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Design, Fabrication, and Evaluation of Forage Chopper Machine using three Different Diameter Pulleys

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Abstract

This study is designed and fabricated in order to help people particularly farmers who engaged in forage in order for them to produce a voluminous forage in less time easily. The primary goal of this study was to design, fabricate, and evaluate the performance of the forage chopper machine. The study specifically aimed to evaluate the performance of the machine using three different diameter pulleys in terms of: 1) Throughput Capacity (kg/hr), 2) Chopping Capacity (kg/hr), 3) Chopping Recovery (%), 4) Machine Efficiency (%), and 5) Percent Loss (%). The sample used to evaluate the performance of the machine was a constant feeding rate of 500 grams of a freshly harvested Napier Grass (*Pennisetum purpureum*). There were three treatments namely T_1(3-inch diameter pulley), T_2(4-inch diameter pulley), and T_3(5-inch diameter pulley). Three replications for every treatment were used. During the data gathering, the time of chopping for every 500 grams of sample that was fed was measured. Also, the output or the chopped materials were sorted into two (accepted output and unaccepted output) and weighed using a weighing scale. The study revealed that the difference in diameter pulley greatly affected the chopping capability as well as the chopping uniformity of the machine. It was also observed during the data gathering that the use of bigger diameter on the machine gave much better result which led on a much higher machine efficiency. The highest throughput capacity was the T_3 (5-inch diameter pulley) that has the fastest speed among the three treatments. As to the chopping, the highest chopping capacity was T_3 (5-inch diameter pulley) that has the faster speed among the three treatments. As to the chopping recovery, the highest chopping recovery was the T_1 (3-inch diameter pulley) which has the slowest speed among the three treatments. The highest machine efficiency was the T_3 (5-inch diameter pulley) which has the fastest speed among the three treatments. The highest percentage of loss was the T_1 (3-inch diameter pulley) which has the slowest speed among the three treatments.

Keywords: design, fabrication, forage, forage chopper machine, napier grass

Introduction

Forage grass may be of little importance as we perceive it but it has a numerous economic importance and uses most especially in providing nourishment for most dairy animals. Future intensive and sustainable livestock production systems, requires a thorough knowledge of the

potentials and limitations of the system. Forage availability is one of the most important factors determining the potential of a given ruminant livestock production system (E.A. Lazaro et al.).
To some extent, forage grass is easy to cultivate with. And in most localities, farmers harvest forage grass from its stem and cut the crop into short parallel length for a period of time and then mix it with the other constituent's until it becomes ready for feeding. Forage chopping is a common process done by most local farmers in feeding livestock. These process takes a lot of time and effort especially in a large scale unit which led to the realization of lessening the problem. Forage chopper is used to cut/chop forage as a replacement of a cutlass (E.A. Lazaro et al.). Designing and constructing a Forage Chopper Machine for feeding livestock is one of the most appropriate way in solving the problem. This Machine could cut the laborious process of manual chopping and could save the time to be used in large scale of feeding livestock.

Objectives of the Study

This study aimed primarily to design, fabricate, and evaluate the performance of Forage Chopper Machine. Specifically, it aimed to evaluate the performance of the machine with respect to: 1) Throughput Capacity (kg/hr); 2) Chopping Capacity (kg/hr); 3) Chopping Recovery (%); 4) Machine Efficiency (%); and Losses (%)

Methods

The Forage Chopper Machine was fabricated at Seabreeze Machine Shop, Tambo Highway, Iligan City on March 2016. The design of the machine was based on the gathered information from the books and on the internet having the same concept as of forage chopper machine.

