Faculty of Agricultural Technology, Andalas University, Indonesia
E-mail: mislaini_rahman@yahoo.co.id

^{*}Laboratory of Food Processing and Agricultural Products Faculty of Agricultural Technology, Andalas University, Indonesia

Abstract— This study is to evaluate the performance of the machine corn sheller and perform basic cost analysis and break-even point. Sheller was done on three varieties of maize in Padang and surrounding areas. Corn used is corn that has a moisture content (17-20)% with three repetitions. Based on research, capacity sheller machine Maxpro NK 99 varieties obtained 80.49 kg / h with the cost of Rp.120,88 / kg and breakeven 38135.59 kg / year. Pioneer 24 varieties of working capacity of 67.52 kg / h with the basic cost of Rp 114.48 / kg and the breakeven point at 66399.66 kg / year, and the work capacity of NK Maxpro 22 varieties of 55.40 kg / h with a cost of Rp. 139.53 / kg with a breakeven point 40186.26 kg / year.

Keywords— performance evaluation; basic costs; corn sheller capacity; corn sheller machine; the break-even point

I. INTRODUCTION

One of the products that use corn as a food source is the manufacture of animal feed ingredients. Corn is used is corn that has been shelled the water level is much reduced so that the corn becomes harder. Mostly in areas that do not have adequate agricultural machinery, corn sheller process still using human labor. This will take a long time and cost too much more when compared to using a tool such as corn sheller machine.

Corn sheller machine is one of the tools that can be used to speed up the process corn sheller . This is due to the performance of a machine that uses a motor power source has a power far greater than human power. This will improve the quality and quantity of corn shelled save time and labor when compared with shelled manually. For adult women can shoplifting corn by hand 2-9 kg per hour, for sheller type of manual tools (type TPI) can shoplifting corn 12-15 kg / h. Sheller appliance models for car tires can shoplifting corn 20-30 kg / h, for tool shoplifting corn sheller can Serpong approximately 40 kg / h . However, the constraints on the field, mostly corn sheller machine existing still marketed to upper middle industrial scale. This led to the use of corn sheller machine is limited only to the middle to the top alone.

Modifications corn sheller machine that can be used in household scale that can be used by the people of the middle to lower. Machine made of angle steel, cylinder sheller, pulley, and eye cylinder is driven by an electric motor to power the electric motor ½ HP and 1500 rpm. Modified corn sheller machine is named with the MPL-01-TEP-2014 with an effective capacity of 45.50 kg / h [1]. Therefore it is necessary to do research on “Study of Techno-Economic of Corn Sheller Type MPJ-01-TEP-2014 Design of Study Program Agricultural Engineering Program, University of Andalas”.

II. RESEARCH METHODS

A. Time and Location Research

This study was conducted in May-July 2014 Production and Management Laboratory of Agricultural Machinery and Engineering Laboratory of Food and Agricultural Products Processing Technology Faculty of Agriculture, University of Andalas, Padang.

B. Materials and Tools

The materials used are maize varieties Maxpro NK 99, Pioneer 24 and MaxproNK 22, while the tool is needed that corn sheller machine, scales, grand moisture taster, stopwatch, tachometer, sound level meter, AC/DC Clamp Meter and tarpaulins

C. Research Procedure

Corn cobs have been harvested corn with moisture content of 17% - 20% were taken to the Laboratory of Production and Management Tools and Agricultural Machinery for testing corn sheller machine. Testing is done using three treatments and three times with different varieties. After the evaluation of the corn sheller machine designs Agricultural Engineering, University of Andalas, Padang.

D. Performance Evaluation of corn sheller

The basic point examined in this study is :

- Frequency
- Work Capacity
- Rendemen
- Engine Noise Level
- Specific energy for Corn sheller
- Efficiency sheller
- Cleanliness level results shelled corn
- Damage levels mechanical seed corn results
- Power and Electricity Needs Motor Drive

E. Economic analysis

1) Cost of corn sheller machine

To get the cost of goods, need to be calculated budget fixed costs and variable costs. Fixed costs consist of the cost of capital depreciation and interest costs, while variable costs include the cost of maintenance, operator costs, and fuel costs. Economic Analysis calculated based on the equation according to [2].

