The Design of Flexible Rubber Tapping Tool with Settings the Depth and Thickness Control

H Susanto1*, S Ali1 and Hanif 2
1Department of Mechanical Engineering, Faculty of Engineering, Teuku Umar University, West Aceh, Indonesia
2Department of Mechanical Engineering, Lhokseumawe State Polytechnic North Aceh, Indonesia

*Corresponding author: herdisusanto@utu.ac.id

Abstract. Road map of land for agricultural commodities in West Aceh is prioritized for rubber plantations. This commodity is the main source of livelihood and employment for the commodity. Furthermore, it is very difficult for a novice tap to be able to control the depth, thickness, and slope of tapping angle. Therefore, rubber tapping is created to increase the productivity of rubber crops in this region. This research conducted using software where the selection of component materials and manufacturing are tested on 9 rubber trees. The treatment is carried out according to the design plan; controlling the depth between 1-1.5 mm of cambium, tapping the thickness 1.5-2 mm, and tilting the angles of 35°-60°. Thus, the result of the functional testing shows that rubber tapping can function properly and the test data at interval 09:00-10:00 WIB for slope 60°, 45°, 35° obtained the average latex amount of 1.83 grams, 1.11 grams, and 0.74 grams. In addition, the rubber tapping capacity of 5-6 seconds per tree is better when compared to conventional rubber tapping between 6-8 seconds with 5.32 cm³ rubber bark consumption.

Keywords: Latex extraction, equipment testing, tapping slope

1. Introduction

The rubber tree is one of the major economic crops in Southeast Asia and valued for its latex production and timber [1]. Indonesia has appropriate land for planting rubber trees. Some of which are in Sumatra and Kalimantan. In 2005, the area of rubber plantations was recorded at more than 3.2 million hectares and spread throughout Indonesia. Around 85% of rubber plantation land belongs to the society, about 7% is state-owned, and around 8% is privately owned. [2]

Road map for land use in the West Aceh farming community prioritized for rubber plants [3,4]. Thus, it makes rubber as one of the leading commodities with the plantation area cultivated by the society reaching 23,862.37 hectares with an average income of 52,091.24 tons per year [5]. This community is the main source of livelihood for society in West Aceh.

Rubber tapping is the process of extraction of latex from rubber trees. Rubber tree tapping is considered to be a skill-oriented job. During the tapping process, the taper has to make a downward half spiral incision on the tree bark to extract the white milky liquid called latex [6]. Rubber tapping...
technology has an important role in increasing rubber productivity. A rubber tapper must be able to control bark consumption and depth of tapping to protect tissue of the wood [7,8]. Tapping is performed on a very limited area of the stem, which raises the question of the spatial extent of the affected area with respect to its impact on radial growth. Rubber tree growers generally estimate total wood production or production deficit due to tapping on the basis of girth measurements at a particular height, which is assumed representative of the whole stem growth [9,10]. Skills in rubber tapping must be trained for years and the current conditions are increasingly difficult to get skilled workers in rubber tapping. In general, rubber planters often find difficulty to tap it in accordance with applicable regulations [6]. This is due to the quality of tapping that is not qualified [11]. Based on the results of monitoring and interviews that have been carried out with several rubber planters, the researcher found that one of the main obstacles in tapping rubber is if the tapping technique in slicing rubber tree bark is not optimal, so the depth and thickness of slicing are irregular. In addition, if the cambium from the rubber tree is tapped, then, the bark of the rubber tree will be cured for a long time and even it can die. For this reason, the application of rubber tapping aids with depth, thickness, and tilt angle can be examined.

2. Research Methodology

2.1. Rubber Tapping Tool Design

The design of rubber tapping tools is designed and simulated using software. The components are arranged according to the specifications of good tapping techniques with the main consideration of control tapping depths of 1 - 1.5 mm from cambium and tapping thickness 1.5 - 2 mm and slope tapping grooves 30°-40° [12,13]. The slice depth regulator can be adjusted according to the slices in the range of 1-1.5 mm, depending on the age of the rubber plant; the older the rubber tree, the depth of the slices from the bark of the rubber tree will be deeper because of the more latex vessels [14]. In that case, blades are used using bolt joints so that it is easy to replace if blunt has occurred.