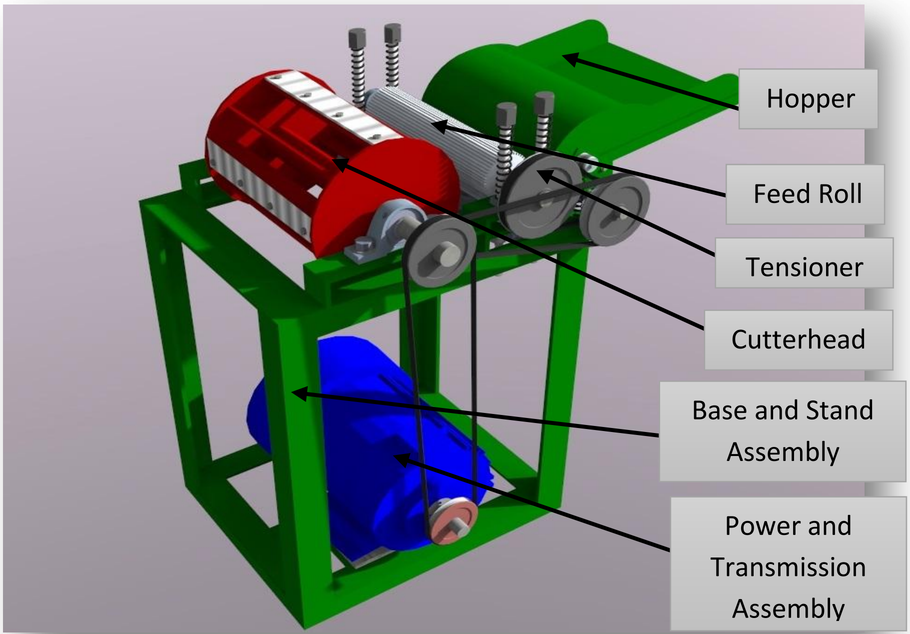

Figure 13. Main Components of the Forage Chopper Machine

The Hopper

Part of the machine wherein forage grass is put and prepared prior to feeding into the machine.

The Feed Roller

Cylindrical roll generally with protrusions or flutes, used to gather, compress and advance the crop into the cutterhead. This Feed Roller is unique that it can adjust its clearance by moving vertically according to amount and volume to be fed into the hopper. This capability of the roller is due to its unique design by putting a two pair of spring each side of the shaft.

The Cutterhead

Cutting rotor devices intend to cut the crop into short lengths with reasonable consistency within a range of optional settings.

Base and Stand Assembly

Base and stand assembly is considered as the backbone of the machine functioned to support mainly all the parts of the machine. This is made up of steel bars and heavy duty mild steel to assure the durability of the materials.

Power Transmission Assembly

Power transmission assembly is done by mechanical operation. This is made up of electric motor, belt, shaft and pulley.

Tensioner

Tensioner is used to tighten the belt to make a better grip between the pulley and the belt.

Design and Fabrication

The Forage Chopper Machine was fabricated at Seabreeze Machine Shop, Tambo Highway, Iligan City on March 2016. The design of the machine was based on the gathered information from the books and on the internet having the same concept as of forage chopper machine. On the basis of the related data gathered and with the data of the test material that was used. The design was based on the following criteria: (a) Availability of the materials, (b) Simplicity and ease of machine operation and repairs, (c) Adaptability of the machine to small-scale farm owners, and (d) Conformation to the PAES.

Parts of the Machine

The machine consisted of six (6) major components are as follows: (1) the feed hopper, (2) the feed roll, (3) the cutting assembly, (4) the frame stand assembly, (5) the power transmission assembly, and (6) the material outlet.

Materials and Instruments

The materials and instruments twere used in evaluating the machine are as follows: (1) Three different sizes of pulley diameter, (2) Weighing Scale, (3) Stopwatch, seconds: milliseconds, (4) Bolo, (5) Pen and Papers, (6) Sack, (7) Digital Camera, (8) Open and Adjustable wrenches, (9) Test Material (Napier grass).

