DESIGN AND DEVELOPMENT OF TIGER GRASS POLLEN REMOVER CON WOOD WORKING MACHINE

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Abstract

The potential of tiger grass production in the Province of Romblon, Philippines was seen as a good alternative source of income along with the main source such as farming and fishing. Two municipalities were identified as major producers of tiger grass where production are extensive and commercialized because it is easy to grow and a potential source of income. Fetalvero(2011) mentioned that tiger grass production can generate estimated revenue of Php1M to Php2M depending on the prevailing market prices. However, if these raw materials were to be processed into soft brooms, an estimated 241,890 brooms can be produced creating annual revenue ranging from Php3.6M to Php7.3M. Figures may be higher if their primitive farming and traditional marketing practices could be improved. The machine is composed of four major components, the pollen remover assembly, the power unit, the machine frame or support, and the wood lathe assembly. The machine was also equipped with pollen catcher for safety and health purposes. During the test conducted to determine the performance of the machine, it was revealed that there is no significant difference in using the 5-inch pulley and the 7-inch pulley using the different nylon length. It was also revealed in the study that the time consumed in making a handle depends on the skill of the operator and the size of the raw wood to be used. To determine the viability of the machine, a different approach of economic analysis was conducted and all approaches showed that an investment for the tiger grass pollen remover con wood working machine is profitable.

Keywords: *Broom Making, Pollen Remover, Tiger Grass, Walis Tambo, Wood Working Machine*

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1. INTRODUCTION

Tiger grass (thysanolaena maxima), also known as "luway" (**Figure 1**) is chiefly used as raw materials in the making good quality soft brooms. This widely known *walistambo* can be found in many parts of the Philippines especially in the hilly parts of Northern Luzon.

Figure 1: Physical Appearance of Tiger Grass (Luway)

In Romblon, two municipalities are identified as major producers of tiger grass, the municipalities of San Agustin and San Andres. The production of tiger grass in these municipalities are extensive and commercialized because tiger grass is easy to grow and a potential source of income. It is estimated that around 400 hectares of land in Tablas Island in the province of Romblon are planted with tiger grasses with more farms being established each year for the past three years.

According to the Department of Science and Technology (DOST) - Provincial Science and Technology Center – Romblon, 200 has. of land in barangay Dona Juana, San Agustin, Romblon is planted with tiger grass. The value of the annual harvest for tiger grass is estimated at Php4M. The brooms that come from this raw materials source are valued at Php25 and there are about 400 farmers engaged in planting and harvesting this crop. Realizing the potential of the industry and the need to modernize production, the Mayor of San Agustin implemented a project that would provide a common service facility for processing tiger grass.

In the study conducted by Fetalvero and Faminial (2010), tiger grass farming and production is already a long time economic activity in Maringondon Norte, San Andres, Romblon. The approximate income in tiger grass farming in the area ranges from Php2,500 to Php130,000 with an average income of Php20,500 per farmer annually. Out of the one hundred tiger grass farmers surveyed, 86 of this farmers get their income mainly in tiger grass farming alone and the remaining 14 are farmer - processor. The total farm size in this area was 130.6 has distributed in different location. Ambunan has 39 hectares, Hagnaya with 37.8 has. Naruntan with 24.75 has., Lindero with 14.3 has., Hamigit big with 7.75 has., and Hamigit small with 7 has.

Accordingly, two tiger grass products were produced in the Marigondon Norte, San Andres, Romblonthe dried *luway* and the soft broom (walistambo). Most of the dried luway produced are sold to wholesalers and agents in different municipalities in the province and nearby provinces like Mindoro.

Fetalvero and Faminial (2010) said that one of the common problems encountered by tiger grass farmers are the absence of modern tiger grass processing facilities. As mentioned earlier, out of the one hundred farmers surveyed, only 14 percent are engaged in tiger grass farming – processing. It is a clear indication that processing of tiger grass is a problem in the area and needs to be addressed.

In an interview conducted how tiger grass pollen is removed from the stalks, respondents Librado and Francisco who hailed from San Andres, Romblon said that the traditional way of removing tiger grass pollen is by striking and shaking by hand and it entails 10-15 minutes per 100 stalks of manual cleaning. This procedure is tedious and time consuming and besides, not all seeds are shaken off and stalks can be broken.