Main costs can be calculated using the following equation:

$$BP = \frac{\left(\frac{BT}{N}\right) + BTT}{K} \quad (1)$$

Explanation :

- BP = Main costs (Rp/kg)
- BT = Fixed costs (Rp/year)
- BTT = Variable cost (Rp/h)
- K = Corn sheller machine capacity (kg/h)
- N = Total hours of work (h/year)

2) Break Event Point (BEP)

Break-even point can be calculated using the formula:

$$BEP = \frac{BT}{1.1 BP - \left(\frac{BTT}{Ke}\right)} \quad (2)$$

Explanation :

- BEP = Breakeven point(kg/year)
- BT = Fixed costs (Rp/year)
- BTT = Variable cost (Rp/h)
- BP = Main costs (Rp/kg)
- Ke = Effective working capacity corn sheller machine (kg/h)
- 1,1 = Coefficient which indicates that the leases equipment with a profit of 10% of the main cost.

III. RESULT AND DISCUSSION

A. Moisture Corn

Corn sheller machine performance testing is to use three different corn varieties, namely maize varieties Maxpro NK 99, Pioneer 26 maize varieties and maize varieties Maxpro NK 22. According to [3], moisture content of corn used is corn that has a moisture content ranging from 17-20%. While corn is based on SNI 3920-2013, maximum water content is 17% [4]. Moisture content of corn varieties Maxpro NK 99, Pioneer 26 varieties, and varieties Maxpro 22 consecutive NK obtained is equal to 17.35%, 17.73%, and 18.36%.

According to [5] water levels affect the capacity sheller . The smaller the water content of corn then sheller will be easier and reduce damage to the corn kernels so that more and more capacity. Conversely the greater the water content, the capacity corn sheller and corn results will be slightly shelled will easily be damaged.

B. Frequency Rotate corn sheller machine

Frequency value of the frequency value rotary rotary machine corn sheller can be seen in the following table:

TABLE I
FREQUENCY ROTATE CORN SHELLER MACHINE

Varieties	Disposable load		No load	
	Rpm motors	Rpm pulleys	Rpm motors	Rpm pulleys
Maxpro NK 99	1468	363,36	1479	365,2
Pioner 26	1468	359,26		
Maxpro NK 22	1468,8	362,1		
Average	1468,26	361,57		

The table can be seen that the rotational frequency value using a smaller load than the rotary frequency with no load. This is due to the engine work harder if subjected to loads causing the engine rotation becomes slow. In addition, the diameter pulleys also affect the frequency of a rotary engine. The smaller the diameter of the motor pulley is used then the frequency will turn more and more. Conversely the larger the diameter of the motor pulley is used then the value of the frequency of the rotary engine gained a little.

C. Work Capacity corn sheller machine

The difference in capacity for each variety can be seen in Fig. 1

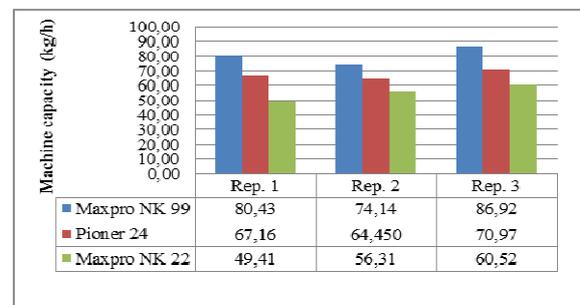


Fig. 1 Corn sheller machine capacity

Average of the highest capacity is obtained from corn varieties Maxpro NK 99 is 80.50 kg / h. The results obtained from the smallest capacity maize varieties Maxpro NK 22 is as much as 55.41 kg / h. The smaller the water content it will be easier shelled thus increasing capacity and reducing damage when shelled.

Corn sheller machine can be compared with a shoplifting corn on domestic industries and small industries such as, tool manual sheller type (type TPI) can shoplifting corn 12-15 kg / h. Tool sheller model of car tires can shoplifting corn 20-30 kg / h, while the tool can corn sheller Serpong approximately 40 kg / h. For industrial scale has a huge working capacity and greater use of power, for its capacity ranges from 1-2 tons / hour and the power used by 6 HP. For industrial scale sheller has a greater dimension, so the cost to produce corn sheller is certainly a very large class.