Machine Operation

The forage chopper machine is generated by an electric motor which serves also as the heart of the machine having a speed of 1720 revolutions per minute (rpm). The electric motor is connected to pulleys of different sizes either driver or driven through the use of belts. The other parts of the machine are then functioning accordingly as to how fast the pulley is. Operating the forage chopper machine is simple. Just plug in the electric motor in the source, feed the forage grass in the hopper and leave the rest in the machine. Just be sure to be attentive in operating the machine to prevent future complications. Unplug as soon as the operation is done.

Data Gathering Procedures

The following processes have been done in gathering the data are as follows: (1) All the necessary materials before testing the forage chopper machine must be gathered including all important tools needed in case of any adjustment to avoid failure in the operation, (2) The machine must run for a minute before feeding the desired grass to check the functionality of the machine and its parts, (3)

A specific amount of forage grass will be feed at the hopper for chopping, (4) Never forget to jot down the time of the operation starts and ends, (5) The amount of the output after chopping must be weighed to any weighing scale, (6) After weighing, sort all the output and separate all the uncut grasses, (7) Again weigh the uncut grasses in any weighing scale, (8) Unplug the machine when notice any complication during the operation and as soon as the operation ends, (9) Repeat all the necessary instructions for the data gathering using other size of pulley diameter.

Evaluation of Machine and Manual Chopping Performance

After the data gathered, the following determinations were carried out:

Throughput Capacity

The throughput capacity was measured based on the sample's input weight which is 500 grams divided by its chopping time in (kg/hr). The results were expressed as Replication 1, Replication 2, and Replication 3. The mean value of the three measurements was also computed.

Chopping Capacity

The Chopping recovery was measured based on the weight of the accepted output divided by its chopping time. The results were expressed as Replication 1, Replication 2, and Replication 3. The mean value of the three measurements was also computed.

Chopping Recovery

The chopping recovery was measured based on the weight of the total output divided by its input weight multiplied by 100. The results were expressed as Replication 1, Replication 2, and Replication 3. The mean value of the three measurements was also computed.

Percent Loss

Percent loss was computed based on the ratio if the difference of input weight and the accepted output weight divided by the input weight expressed in percent. The results were expressed as Replication 1, Replication 2, and Replication 3. The mean value of the three measurements was also computed.

Machine Efficiency

Chopping efficiency was computed based on the ratio of the accepted output and input. The results were expressed in percent. The results were expressed as Replication 1, Replication 2, and Replication 3. The mean value of the three measurements was also computed.

Experimental Design and Data Analysis
The experimental design used in the calculation and analysis of statistical data are the Completely Randomized Design (CRD) and Duncan's Multiple Range Test (DMRT). Analysis of Variance (ANOVA) was used to determine the differences among the treatment means.

Results and Discussion
The variables or treatments of the study were the different diameter pulleys attached to the motor. Only one type of blade was used in the experiment. The treatments were T_1 (3-inch Diameter Pulley), T_2 (4-inch Diameter Pulley), and T_3 (5-inch Diameter Pulley). The weight of the Napier Grass in each trial is 500 grams with different thickness and length. The procedures for getting the data were that the test material was feed into the machine's hopper and was chopped. The chopping time and the output was then recorded. The outputs were classified as accepted and unaccepted. The classified outputs were weighed and recorded. The outputs were labeled according to the order of its treatments and replications. These processes were repeated three times for every treatment.

The tables below show the data that were gathered during the data gathering.

Table 1. Data gathered of the first treatment T_1 (3-inch Diameter Pulley) with three replications.

Treatment Combination	Input (g)	Total Output (g)	Output Classification (g)		Total Losses (g)	Chopping Time (sec)
			Accepted	Unaccepted		
T_1R_1	500	480	400	80	100	9.71
T_1R_2	500	490	430	60	70	10.1
T_1R_3	500	485	405	80	95	7.38

Table 2. Data gathered of the second treatment T_2 (4 inch Diameter Pulley) with three replications.