Based on the interview conducted to the producer of *walistambo* the usual handle of the broom is made from the stalks of the tiger grass, but it is time consuming and needs tying wire to hold the stalk. Some uses wood from tree branches but they complained of the handle's irregular shape which is not attractive to consumers. Others used plastic rattan to cover the irregular shaped handle to be attractive but it also entails additional cost.

Fetalvero and Faminial (2010) mentioned that tiger grass farmers should be reorganized and a comprehensive plan for tiger grass industry including soft broom processing should also be prepared. The Department of Science and Technology (DOST)-Romblon is also proposing a Techno Demo cum Forum on Tiger Grass Technologies in the municipality of San Agustin and this would include purchasing tiger grass inflorescence remover, the machine developed in Don Mariano Marcos State University, San Fernando City, La Union. The tiger grass inflorescence remover machine is the only known machine developed in the country. Since Romblon is a far place from La Union, purchasing this machine in this place would entail additional travelling expenses.

Based on recommendation and problems identified, the proponent decided to design, construct and performance test a motorized tiger grass pollen remover con woodworking machine to be designed and constructed at the Romblon State University.

2. OBJECTIVES

The study was conducted to design, construct and performance test a tiger grass pollen remover con woodworking machine at Romblon State University, Odiongan, Romblon, Philippines during the academic year 2011-2012.Specifically, the objectives of the study were:

(2.1) To design and fabricate the components of the tiger grass pollen remover con woodworking machine such as:

a. Pollen Remover Assembly
b. Wood Working Unit;
b.1 Head stock assembly
b.2 Tail stock assembly
b.3 Tool rest assembly
c. Driving mechanism, and
d. Frame

(2.2) To conduct performance testing to:

a. determine the average time consumed in removing tiger grass pollen at different speeds using 5-inch and 7-inch pulley sizes and different nylon brush length;
b. determine the average number of stalks damaged at different speeds using the 5-inch and 7-inch pulleys and different nylon brush length;
c. determine the average length of detached tips from the stalks at different speeds using the 5-inch and 7-inch pulleys and different nylon brush length;
d. determine the appropriate pulley size and nylon brush length suited to attain the maximum performance of the machine; and
e. determine the time consumed in making a broom handle

(2.3) To determine the economic viability of the machine

3. SIGNIFICANCE OF THE STUDY

The unavailability of locally developed tiger grass pollen remover and handle maker machine encouraged the researcher to design, construct, and performance test the proposed machine. Benefits derived from this study will have a greater income for tiger grass growers and soft broom manufacturer. Since tiger grass is a good raw material for soft broom, this study will encourage farmers to engage in the production of tiger grass since this is a flourishing industry in the country.

In addition, agriculture related agencies will financially support research endeavors how to increase tiger grass production. Cooperatives and lending institutions will extend their services to the community for the production of tiger grass. Finally, this project will also serve as guide to future researchers who will conduct similar studies.

4. METHODOLOGY

Figure 2 shows the flowchart of the major activities in the conduct of the study. These activities cover the assembly of the different components of the machine, testing evaluation, modification for improvement, final testing and report preparation.