D. Rendemen

Rendemen is comparison between the weight of corn grain obtained from the main drain holes on the weight of the corn seed should shelled based seed corn cob ratio expressed in percent. Rendemen for each variety can be seen in Table II.

TABLE III
RENDEMEN OF DATA TABLE RESULTS THIRD CORN VARIETIES

No	Varieties	Rep.1	Rep.2	Rep.3	Average (%)
1	Maxpro NK 99	76,41	78,57	77,94	77,64
2	Pioner 24	84,85	84,62	87,94	85,41
3	Maxpro NK 22	68,07	67,73	69,74	68,51

Based on the above data rendemen of sheller machine is quite good because the overall average rendemen produced three varieties of maize by 77.32%. Rendemen is affected by moisture content. The lower the moisture content of corn, then the lower the yield produced. Conversely, the higher the water content in the corn, the number of seeds that came out much more so that the yield can be reduced.

E. Engine Noise Level

Corn sheller machine noise was measured using a sound level meter. Noise data for all varieties can be seen in table III.

TABLE IIIII
NOISE LEVEL CORN SHELLER MACHINE

No	Varieties	No load	Disposable load
1	Maxpro NK 99	80,9 dB	97,07 dB
2	Pioner 24		97,06 dB
3	Maxpro NK 22		97,08 dB
	Average		97,07dB

Average noise level corn sheller machine used at the time amounted to 97.07 dB. Based on Indonesian National Standards Body allowable safe limit of hearing is at 90 dB [6]. The size of the noise machine corn sheller MPJ-01-TEP-2014 is influenced by the size of the corn that shelled. At the time of using corn sheller large then the engine noise level will be even greater.

F. Percentage Weight Corn Not Shelled

Percentage weight of corn not shelled differ for each variety. Varieties obtained Maxpro NK 99 weight percentage of corn that does not shelled of 8.13%. Pioneer at least 24 varieties of corn are not shelled the percentage of the average of 1.47%. It's because the size of a medium-sized corn so the corn kernels can shelled maximum.

G. Corn sheller machine efficiency

Corn sheller machine efficiency data for each variety can be seen in Table IV.

TABLE IVV
EFFICIENCY FOR EACH MAIZE VARIETIES

No	Var.	Rep. 1	Rep.2	Rep. 3	Average (%)
1	Maxpro NK 99	92,46	90,72	92,45	91,88
2	Pioner 24	98,85	98,01	98,73	98,53
3	Maxpro NK 22	90,97	93,92	92,96	92,60

Efficiency value is based on the Indonesian National Standards by 90%, so the efficiency sheller machine has been designed in accordance with the National Standard of Indonesia. Efficiency is affected by the speed of the cylinder. To improve the efficiency can be done by increasing the capacity of the feeder tool with round cylinder gear set thresher.

H. Corn Cleanliness Level Results Shelled

The level of cleanliness is a comparison of maize grain weight and the weight of the dirt out of the main drain holes. The level of cleanliness of the highest corn sheller is maize varieties. Pioneer 24 is obtained values cleanliness level of 98.05%. This is due to the moisture content of corn cobs are used in accordance with the large water content for corn grain shelled causing the broken bit and improve hygiene shelled results. Based on Indonesian National Bureau of Standards recommended level of cleanliness corn is 95% [3], so that the level of cleanliness shelled results already meet the Indonesian National Standard.

I. Damage levels levels Corn Seed corn sheller machine

Seed corn is broken corn kernels were cracked or broken out through the drain holes due to engine work. The data rate of damage corn maize sheller machine results can be seen in Table V.

TABLE V
CORN DAMAGE LEVEL DATA RESULTS CORN SHELLER MACHINE

No	Varieties	Rep.1	Rep.2	Rep. 3	Average (%)
1	Maxpro NK 99	9,52	7,41	7,81	8,25
2	Pioner 24	9,09	8,29	6,09	7,82
3	Maxpro NK 22	22,22	22,70	18,48	21,13

Corn moisture content affects the degree of mechanical damage corn shelled results. This is because the water content is too high will make it difficult to shelled seed corn

because corn is still strongly attached to the cob and break easily due to friction between the surface of the eye with seed corn sheller machine.

