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Development and Evaluation of a Red Onion (Allium cepa L.) Stem Cutting Machine: Performance Analysis and Cost Efficiency

Engr. Marjun E. Caguay, M.Sc.
Mindoro State University, Philippines
Corresponding Author e-mail: abeminscat@gmail.com

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Abstract

Aim: Bulb onions (Allium cepa L.) are crucial culinary ingredients globally. In the Philippines, the manual labor-intensive stem cutting operation in onion production necessitates the development of a specialized machine. This study aims to design and evaluate a Red Onion stem cutting machine equipped with counter-rotating blades, gears, a handle, frame assembly, collection bin, wheels, and power transmission assembly.
Methodology: To evaluate the cutting capacity, efficiency, and energy demand of the machine, three different treatments were employed, varying the shaft speeds at 450 rpm, 900 rpm, and 1350 rpm. Statistical analysis was conducted using common methods such as analysis of variance (ANOVA) and least significant difference (LSD) tests. A significance level of 5% was applied to determine the statistical significance of the results. These analyses provided robust and reliable insights into the performance of the machine across different operating conditions.
Results: Results indicated that the highest cutting capacity of 59.43 kg/hr was achieved at 1350 rpm, with a cutting efficiency of 98.16%. However, the machine fell short of the standard onion stem cutting length (2.5-5 cm), which affected its overall efficiency. The energy demand was measured at 0.0054 kW-hr/kg. Cost analysis revealed that the machine would require cutting a total of 1601.65 kg of onions to break even, considering a custom rate of Php 1.5/kg. The initial investment cost of Php 5,500.00 could be recovered in just 0.32 years or a single harvesting season, making the machine a cost-efficient solution.
Conclusion: The study's outcomes demonstrate the effectiveness, affordability, and financial benefits associated with implementing the cutting machine in onion processing. These findings provide valuable insights and practical implications for the industry, paving the way for improved efficiency, profitability, and sustainability in onion farming and processing practices.

Keywords: Bulb onions (Allium cepa L.), Onion production, Red Onion stem cutting machine

INTRODUCTION

The Philippines has a comparative advantage in producing onions for export over temperate countries. In 2021, the volume of onions produced in the country amounted to approximately 218 thousand metric tons with 2.29kg per capita consumption (Statista, 2022). However, the country faces industry problems such as: insufficient marketing and distribution, lack of financing, high cost of inputs, limited postharvest facilities and technologies at farm level, and inadequate research, training, and extension (FAO, 2021).

Currently, apart from land preparation, the onion production process in the country heavily relies on manual labor, from seedling cultivation to postharvest procedures, mainly due to the unavailability of machinery for these operations. A significant factor that hampers the efficiency of postharvest processes is the manual removal of leaves following the onion digging operation.

According to Arim et al. (2019), for optimal shelf life during storage, the recommended length for trimming onion foliage is approximately 2.5 - 5 cm of the stem section at the neck. Based on benchmarking studies, skilled individuals using traditional tools such as a "bolo" or sickle can only achieve a maximum cutting capacity of 31.25

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kg/h. This poses several challenges, including a limited output capacity with traditional cutting methods and a scarcity of skilled personnel available to perform the task. As a result, farmers often resort to employing unskilled labor, leading to longer and more expensive work processes, damage to the onions, and lower market prices for non-compliant cuts or even unsellable produce. Moreover, the use of exposed blade tools in traditional onion stem cutting operations raises safety concerns for the workers. Additionally, performing the task manually causes discomfort, including wrist, arm, and back pain, as well as exposure to the strong odor emitted during the cutting process.

Objective

The general objective of this study was to develop a red onion (Allium cepa L.) stem cutting machine. Specifically, this study aimed to:

1. Design and fabricate a red onion stem cutting machine out of locally available materials and manufacturing technology.
2. Evaluate the performance of the device in terms of machine cutting capacity and machine cutting efficiency.
3. determine the electrical energy consumption of the device; and
4. Analyze the cost of using the machine.