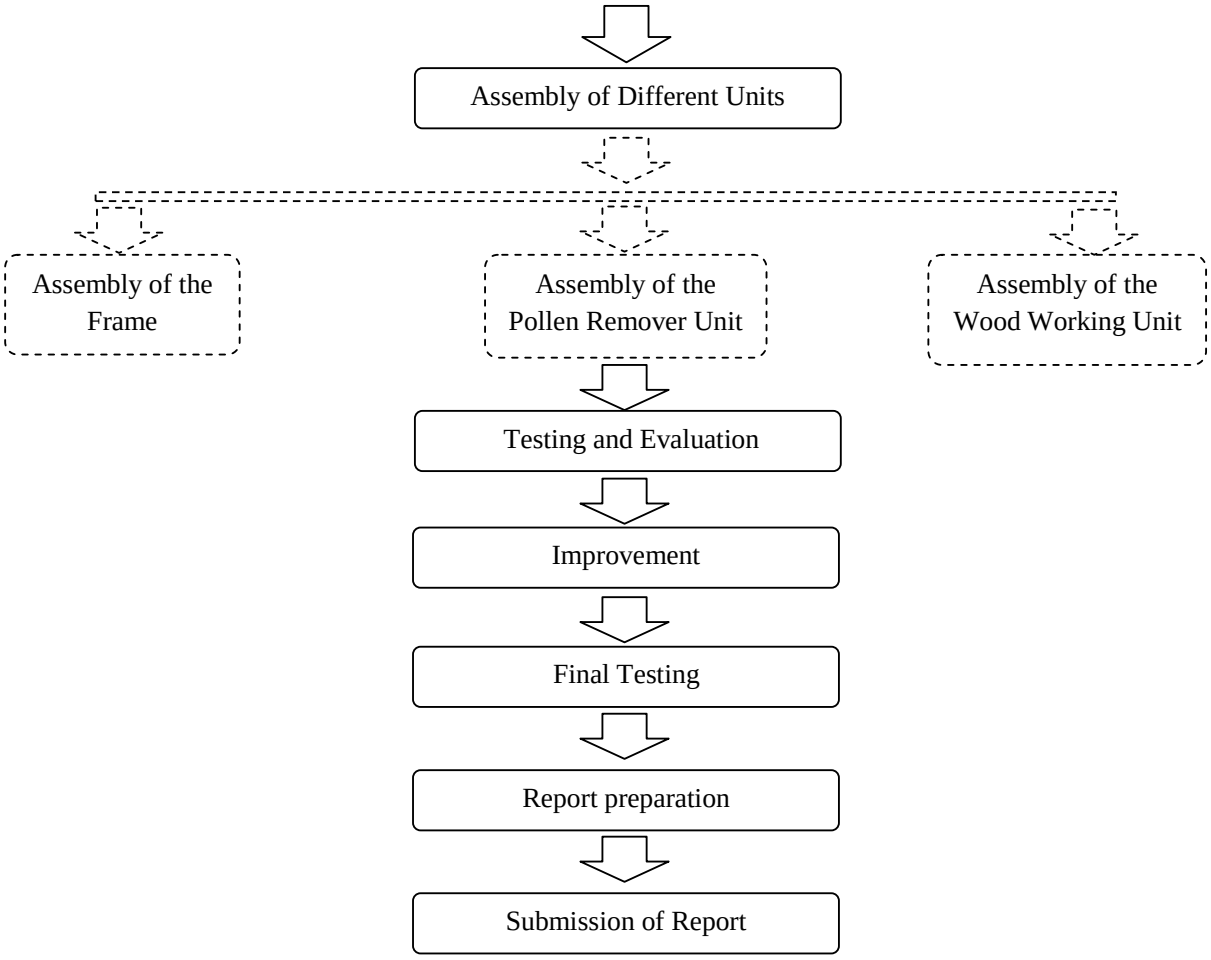


Figure 2: Flowchart of the Activities

4.1 Construction Procedure

The construction procedures of the tiger grass pollen remover con wood working machine are presented in details below.

1. The Frame
a. Secure all the supplies, materials, tools and equipment needed in the construction the frame
b. Measure and cut the pieces to the required dimension.
c. Cut all intersections to the required angle.
d. Assemble the frame. Use an electric arc welding in joining the angle bars.
e. Grind the protruding welded parts of the frame with a portable grinder.
f. Use the file to grind the protruding parts that are not removed by the grinder

2. The Shaft
a. Prepare all supplies and materials needed.
b. Used welding machine to connect the flat bars to the shaft. Then grind the welded parts for smooth finish.
c. Insert the pillow block in the shaft using hydraulic press.
d. Insert the small pulley to the shaft.
e. Screw the pillow block to the frame

3. The Pollen remover
a. Insert the nylon in shaft then used the flat bar to tense up the nylon then used the bolts and nuts to lock.
b. Used the bench tools for the tightening of the bolts and nuts.

4. The Power Unit
a. Measure the distance of the two pulleys.
b. Lay out the motor
c. Screw the motor to the frame
d. Assemble the switch to the main frame
e. Make sure electric wiring are in place
f. Connect the male plug to the wire

5. Cover
a. Measure and cut the sheet with a tin cutter
b. Grind using sandpaper to ensure smooth finish to avoid scratches when holding the cover
c. Weld the cut sheet to the frame
d. Grind using electric grinder the welded parts

6. Tail Stock
a. Make the frame of the tail stock
b. Turn dead center assembly
c. Attach hand wheel to the dead center
d. Assemble the dead center assembly into the tail stock frame

e. Make a lock for the tail frame assembly

7. Tool rest
a. Make the frame for the tool rest and table attachment
b. Make T-test
c. Make the lock for tool rest assembly on the table

8. Finishing
a. Grind using sandpaper all the rough surfaces of metal and wood as well
b. Use number 120 sandpaper in final sanding
c. Apply primer to the metal
d. Apply the finishing materials for the first coat
e. Apply the paint for the final coating

4.2 The Working Drawing

Figure 3 illustrates the machine frame, while **Figure 4** is the pollen remover assembly, and **Figure 5** is the wood working assembly. All of these drawings are not drawn to scale.