Treatment Combination	Input (g)	Total Output (g)	Output Classification (g)		Total Losses (g)	Chopping Time (sec)
			Accepted	Unaccepted		
T_2R_1	500	475	436	39	64	6.19
T_2R_2	500	480	440	40	60	7.66
T_2R_3	500	485	457	28	43	5.23

Table 3. Data gathered of the third treatment T_3 (5-inch Diameter Pulley) with three replications.

Treatment Combination	Input (g)	Total Output (g)	Output Classification (g)		Total Losses (g)	Chopping Time (sec)
			Accepted	Unaccepted		
T_3R_1	500	481	471	10	29	4.14
T_3R_2	500	476	456	20	44	3.24
T_3R_3	500	478	458	20	42	3.79

Throughput Capacity

Throughput capacity refers to the ratio of the input weight of Napier grass that was fed into the hopper and its chopping time.

Table 4 shows the Throughput Capacity of the Forage Chopper Machine fed by 500 grams of fresh harvest Napier grass with three (3) different treatments with three replications. As shown from the table that when the machine was loaded by the test material, T_3 has the highest Treatment Mean of Throughput Capacity (488.42 kg/hr), followed by T_2 (289.98 kg/hr), and T_1 (202.49 kg/hr). Subjecting the data to Analysis of Variance, Table 4a shows a highly-significant treatment mean differences at 1% level of significance, which means that the three different sizes of pulley diameter affects significantly to the study of throughput capacity.

The DMRT analysis in Table 4b shows that the Treatment T_2 (4-inch diameter pulley) and Treatment T_1 (3-inch diameter pulley) were significantly to differ Treatment T_3 (5-inch diameter pulley). Whereas, Treatment T_2 (4-inch diameter pulley) and Treatment T_1 (3-inch diameter pulley) were not significantly differ from each other.

This means that the chopping machine can have a highest throughput capacity when Treatment T_3 (5-inch diameter pulley) was used because of its fast rpm. Thus chopping time was faster. The DMRT also shows that whether Treatment T_2 (4-inch diameter pulley) and Treatment T_1 (3-inch diameter pulley) were used, the difference of the throughput capacity is negligible.

Table 4. Throughput Capacity of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys in Conducted in CRD Experiment with Three Replications.

Treatments	Throughput Capacity (Kg/hr)			Treatment Total	Treatment Mean
T_1 (3” dia. pulley)	185.37	178.21	243.90	607.50	202.50
T_2 (4” dia. pulley)	290.79	234.98	344.16	869.95	289.98
T_3 (5” dia. pulley)	434.78	555.55	474.93	1465.27	488.42
Grand Total				2942.72	
Grand Mean					326.97

Table 4a. Analysis of Variance of Table 4 (Throughput Capacity of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment With Three Replications.)

Source of Variance	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F	
					5%	1%
Treatment	2	128785.82	64392.91	23.96**	5.14	10.92
Expt'l Error	6	16124.31	2687.38			
Total	8	144910.12				

cv = 15.85%

** = highly significant 1% level

Table 4b. DMRT of Table 4a (Throughput Capacity of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment with Three Replications.)

Treatment	Treatment Mean (Kg/hr) [e]	DMRT
T_3 (5 inch-diameter pulley)	488.42	a
T_2 (4 inch-diameter pulley)	289.98	b
T_1 (3 inch-diameter pulley)	202.49	b

*Treatment means having the same letter are not significantly different from each other at 5% significance level