METHODS

Conceptualization of the Study

The study's conceptualization was guided by the input gathered from interviews with local onion farmers, taking into account their concerns. In addition to ensuring compliance with the standard onion stem cutting requirements, the developed machine offers significant advantages in expediting the current post-harvest operations of onions in the area, especially in situations where there is a pressing need to meet high market demand promptly. The machine also effectively reduces expenses associated with the stem cutting process, leading to higher profitability for the farmers. Furthermore, the machine is designed with user-friendliness in mind, incorporating gender-sensitive considerations. It is constructed using locally available materials and manufacturing technology, facilitating easier repair and maintenance procedures.

Figure 1 shows the conceptual framework of the study, following the input-process-outcome method. It was primarily based on the general objective of the study which was to develop a Red Onion (*Allium Cepa L.*) Stem Cutting Machine.

INPUT	PROCESS	OUTPUT	OUTCOME
1. Literatures, IP search, Design considerations, Benchmarking, solidworks software	1.Design conceptualization, design analysis, design calculations	1. 2D and 3D Design plan of the Onion stem cutting machine	Red Onion Stem Cutting Machine
2. Design plan of the machine, licensed manufacturer, locally available materials	2. Fabrication of the machine using local manufacturing technology	2. Red Onion Stem Cutting machine	- Cutting capacity of 59.43 kg/h
3. Red Onion Stem Cutting Machine and other test material	3. Preliminary Testing Adjustment, Final Testing and Performance Evaluation	3. Machine Operating Performance, Energy Demand and other assumptions	- Cutting efficiency of 98.16%
4. Machine operating performance, energy demand and other assumptions	4. Cost Analysis	4. Machine Annual cost, break-even point and payback period	Annual Net Income of Php. 15,685.584, at a custom rate of Php 1.50 per kg.

Figure 1. Conceptual framework of the study

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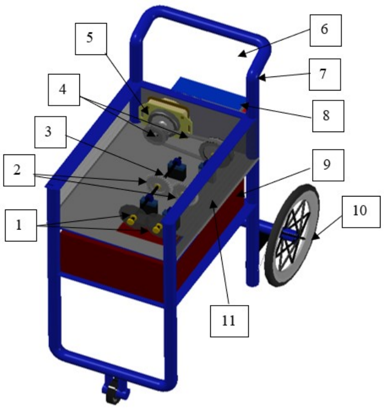
Design Concept of the Machine

The machine's design prioritizes gender sensitivity by taking into account a range of factors that ensure inclusivity and effectiveness for all users. These considerations encompass aspects like ergonomics and comfort, which factor in the distinct physical characteristics between genders. By designing the machine with a seated operator in mind, it accommodates a diverse spectrum of body sizes and shapes while also focusing on comfort. Additionally, the design factors in the necessary physical strength required for operating the machine.

The incorporation of wheels into the device aims to minimize the need for heavy lifting or tasks that might disproportionately affect certain genders. Safety measures are also integral to the design, featuring covers or guards on all moving parts, particularly the transmission system and blades, to mitigate the risk of accidents and injuries. Moreover, the machine's design facilitates ease of maintenance and repairs through easily replaceable and accessible components, reducing obstacles for all users to maintain the machine's optimal functionality.

The primary objective behind the machine's design is to assist operators in achieving onion stems of a specific length, ranging from 2.5 to 5cm. Its key components encompass counter-rotating blades, a counter-rotating gear, a handle, frame assembly, a collecting bin, wheels, ventilation, and power transmission assembly.



1	Counter rotating blades
2	Counter rotating gears
3	Shaft
4	Pulley and Belt
5	Electric Motor
6	Handle
7	Frame
8	Battery
9	Collecting bin
10	Wheels
11	Ventilation

Figure 2. Perspective view of the cutting machine.

Design of Major Components

1. Counter-rotating Blades

The machine has two counter-rotating blades (Figure 3) made from stainless steel attached to the gears by a shaft. Stainless Steel was used as material for the blades due to its characteristics of resistance to corrosion and ease of maintenance. It is can also withstand exposure to moisture and acidic substances and can maintain their sharpness for longer periods of time than carbon steel blades, making them a reliable choice for consistent, clean cuts. Moreover, stainless steel blades are more difficult to damage, as they are less prone to chipping or bending. The onion stem was wedged in between the two blades cutting it into its desired size.