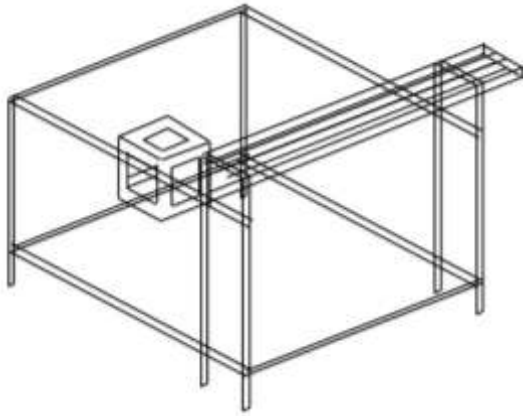


Figure 3: Project Frame

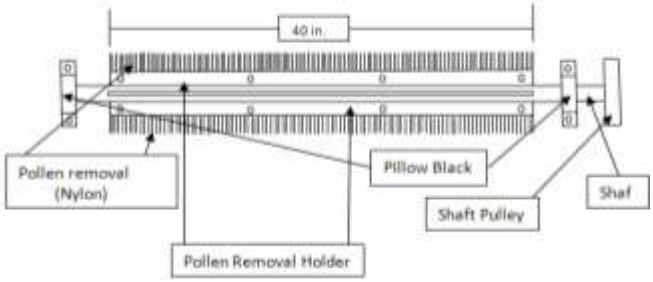


Figure 4: The Pollen Remover Assembly

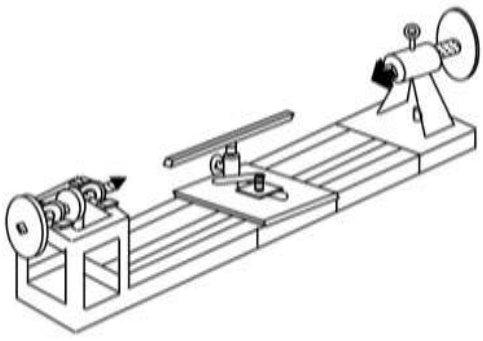
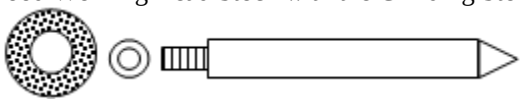


Figure 5: Wood Working Assembly

On the other hand, **Figures 6, 7** and **8** are the shafting components, pollen remover assembly, and the detailed tailstock assembly drawing, respectively, All drawings are not drawn to scale.

Wood Working Head Stock with the Grinding Stone



Pollen Remover Assembly

Figure 6: The Shafting Components

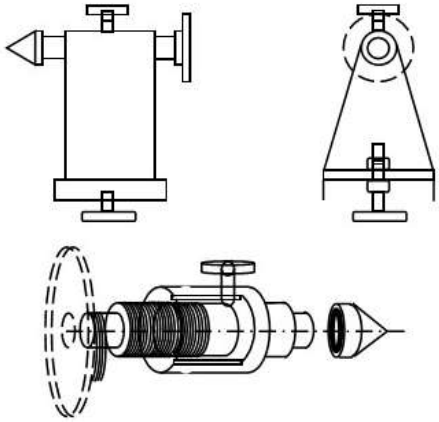


Figure 7: Detailed Drawing of Tailstock Assembly

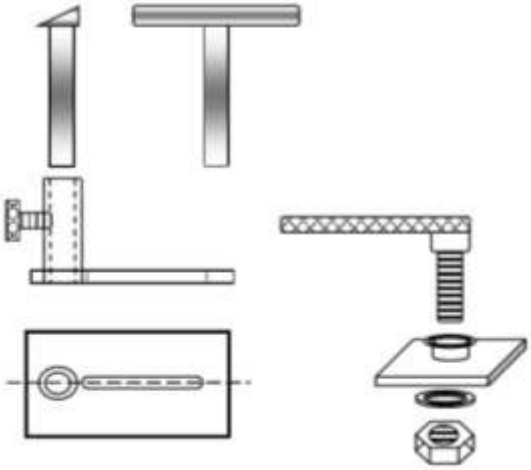


Figure 8: The Tool Rest Assembly

5. RESULTS AND DISCUSSION

The succeeding discussion covers the results of the study in terms of the components assembly of the machine, as well as the findings in the performance of the machine.