[e] – Means of three replications

Chopping Capacity

Chopping Capacity of the machine is the ratio of the accepted output over the chopping time. Table 5 shows the Chopping Capacity of the Forage Chopper Machine when fed by 500 grams of freshly harvested Napier Grass with three (3) different treatments with three replications. As shown from the table that when the machine was loaded by the test material, T_3 has the highest Treatment Mean of Chopping Capacity (450.42 kg/hr), followed by T_2 (258.31kg/hr), and T_1 (166.37 kg/hr). Subjecting the data to Analysis of Variance, Table 5a shows a highly-significant treatment mean differences at 1% level of significance, which means that the three different sizes of pulley diameter affects significantly to the study of Chopping Capacity. The DMRT analysis (Table 5b) shows that the Treatment T_2 (4-inch diameter pulley) and Treatment T_1 (3-inch diameter pulley) were significantly differ to Treatment T_3 (5-inch diameter pulley). Also the table reveals that Treatment T_2 (4-inch diameter pulley) and Treatment T_1 (3-inch diameter pulley) were significantly differ from each other. This means that the machine can obtain a higher chopping capacity in Treatment T_3 (5-inch diameter pulley) compared to Treatment T_2 (4-inch diameter pulley) and Treatment T_1 (3-inch diameter pulley) because of its faster rpm and higher value of acceptable output.

Table 5. Chopping Capacity of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment with three Replications.

Treatments	Chopping Capacity (Kg/hr)			Treatment Total	Treatment Mean
T_1 (3" dia. pulley)	148.30	153.27	197.56	499.13	166.38
T_2 (4" dia. pulley)	253.57	206.79	314.57	774.93	258.31
T_3 (5" dia. pulley)	409.56	506.67	435.04	1351.27	450.42
Grand Total				2625.33	
Grand Mean					291.70

Table 5a. ANOVA Table of Table 5 (Chopping Capacity of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment With Three Replications.)

Source of Variance	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F	
					5%	1%
Treatment	2	126042.58	63021.29	30.54**	5.14	10.92
Expt'l Error	6	12382.51	2063.75			
Total	8	138425.09				

cv = 10.085%
** = highly significant 1% level

Table 5b. DMRT of Table 5a (Chopping Capacity of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment with Three Replications.)

Treatment	Treatment Mean (Kg/hr) [e]	DMRT
T_3 (5-inch diameter pulley)	450.42	a
T_2 (4-inch diameter pulley)	258.31	b
T_1 (3-inch diameter pulley)	166.37	c

*Treatment means having the same letter are not significantly different from each other at 5% significance level
[e] – Means of three replications

Chopping Recovery

Chopping Recovery is the ratio of the total output and input material in percent. Table 6 shows the Chopping Recovery of the Forage Chopper Machine when fed by 500 grams of freshly harvested Napier Grass with three (3) different treatments with three replications. The table reveals that the Treatment T_1 has the highest Treatment Mean of Chopping Recovery (97%), followed by the T_2 (96%), and T_3 (95.66%). Subjected the data to Analysis of Variance, Table 6a shows a Non-significant result of Treatment Means at 1% and 5% level of significance which means that the three different sizes of pulley diameter did not affect significantly to the study of Chopping Recovery.

Table 6. Chopping Recovery of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment with Three Replications.

Treatments	Chopping Recovery (%)			Treatment Total	Treatment Mean
T_1 (3" dia. pulley)	96	98	97	291	97
T_2 (4" dia. pulley)	95	96	97	288	96
T_3 (5" dia. pulley)	96.2	95.2	95.6	287	95.67
Grand Total				866	
Grand Mean					96.22

Table 6a. ANOVA of Table 6 (Chopping Recovery of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment With Three Replications.)

Source of Variance	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F	
					5%	1%
Treatment	2	2.89	1.44	1.92 ^{ns}	5.14	10.92
Expt'l Error	6	4.51	0.75			
Total	8	7.40				