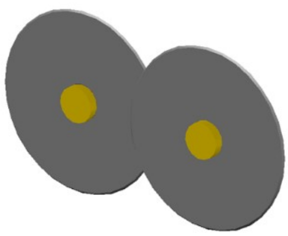


Figure 3. Counter-rotating blades of the machine

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2. Power Transmission Assembly

The machine offers versatility, suitable for deployment both in the field and within onion storage spaces. To accommodate scenarios of power outages or locations lacking electricity, the design incorporates provisions for a battery and inverter holder. Figure 4 depicts the power transmission assembly, responsible for conveying power from a source to the dynamic components of the machine, including shafts, pulleys, gears, and blades. Powering the machine is a 0.186 kW AC electric motor.

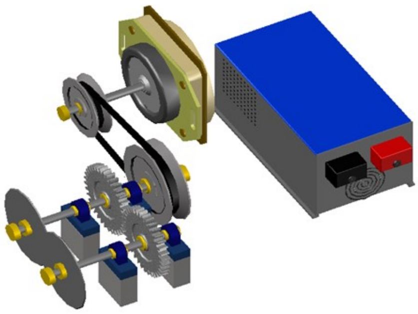

Figure 4. Power transmission assembly

The following equations was used for the calculation of transmission assembly. For Pulley Calculation from PAES 301:2000.

$$N_1D_1 = N_2D_2 \quad (1)$$

Where: N_1= rpm of driver pulley
D_1= Diameter of the driver pulley
N_2= rpm of driven pulley
D_2= Diameter of the driven pulley

For the calculation of belt from PAES 302:2000.

$$L = 2C + \frac{\pi}{2}(D_L + D_s) + \frac{(D_L - D_s)^2}{4C} \quad (2)$$

Where: L = length of the belt (mm)
C = distance between centers of pulleys (mm)
D_L = diameter of the large pulley (mm)
D_S = diameter of the small pulley (mm)

3. Frame Assembly

Taking into consideration the materials at hand for fabrication, the machine's frame assembly was constructed using metal pipes and flat bars, subsequently shielded by sheet metals. To prevent motor overheating, checkered stainless steel was employed as ventilation on both the right and left sides of the frame.

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Figure 5. Frame assembly of the machine

4. Counter-rotating Gears

Gears were connected on the same side of the shaft to produce the counter rotation of the shafts. Spur gear design and calculations was based on PAES 306:2000 (Table 1).

Table 1
Spurgear Calculations

TO OBTAIN	GIVEN	FORMULA
Module	Circular pitch	$\frac{\text{Circular pitch}}{\pi}$
	Number of teeth and pitch diameter	$\frac{\text{Pitch diameter}}{\text{Number of teeth}}$
Pitch diameter	Number of teeth and module	Number of teeth x Module
Number of teeth	Pitch diameter and module	$\frac{\text{Pitch diameter}}{\text{Module}}$
Tooth thickness of the pitch line	Module	1.5078 x Module
Outside diameter	Pitch diameter and addendum	Add 2 addendums to the pitch diameter
Minimum whole depth	Module	Coarser than 1.0583 module, 2.35 x module
Addendum	Module	addendum = module
Dedendum	Module	dedendum = 1.25xmodule
Clearance	Whole depth and addendum	Subtract two addendums from the whole depth
Center distance	Number of teeth of driver and driven gear, t_1 and t_1 Module	$\frac{\text{module}(t_1 \text{ and } t_1)}{2}$

Principle of Operation

The machine's design facilitates operation by a single individual. The operational process is illustrated in Figure 6 through a schematic diagram. The loading of input materials into the input chute begins once the machine reaches

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its maximum speed. Continuous feeding of Red Onions is maintained until the final stem is cut. Subsequently, the input materials descend into the collection bin. The cutting action is executed by two counter-rotating sets of blades, driven by a 0.186kW electric motor. A pair of equally-sized spur gears is employed to ensure the counter rotation of the blades, maintaining consistent rpm levels across the shafts.