A. The Machine

The machine is composed of four major components, the pollen remover assembly, the power unit, the machine frame or support, and the wood lathe assembly.

a.1 The Pollen Remover Assembly
The Pollen Remover is made of several nylon brush, tightly held by a square bar with wholes fixed inside the angle bar form like a rectangular tube and the spring use to return the middle square bar in its original place while bolt was being tightened. The six pair nylon holders are welded to the solid shaft. The shaft was driven by0.5 horsepower (hp) motor.

a.2 The Power Unit
The power unit consists of electric motor, v-belt and pulley. The electric motor with 0.5 hp capacity is the prime mover of the machine. The researcher uses two different sizes of belts(B53 and B57) for two different pulleys (5 inch and 7 inch). The electric motor having a shaft pulley of three (3) inches transmits power from the electric motor to the 1 inch pollen remover shaft. The same motor was also used in operating the wood lathe.

a.3 The Machine Frame
The machine frame measures 37 in. x 30 in. x 31 inch and carries the component of the machine. The frame was made of 1 ½" x 1 ½'' and 2" x 2" angle bar, gage 22 G.I. sheet and plastic mesh wire. The joints were shielded metal arc welded to insure strength of the joints.

a.4 The Wood Lathe Assembly
1. The HEADSTOCK is rigidly fixed to the left end of the lathe bed and carries a spindle. The spindle carries the chuck which will then hold material to b e turned. A six-inch pulley is attached to the headstock spindle and is driven by the 0.5 hp motor.
2. The TAILSTOCK is movable and can be locked in any position along the bed. It also has a spindle that holds the cup center. This spindle can be moved in and out of the tailstock by turning the hand wheel. The cup center is removed by turning the handwheel counterclockwise.
3. The TOOL REST (also called the tool support) clamps to the bed and can be adjusted up and down, at any position along the bed. The top edge must be straight and smooth so that the lathe tools can be easily moved.

B. The Performance of the Machine
The results of the performance of the machine are shown in **Tables 1, 2, 3, 4, 5 and 6**. During the test conducted to determine the performance of the machine, it was revealed that there is no significant difference in using the 5-inch pulley and the 7-inch pulley using the different nylon length. With this result, the author recommends that the machine be equipped with 7-inch pulley and 2 ½ inch or 3 inch nylon brush. The 7-inch pulley yielded 0 damages while in removing pollen from the stalks using the 3-inch nylon brush, it yields an average time of 1.21 minutes per bundle. In using the same pulley and the 2 ½ -inch length of nylon brush, the detached tips from the tiger grass revealed as having the shortest with 2.28 inch.

Table 1: Result of test conducted to determine the performance of the machine using the 5 inch pulley at different brush size

Trial	1 inch nylon	1.5 inch Nylon	2 inch Nylon	2.5 inch nylon	3 inch nylon
1	0.81	2.05	1.75	1.20	1.17
2	1.81	2.46	2.17	1.7	1.91
3	2.00	1.13	2.33	1.5	1.83
4	1.62	2.47	1.42	1.35	1.30
5	1.34	2.08	1.51	1.37	1.33
Ave	**1.52**	**2.04**	**1.84**	**1.42**	**1.51**

Table 2. Number of stalks damaged using the 5 inch pulleys at different brush size

Trial	1 inch nylon	1.5 inch Nylon	2 inch Nylon	2.5 inch nylon	3 inch nylon
1	1	0	0	1	1
2	1	0	0	0	0
3	0	0	0	1	0
4	1	0	0	0	0
5	1	0	0	1	0
Ave	**0.80**	**0.00**	**0.00**	**0.60**	**0.20**

Table 3. Result of test conducted to determine the performance of the machine using the 7 - inch pulley at different brush size