cv = 0.90%

^{ns} = not significant

Percent Loss

Percent loss is the ratio of the difference of the input weight and the accepted output weight divided by input weight expressed in percent. Table 7 shows the Percent Loss of the Forage Chopper Machine when fed by 500 grams of freshly harvested Napier Grass with three (3) different treatments with three replications. The table reveals that the Treatment T_1 (3-inch diameter pulley) has the highest Treatment Mean of Percent Loss which is (17.66%), followed by T_2 (11.13%), and T_3 (7.66%) respectively. Subjecting the data to Analysis of Variance, Table 7a shows a highly significant treatment mean differences at 1% level of significance, which means that the three different sizes of pulley diameter affects significantly to the study of Percent Loss. The DMRT analysis (Table 7b) reveals that Treatment T_2 (4-inch diameter pulley) and Treatment T_3 (5-inch diameter pulley) significantly differ to Treatment T_1 (3-inch diameter pulley). Also the table reveals that Treatment T_2 (4-inch diameter pulley) and Treatment T_3 (5-inch diameter pulley) does not significantly differ from each other. The Treatment T_1 has the highest Percentage Loss because it has the slowest revolution per minute (rpm) among the three treatments. It means that the faster the revolution per minute (rpm) the lesser the Percentage of loss.

Table 7. Percent Loss of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment With Three Replications.

Treatments	Percent Loss (%)			Treatment Total	Treatment Mean
T_1 (3-inch dia. pulley)	20	14	19	53	17.67
T_2 (4-inch dia. pulley)	12.8	12	8.6	33.4	11.13
T_3 (5-inch dia. pulley)	5.8	8.8	8.4	23	7.67
Grand Total				109.4	
Grand Mean					12.16

Table 7a. ANOVA of Table 7 (Percent Loss of the Forage Chopper Machine in Kilograms per Hour Obtained from three Diameter Pulleys Conducted in CRD Experiment with three Replications.)

Source of Variance	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F	
					5%	1%
Treatment	2	154.70	77.35	12.92**	5.14	10.92
Expt'l Error	6	35.92	5.99			
Total	8	190.62				

cv = 20.13%%
** = highly significant 1% level

Table 7b. DMRT Table of Table 7 (Percent Loss of the Forage Chopper Machine in kg/hr Obtained from three Different Diameter Pulleys Conducted in CRD Experiment with three Replications.)

Treatment	Treatment Mean (%) [e]	DMRT
T_1 (3-inch diameter pulley)	17.67	a
T_2 (4-inch diameter pulley)	11.13	b
T3 (5-inch diameter pulley)	7.67	b

*Treatment means having the same letter are not significantly different from each other at 5% significance level

[e] – Means of three replications

Machine Efficiency

Machine Efficiency is the ratio of the weight of the accepted output and input expressed in percent. Table 8 shows the Machine Efficiency of the Forage Chopper Machine fed by 500 grams of freshly harvested Napier Grass with three (3) different treatments with three replications. The table reveals that the Treatment T_3 (5 inch-diameter pulley) has the highest Treatment Mean of Machine Efficiency which is (92.33%), followed by Treatment T_2 (88.86%), and Treatment T_1 (82.33%) respectively. Subjecting the data to Analysis of Variance, Table 8a shows a highly-significant treatment mean differences at 1% level of significance, which means that the three different sizes of pulley diameter affects significantly to the study of Machine Efficiency. The DMRT analysis (Table 8b) shows that the Machine Efficiency of Treatment T_2 (4-inch diameter pulley) does not significantly differ to Treatment T_3 (5-inch diameter pulley). Also the table reveals that Treatment T_1 (3-inch diameter pulley) significantly differ to Treatment T_2 (4-inch diameter pulley). It means that Machine Efficiency is lesser in Treatment T_1 which has a slower rpm compared to the remaining two Treatments. It also shows that the faster the rpm of the machine the better the result. Treatment T_3 (5-inch diameter pulley) and T_2 (4-inch diameter pulley) did not significantly differ from each other because they have both fast revolution per minute (rpm).

Table 8. Machine Efficiency of the Forage Chopper Machine in Kilograms per Hour Obtained from three Different Diameter Pulleys in CRD Experiment With Three Replications.