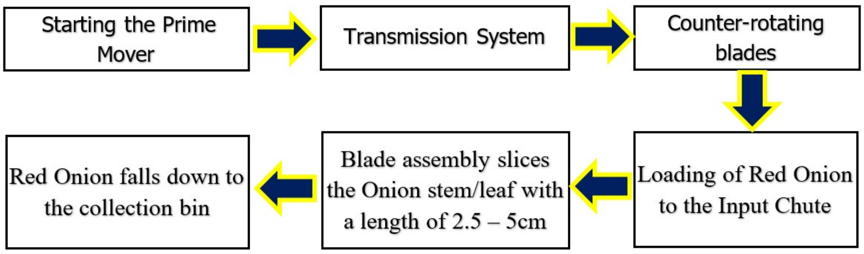

Figure 6. Schematic diagram of the principle of operation of the machine

RESULTS and DISCUSSION

Description of the machine

The fabricated machine (Figure 7) worked in continuous feeding manner wherein the material was fed in the machine nonstop until the last material unless the machine experiences clogging.

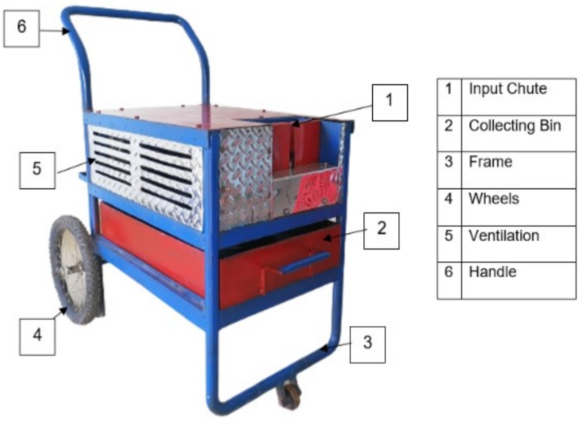

Figure 7. Fabricated Red Onion Stem Cutting machine

Transmission Assembly

The transmission assembly consisted of a pulley with a diameter of 76.2mm, linked to another pulley to achieve the desired RPM. To facilitate ease of repair and maintenance, the specifications of commonly available local prime movers were considered. The machine utilized a prime mover with a power output of 0.186kW and a rotational speed of 1350 revolutions per minute (rpm).

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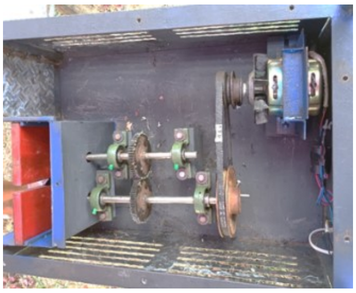

Figure 8. Transmission assembly of the machine

Input Chute

The input chute where the onions are feed in was made of sheet metal. The chute can accommodate up to eight Onions during operation.

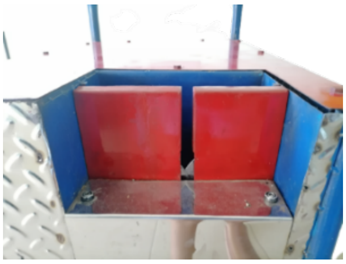

Figure 9. Input chute of the machine.

Frame Assembly

The frame of the machine isn consist of angle bars with and hollow steel tube with 25mm diameter. A battery holder was included in the frame assembly as the battery can be used as power source during power outage and/or field operation.

Figure 10. Frame assembly of the machine

Collecting Bin

The collecting bin of the machine was made up of sheet metal with a length of 700 mm and width of 500 mm and has a capacity of up to 15kg.

Figure 11. Collecting bin of the machine

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Table 2
Specifications of the Red Onion stem cutting machine

ITEM	SPECIFICATION
Main structure	
Overall dimensions, mm	
Length	750
Width	525
Height	1000
Weight, kg	25
Power Transmission system	
V-Pulley	152.4mm diameter, single groove
V- Pulley	76.2mm diameter,Single groove
V-belts	Size A
Gear	127mm outside diameter, 32 teeth, AISI 1045
Shafts	12.7mm diameter, ASTM A36 Steel
Cutting Assembly	
Cutter blades	180mm diameter, 1mm thickness, Stainless Steel 304
Prime Mover	
Electric Motor	0.186kW, Single Phase
Covers (Ventilation)	1mm thickness checkered Stainless
Frame Assembly	25mm hollow steel tube
Machine Performance	
Cutting Capacity	59.43 kg/hr
Cutting Efficiency	98.16 %

Machine Performance Evaluation

The machine was evaluated in terms of the capacity, efficiency and energy demand as affected by different speed of the shaft (450rpm, 900rpm and 1350 rpm). The The results were analyzed statistically using Statistical Tool for Agricultural Research (STAR).