Trial	1 inch Nylon	1.5 inch Nylon	2 inch Nylon	2.5 inch nylon	3 inch nylon
1	2.91	1.75	2.84	1.25	1.26
2	5.21	1.89	1.89	1.63	1.25
3	5.74	2.52	1.94	1.56	1.12
4	6.19	1.94	1.75	1.42	1.2
5	6.55	2.73	1.49	1.58	1.21
Average	**5.32**	**2.17**	**1.98**	**1.49**	**1.21**

Table 4. Number of stalks damaged using the 7-inch pulleys at different brush size

Trial	1 inch nylon	1.5 inch Nylon	2 inch Nylon	2.5 inch nylon	3 inch nylon
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
Average	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Table 5. Average length (inch) of detached tips from the stalks

Trial	1 inch nylon	1.5 inch Nylon	2 inch Nylon	2.5 inch nylon	3 inch nylon
5 inch pulley	3.35	3.19	2.48	4.29	2.44
7 inch pulley	3.19	2.72	2.52	2.28	3.98

Table 6. Time consumed in making handle

Operator	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Skilled	4	6	5	6	4
Novice	10	15	12	14	15

Moreover, during the test of the wood lathe, the time consumed in making a handle depends on the skill of the operator and the size of the raw wood to be used. A skilled operator can make one handle at an average time of 5 minutes using a 2 x 2 x 24 inch commercial lumber while a novice operator can make one handle at a time of10-15 minutes using the same wood and size. The machine was also equipped with pollen catcher for safety and health purposes.

C. The Power Consumption

The motor was rated at 0.5 horsepower (hp) equivalent to 0.374 kilowatt (KW). According to the Tablas Electric Cooperative, the prevailing price of electric power is P12.13/KW-hr., therefore the machine has power consumption of P4.52/KW-hr as calculated from 0.374 KW x (P 12.13/KW-hr) = P 4.52/hr.

Table 6: Summary of Actual Annual Financial Requirements

Particulars	External Funding (Php)	Internal Funding (Php)	Total (Php)
Personnel Services	59,300.00	44,000.00	103,300.00
Materials	10,763.00		10,763.00
Tools and Equipment	33,951.00		33,951.00
Overheads		20,000.00	20,000.00
TOTAL	**104,014,00**	**64,000.00**	**168,014.00**

6. CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, the researcher had drawn the following conclusions:

a. Since the design of the machine is simple and its components are easy to fabricate, grass pollen remover machine must be utilized to help ease the burden of tiger grass farmers and processors in Romblon and other tiger grass producing areas in the Philippines;
b. With proper coordination in transferring the technology, an ordinary fabricator can easily duplicate the machine;
c. The wood working unit of the machine can produce a uniform handle which the broom maker can select the handle to be used for different purpose;
d. The wood working machine can produce a handle which could be replaced with a recyclable polyvinylchloride (PVC) pipe; and
e. The machine is economically viable as evidenced by the different methods of economic analysis conducted.

Furthermore, based on the findings and conclusions, the following concerns are highly recommended:

a. It is highly recommended that the developed tiger grass pollen remover machine be used for removing tiger grass pollen;
b. The wood working unit must also be utilized to produce quality handle and to maximize the utilization of wood as handle;
c. Transfer the technology; and
d. Conduct further study on the total mechanization of the tiger grass pollen remover machine.

7. ACKNOWLEDGEMENT

The author acknowledges the financial assistance from the Department of Science and Technology (DOST) – MIMAROPA and the Romblon State University in the conduct of the study towards the development of the machine.

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APPENDICES

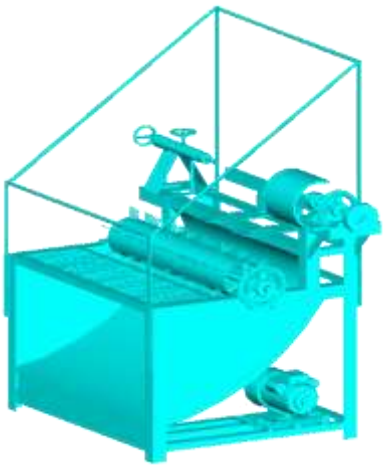

Figure 9. The perspective drawing of the machine

Figure 10. The assembled machine

Figure 11. Testing the pollen remover machine

Figure 12. Testing the wood working machine in making broom handle

Figure 13. The broom handle fabricated at the machine

BIOGRAPHY

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