Treatments	Machine Efficiency (%)			Treatment Total	Treatment Mean
T_1 (3-inch dia. pulley)	80	86	81	247	82.33
T_2 (4-inch dia. pulley)	87.2	88	91.4	266.6	88.87
T_3 (5-inch dia. pulley)	94.2	91.2	91.6	277	92.33
Grand Total				790.6	
Grand Mean					87.84

Table 8a. ANOVA of Table 8 (Machine Efficiency of the Forage Chopper Machine in Kilograms per Hour Obtained from three Different Diameter Pulleys Conducted in CRD Experiment with three Replications.)

Source of Variance	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F	
					5%	1%
Treatment	2	154.70	77.35	12.92**	5.14	10.92
Expt'l Error	6	35.92	5.99			
Total	8	190.62				

cv = 2.78%%
** = highly significant 1% level

Table 8b. DMRT Table of Table 8 (Machine Efficiency of the Forage Chopper Machine in Kilograms per Hour Obtained from three Different Diameter Pulleys Conducted in CRD Experiment with three Replications.)

Treatment	Treatment Mean (%) [e]	DMRT
T_3 (5-inch diameter pulley)	92.83	a
T_2 (4-inch diameter pulley)	88.87	a
T_1 (3-inch diameter pulley)	82.33	b

*Treatment means having the same letter are not significantly different from each other at significance level

[e] – Means of three replications

Findings of the Study

The highest throughput capacity was the T_3 (5-inch diameter pulley) that has the fastest speed among the three treatments. Followed by the T_2 (4-inch diameter pulley) and T_1 (3-inch diameter pulley) respectively. The highest chopping capacity was T_3 (5-inch diameter pulley) that has the faster speed among the three treatments. Followed by the Treatment T_2 (4-inch diameter pulley) and T_1 (3-inch diameter pulley) respectively. The highest chopping recovery is the Treatment T_1 (3-inch diameter pulley) which has the slowest speed among the three treatments. Followed by the Treatment T_2 (4-inch diameter pulley) and T_3 (5-inch diameter pulley) respectively. The highest machine efficiency is the Treatment T_3 (5-inch diameter pulley) which has the fastest

Speed among the three treatments. Followed by T_2 (4-inch diameter pulley) and T_1 (3-inch diameter pulley) respectively. The highest percentage of loss is the Treatment T_1 (3-inch diameter pulley) which has the slowest speed among the three treatments. Followed by T_2 (4-inch diameter pulley) and T_3 (5-inch diameter pulley) respectively.

Conclusions and Recommendations

The following are the conclusions made through the results of the five days evaluation of the Forage Chopper Machine using three different speeds. The 3-inch diameter pulley, 4-inch diameter pulley, and 5-inch diameter pulley. The speed of the machine affects the length of cut of the forage. The faster the speed the shorter the length of its cut. The slower the speed the longer the length of cut. The faster the speed the lesser the losses and higher the accepted output. The slower the speed of the machine the bigger the losses and lower the accepted output as well as the bigger the unaccepted output. The faster the speed of the machine the lesser the chopping time. The slower the speed, the bigger the chopping time. The faster the speed of the machine the higher its efficiency. The slower its speed the lower also its efficiency. The faster the speed of the machine the bigger its capacity. The slower its speed the smaller its machine capacity.

Recommendations are made to improve the performance of the machine as well as its efficiency. Recommendations with respect to my parameter are as follows: If ever you want a longer cut in forage crops to be feed, the use of higher speed in the feed roll is recommended. The speed of feed roll affects directly the length of cut of forage crops. The checking of the clearance between blades and the shear bar should be on a regular basis. During the conduct blade tends to move especially during a long term used on the machine. The efficiency of cutting of forage does not only based on the machine's speed itself but also on the blade and shear bar clearance. The teeth of the feed roll must be more emphasized to have a better grip of the forage stalks. The use of feed roll with much spikes is recommended. The use of wider opening on the material outlet is recommended so that the output material has no difficulty on its way out. The feeding table should be extended to not less than the length of an arm. This study might also become a reference for some students or researchers that are interested to conduct parallel study or propose another type of Forage Chopper Machine.

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