Machine Cutting Capacity

It is the ratio of the weight of the clean cutted Onion product, to the total weight of the input materials subjected to the input chute for cutting, expressed in Kg/hr determined by the following equation (PAES 245:2010):

$$\mathrm{Ci} = \frac{\mathrm{Wi}}{\mathrm{T}} \qquad (3)$$

Where: Ci = Input Capacity, Kg/hr
Wi = Weight of Input Material, Kg
T = Operating Time, hr

As detailed in Table 3, the highest shredding capacity was attained at the swiftest shaft speed of 1350rpm, averaging at 59.43kg/hr. Following closely, the next highest capacity was observed at 900 rpm, with an average value of 57.76kg/hr. Conversely, the slowest main shaft speed resulted in the lowest capacity, averaging at 56.76kg/hr. However, the analysis of variance presented in Table 4, considering a significance level of 5%, revealed that the variation in shaft speed does not exert a statistically significant impact on the cutting capacity of the device. This lack of statistical significance can be attributed to the absence of teeth on the cutter blades.

According to saxtonblades.co.uk (2020) and circularsawblade.net (2022), saws and blades are rated by their RPM, but this measure is not a reliable indicator of their cutting speed. The number of teeth on the blades plays a more significant role in determining the cutting speed. Blades with fewer teeth tend to cut through materials faster, while

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blades with more teeth create a finer finish and a smoother cut. Therefore, the cutting capacity of the device was primarily affected by the operator's familiarity with the machine's operation rather than the shaft speed.

Table 3
Mean cutting capacity at various main shaft speed, kg/hr.

Treatment	Capacity Means
1 (450rpm)	56.76
2 (900rpm)	57.76
3 (1350rpm)	59.43

Table 4
Analysis of variance on the cutting capacity as affected by shaft speed

Source	DF	Sum of Square	Mean of Square	F value	Pr (>F)
Treatment	2	10.9468	5.4734	2.27	0.1850
Error	6	14.4979	2.4163		
Total	8	25.4446			

*The null hypothesis (H0) is accepted, since: 0.185>0.05, (p-value>α) which means there is no difference in the means independently.
*The null hypothesis (H0) is accepted, since: 5.143>2.265, (FT>FC) which means there is no difference in the means independently.

Machine Cutting Efficiency

It is the ratio of the weight of the clean-cut materials, to the total weight of the clean cut and damage onions, expressed in percent determined by the following equation:

$$EC = \frac{CO}{CO + DO} \times 100 \tag{4}$$

Where: EC = Machine Cutting Efficiency, %
CO = Clean-cut onion, kg
DO = Damage onion, kg

Table 5 presents the average cutting efficiency of the machine at various shaft speeds, while Table 6 provides the results of the analysis of variance at a significance level of 5%. The analysis indicated that there were no significant differences observed among the means of all the treatments. In terms of cutting efficiency, onions that did not meet the standard length of cut (2.5-5cm) were classified as damaged onions, which contributed to the inefficiency of the device.

Table 5
Mean cutting efficiency at various main shaft speed, %

Treatment	Efficiency Means
1 (450rpm)	97.95
2 (900rpm)	96.18
3 (1350rpm)	98.16

Table 6
Analysis of variance on the cutting efficiency as affected by shaft speed

Source	DF	Sum of Square	Mean of Square	F value	Pr (>F)
Treatment	2	7.1371	3.5685	2.84	0.1354
Error	6	7.5337	1.2556		
Total	8	14.6708			

*The null hypothesis (H0) is accepted, since: 0.135>0.05, (p-value>α) which means there is no difference in the means independently.
*The null hypothesis (H0) is accepted, since: 5.143>2.845, (FT>FC) which means there is no difference in the means independently.