When compared with other varieties of corn maize varieties obtained Maxpro NK 22 average level of damage to corn kernels largest mechanical shelled result that is equal to 21.13%. This is due to lower corn moisture content is 18.36%. Low water levels will make it difficult to be released from the corn cob corn and potential damage to corn kernels with a low water content is much higher. Damage can be caused by a clash of seed corn sheller machine and so on.

J. Power To Drive Motor

Electric drive motor power measurement is done by measuring the current strength by using the AC / DC Clamp Meter. Measurements were taken at the time of the machine without the use of weights. From the measurement results obtained by means of the value of the potential difference with a powerful 220 volt current 3.1 A, so we get the amount of power needed is 682 Watts.

K. Specific energy corn sheller machine

The research that has been conducted the results obtained for the specific energy of corn varieties Maxpro NK 99 at 30.49 kJ / kg, Pioneer 24 varieties of 36.35 kJ / kg and 22 varieties of NK Maxpro of 44.30 kJ / kg.

L. Economic analysis

1) Main Cost

To get the main cost, need to be calculated budget fixed costs and variable costs. Fixed costs consist of the cost of capital depreciation and interest costs, while variable costs include the cost of repair and maintenance equipment, power consumption costs and operator costs. From the research that has been conducted is obtained at the cost of depreciation Rp.450.000,00 / year and the cost of capital rate obtained by Rp.180.000,00 / year, so the fixed costs that must be incurred within one year amounted Rp.630.000,00 / year .

Variable costs to be incurred within one day covering the cost of repair and maintenance tools. From the research that has been conducted found the cost of repairs and maintenance tool for Rp.450,00 / hour, while the cost of the

operator obtained by Rp.6.250,00 / hour and the cost of electricity consumption obtained by Rp 2673.44 / h. So the variable costs to be incurred each day is Rp 9373.44 / h. So the basic costs that must be paid for one kilogram of maize varieties Maxpro NK 99, Pioneer 24 varieties of corn, and corn varieties Maxpro NK 22 in a row is equal Rp.120,88 / kg, Rp.114,48 / kg, and Rp.139,53 / kg.

2) Break Event Point

Break event point is the point where a production does not lose or gain. Thus, in terms of producing an agricultural machine breakeven calculation must be done in order to determine the cost of production and cost of sales. From a study of corn sheller machine MPJ-01-TEP-2014, obtained breakeven point NK Maxpro machine for 99 varieties in the amount of 38135.59 kg / year. Breakeven varieties obtained by Pioneer 24 66399.66 kg / year and breakeven point NK Maxpro 22 varieties obtained at 40186.26 kg / year.

IV. CONCLUSIONS

Capacity corn sheller machine work MPJ-01-TEP-2014 obtained the highest Maxpro varieties NK 99 is as much as 80.50 kg / h. The economic cost of the maize varieties on Pioneer 24 by Rp 114.48 / kg and to prevent loss of the break-even point to be achieved is the engine must shelled maize 66399.66 kg / year.

REFERENCES

- [1] Aswanda I. Modification corn sheller with Source Electric Motor Drive. Andalas University. Padang. [Thesis]. Faculty of Agriculture, University of Andalas. Page 56. 2014.
- [2] Newnan, D. (1990). Engineering Economic Analysis. Third Edition. Binarupa Aksara Engineering Press, Inc Jakarta Indonesia.
- [3] Bintoro N., Apriadi., dan Amanah H.Z. 2011. Analysis of Heat and Mass Transfer Process Drying Corn Cobs On Some Simple Drying Method. Proceedings National Seminar PERTETA 2011. Jember, Indonesia
- [4] Indonesian National Standardization Agency. Corn (SNI 3920-2013). Jakarta.
- [5] Setia, H.S. Effect of Water Content on Corn (Zea mays, L) Using Corn Sheller. [Thesis]. Padang. Faculty of Agriculture, University of Andalas. Page 63. 2014
- [6] Indonesian National Standardization Agency. Corn sheller (SNI 02-0836.2-1998). Jakarta.