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Electrical Energy Consumption

The amount of electricity consumed by the machine to cut a kilogram of Red Onion leaf expressed in kilowatt-hour per kilogram (PAES 233:2008).

$$E_c = \frac{P_c T_o}{W_o} \tag{5}$$

Where: E_c = Electrical energy consumption, kW-h/kg
P_c = Power consumed, kW
T_o = operating time, h
W_o = Total weight of test material, kg

Table 7 displays the average energy demand at different main shaft speeds. Interestingly, the highest revolutions per minute (RPM) corresponded to the highest energy consumption of 0.0054 kW-h/kg. However, the analysis of variance presented in Table 8 indicated that there were no significant differences among the treatments in terms of energy demand.

Table 7
Mean energy demand at various main shaft speed, kW-h/kg

Treatment	Energy Demand Means
1 (450rpm)	0.0050
2 (900rpm)	0.0043
3 (1350rpm)	0.0054

Table 8
Analysis of variance on energy demand as affected by shaft speed

Source	DF	Sum of Square	Mean of Square	F value	Pr (>F)
Treatment	2	0.0000	0.0000	1.71	0.2588
Error	6	0.0000	0.0000		
Total	8	0.0000			

*The null hypothesis (H0) is accepted, since: 0.2588>0.05, (p-value>α) which means there is no difference in the means independently.
*The null hypothesis (H0) is accepted, since: 5.143>1.71, (FT>FC) which means there is no difference in the means independently.

Mechanized Cutting of Onion Leaf

The preliminary activities provided the data necessary to compute manual capacity and efficiency. A proficient worker's performance was measured by timing the cutting of onion leaves with a bolo over an hour. The resultant cut materials were weighed to determine the output in kg/hr. The cut segments of onion stems were examined to ensure they met the prescribed 2.5-5cm length. Any onions falling outside this range were classified as defects and subtracted from the final output weight. Dividing the final weight by the initial weight yielded a manual cutting efficiency of 95.87%.

Table 9 presents the mean values from the comparison of onion leaf cutting using manual and machine methods. The outcomes highlighted that manual cutting achieved a maximum capacity of 31.25 kg/hr, while machine cutting achieved 59.43 kg/hr. The introduction of the machine effectively doubled the capacity compared to traditional manual cutting, leading to reduced operational time and decreased manual labor requirements.

However, a paired sample t-test was conducted to assess the significance of the difference in efficiency between the cutting machine and manual cutting. The results of the test indicated that there was no significant difference in efficiency between the two methods at a 95% confidence level.

Table 9
Comparison of manual and mechanized capacity of Red Onion cutting

Treatment	Capacity (kg/hr)	Cutting efficiency (%)
Machine	59.43	98.16

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Manual	31.25	95.87

Cost Analysis on the use of the device

The cost of the Red Onion cutting machine is Php 5,500.00 (98.78$). Operating the machine incurs an annual expense of Php 21,755.32. To reach the breakeven point, the machine needs to cut a total of 1601.65 kg/yr of Onion Leaves. The established custom rate stands at Php 1.5/kg (0.027$), resulting in a yearly net profit of Php 15,685.58 for the machine owner. The machine yields a rate of return of 72.1%, and its payback period is 0.32 years, equivalent to the first harvesting season. Table 9 showcases data gathered from onion farmers and other underlying assumptions, while Table 10 details the computations for the annual fixed breakeven point. Additionally, Figure 12 illustrates the cost curve linked with the machine's utilization.

Table 9
Basic data, data obtained from onion farmers, and other assumtions

Basic data, data obtained from onion farmers, and other assumtions		UNIT
Investment Cost (Cutting machine)	5,500.00	Php
Life Span	5.00	years
Input Capacity of the machine	59.43	kg/day
Wage for the operator (Mindoro Minimum Wage)	320.00	Php/day
Operator	1.00	Person
Average electric cost (ORMECO Power Rate)	11.50	Php/kw
Operating Time	8.00	hrs/day
Annual Operation (One Cropping per year)	60.00	Days/yr
Machine Power consumption	0.18643	Kw-hr
Custom rate (machine)	1.50	Php/kg
Average yield	7.20	MT/ha
Traditional/Manual Labor	30-40	Person/ha/day
Average custom rate (Manual Labor)	2.22	Php/kg

Table 10
Cost Analysis of using the machine

Particulars			USD ($) conversion
Annual Fixed Cost	1,251.25	Php/yr	22.47
Depreciation	990.00	Php/yr	17.78
Interest on Investment	151.25	Php/yr	2.72
Tax and Insurance	110.00	Php/yr	1.98
Variable Cost	42.72	Php/hr	0.77
Operator's Wage	19,200.00	Php/yr	344.83
Repair and Maintenance	275.00	Php/yr	4.94
Power Cost	1,029.066	Php/yr	18.48
Breakeven Point	1,601.65	Kg/yr	28.77
Net Income	15,685.58	Php/yr	281.71
Rate of Return	72.1	%	
Payback Period	0.32	yr	

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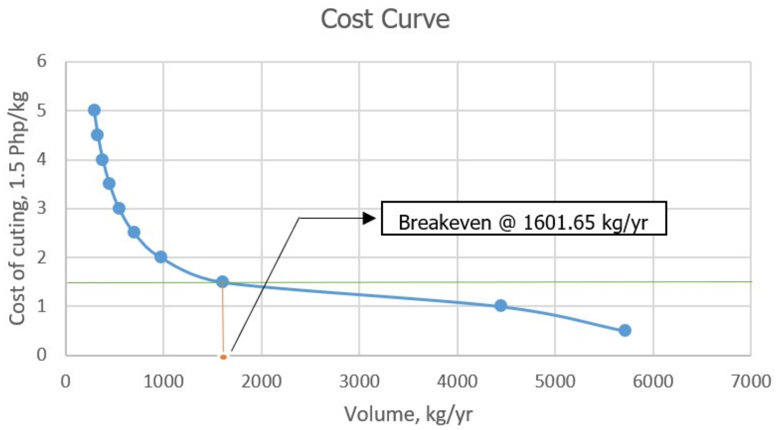

Figure 12. Cost Curve of using the machine

Conclusions and Recommendations

Bulb onion (Allium cepa L.), commonly referred to as 'sibuyas,' holds a paramount role as a culinary staple not only within the Philippines but also on a global scale. With the enactment of the Agricultural and Fisheries Mechanization Act Law in 2013, comprehensive initiatives for mechanization and modernization in agriculture have been introduced. While substantial data updates have been carried out for major crops, onion cultivation has yet to receive such attention. The mechanization of harvesting and postharvest processes in onion production remains relatively underdeveloped, limited primarily to mechanical power employment during hauling. Manual labor, supported by small hand tools, is entirely responsible for tasks like onion pulling, stem and root cutting, cleaning, and bagging.

Consequently, this study is focused on designing and fabricating a red onion stem cutting machine utilizing locally accessible materials and manufacturing techniques. The primary objectives include assessing the machine's performance in terms of cutting capacity and efficiency, gauging its electrical energy consumption, and conducting a cost analysis of its utilization.

Based on the objective and findings of the study, the following conclusions were drawn:

1. The effectiveness of the devised cutting machine's concept and mechanism has been demonstrated in successfully decreasing labor, time, and costs associated with cutting Onion leaves, concurrently yielding supplementary income for farmers and/or processors.;
2. The machine can be fabricated using locally available materials and local manufacturing technologies;
3. The machine has exhibited excellent performance, meeting or surpassing the specified performance parameters. These parameters include cutting capacity and cutting efficiency. The machine's cutting capacity was twice that of manual cutting operations, showcasing its remarkable capabilities. Moreover, the machine displayed superior efficiency in its cutting processes, further highlighting its effectiveness.
4. The energy demand of the cutting machine at shafts speed of 1350rpm is 0.0054kW-hr/kg. Power consumption of the machine is considered economical based on the computed annual power consumption cost of Php 1029.066; and
5. The financial analysis of utilizing the machine demonstrates its viability. By employing the machine for cutting operations, local Onion farmers and/or processors have the potential to reduce labor costs and augment their profits by Php 15,685.58 on an annual basis. The fabrication cost of the machine was a mere Php 5,500.00. The projected annual operating cost amounted to Php 21,755.316, resulting in a computed breakeven weight of 1601.65 kg and a payback period of 20 working days.

Based on the result and conclusions of the study, the following are recommended:

1. To cut the labor cost of onion farmer in cutting the Onion stem and increase their profit, this machine is recommended to cut the stem/leaf of their Onion produce.

2. In order to operate the cutting machine, local onion farmers should consider the following guidelines:
    a. To achieve an input capacity of 59.43kg/hr and a cutting efficiency of 98.16%, run the machine at a shaft speed of 1350rpm.
    b. For optimal electrical energy consumption of 0.0054kw-hr/kg, employ a shaft speed of 1350rpm.
    c. Ensure the machine reaches full speed before introducing onions for cutting.
    d. Avoid removing the machine's covers during operation.
    e. Do not operate the machine without proper understanding of its operational procedures.
3. There should be a provision where onions will be placed. In this way, it will be easier and faster to pick up the onions ready for the cutting.
4. It is advisable to contemplate the inclusion of a container for gathering the cut stems.
5. Incorporate a safety feature for the machine by integrating an emergency stop button.
6. Studies must be conducted to further increase the performance of the machine.

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REFERENCES

Arim, J., Kioko, S., Otieno, S., Efukho, C., Mbuthia, G., Mangoli, F., Oirere, Z., Mbuthia, E., Malenge, F., Aikawa, J., Kita, K., Kitajima, H., Takashina, Y., Seo, T. 2019. Bulb Onion Production. Smallholder Horticulture Empowerment & Promotion Project or Local and Up-Scaling (SHEP PLUS).

Circularsawblade.net. 2022. Circular Saw Blades Rotation Speed. Available at http://circularsawblade.net/speed. Accessed on February 2022.

Food and Agriculture Organization of the United Nations. 2021. Rapid appraisal: postharvest handling of onions in Ilocos, Nueva Ecija and Pangasinan. Available at https://agris.fao.org/agris-search/search.do? Accessed on January 2022.

Kiron, M. 2013. Features and Parts of Round Knife Cutting Machine with Advantages and Disadvantages. Department of Textile Engineering. Ahsanullah University of Science and Technology (AUST).

Philippine Agricultural Engineering Standard. 2010. Agricultural machinery – Biomass Shredder – Methods of Test. Department of Trade and Industry. PNS/PAES 245:2010.

Philippine Agricultural Engineering Standard. 2008. Agricultural Machinery-Multicrop Washer-Peeler–Methods of Test. Department of Trade and Industry. PNS/PAES 233:2008.

Philippine Agricultural Engineering Standard. 2000. Engineering Materials – V-belts and Pulleys for Agricultural Machines – Specifications and Applications. Department of Trade and Industry. PNS/PAES 301:2000.

Philippine Agricultural Engineering Standard. 2000. Engineering Materials – Flat Belts and Pulleys for Agricultural Machines –Specifications and Applications.Department of Trade and Industry. PNS/PAES 302:2000.

Philippine Agricultural Engineering Standard. 2000. Engineering Materials – Keys and Keyways for Agricultural Machines – Specifications and Applications.Department of Trade and Industry. PNS/PAES 304:2000.

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Philippine Agricultural Engineering Standard. 2000. Engineering Materials – Shafts for Agricultural Machines – Specifications and Applications. Department of Trade and Industry. PNS/PAES 305:2000.

Philippine Agricultural Engineering Standard. 2000. Engineering Materials – Spur Gears for Agricultural Machines – Specifications and Applications. Department of Trade and Industry. PNS/PAES 306:2000.

Saxtonblades.co.uk. 2020. How to Choose a Circular Saw Blade. Available at https://www.saxtonblades.co.uk/blog/how-to-choose-a-blade-for-your-circular-saw/. Acessed on January 2022.

Statista. 2021. Production volume of onions in the Philippines from 2012 to 2021. Available at https://www.statista.com/statistics/752167/philippines-onion-production/. Accessed on January 2022.

Yorksaw and Knife Incorporated. 2021. Choosing the right circular knives for your application. Available at https://www.yorksaw.com/ choosing – the – right – circular – knives -for-your application/. Acessed on January 2022.