The track rail of the tapping device functions as a controller for the tilt angle of the tapping groove and it can be arranged in the range of 30°-60°. This rail serves as a tapping mall to save rubber tapping time. If all this time the garden farmers only use rollers and litters to form the tapping patterns, thus, the tapping rails are made to facilitate the tapping process and it is highly recommended for beginner tappers to homogenize the tilt angle. In addition, the tapping device can also be removed from the railroad tracks. For skilled tappers, this tool can be released from the railroad house and in the tapping process; it is permissible to use the tapping device only. In short, the rail house is only used for first tapping, and so on may not use it again.

2.2. The Selection of Rubber Tapping Tool Components

For material selection of rubber tapping components, frame construction using low carbon steel strip plate profiles, rail track components of the blade using ST37 profile steel, while tapping blades made of carbon steel (modified from manual blades) can be found in several markets in Meulaboh. Then, the handle of the pull and grip are made of wood, the depth controller of leather slices using pads, and the assembly using welding connections and bolts.

2.3. Manufacturing Rubber Tapping Tools

The process of manufacturing rubber tapping tools holds at the Teuku Umar University in Mechanical Engineering Workshop. The formation of tapping tool components is formed using a milling machine. The electric welding machines and acetylene is used to connect relatively small component parts and some parts are also needed as depth control; pads and blades for replacement if damaged or dried. Then, it is connected using a bolt for the formation and perforation of the tapping device component using a grinding and sitting drill.
2.4. Testing of Rubber Tapping Tools
The testing of rubber tapping tools with a depth control system, thickness, and slope of tapping grooves implemented at the rubber plantations of Sepakat Group, Paya Lumpat Village, Samatiga District, West Aceh Regency, Aceh Province. Additionally, the tapping testing process was applied to nine rubber trees as the objects in this research. Tapping angles of 35°, 45°, and 60° are arranged with combinations in three rubber trees for three taps testing with the same angle. Then, the same tree is tapped at a different angle. It means, for nine times of testing, each tree will experience three tests for each angle of 35°, 45° and 60°.

2.5. Data Analysis
Analysis of testing data using a rubber tapping tool that has been designed. The manufacture is determined from the results of field testing of rubber trees, and the ratio to the standard size of the slice depth 1-1.5 mm (from cambium), slice thickness 1.5-2 mm, and slope 35°-60°. If the measurement results are in that range, it can be stated that the tool is suitable for use and development. Afterward, rubber tapping test data is analyzed in graphical form to determine the optimal angle of latex production. Rubber tapping capacity, and bark consumption are solved using equation (1) and (2) respectively [15]:

\[ KP = \frac{BPT}{t} \]  
\[ KK = PL \times KS \times TS \]

Where, \( KP \) denotes the tapping capacity (tree per hour); \( BPT \) denotes the number of trees tapped and \( t \) denotes the time (in hour).

\[ KK = PL \times KS \times TS \]

Where \( KK \) is the bark consumption (in cm³), \( PL \) is the length of track (in cm), \( KS \) is the depth of tapping (in cm) and \( TS \) is the tapping thickness (in cm).

3. Result and Discussion
3.1. Rubber Tapping Tool Design
The design of rubber tapping tools is designed using Autocad software, where the components are arranged according to the specifications of good tapping techniques with the main consideration of tapping depth 1-1.5 mm and tapping thickness 1.5-2 mm and tilt slope leads 30°-60° [16,17]. The explanation of the components of the rubber tapping device to adjust the depth, thickness, and slope of the tapping angle are described in Figure 1.

The Captions
1. Depth sensor
2. Depth control wheel
3. Swivel handle screw depth
4. Tapping blade
5. Steering sensor tapping position
6. Screw the tapping sensor position
7. Spring regulating the thickness of the tapping
8. Home tapping aids
9. Pull handle tapping tool
10. Tapping tool binder bolts

Figure 1. Design of rubber tapping tools
3.2. The Process of Making and Assembling Rubber Tapping Tools
The process of making rubber tapping tools using an iron plate and solid and formed by milling, turning and welding according to the design drawings that have been determined [17]. The manufactured rubber tapping equipment is shown in Figure 2.

![Figure 2. Rubber tapping equipment that has been manufactured](image)

3.3. Functional Test
The functional test aims to determine whether all components of the rubber tapping device can function properly in accordance with the design plan that has been determined. The test process is carried out in a mechanical engineering workshop by directly cutting the 2 m long rubber tree, after all rubber tapping aids are guaranteed to function properly, then continued with elementary tests.

3.4. Elementary Test
The initial field testing using a rubber tapping device that had been designed to be constructed was applied on nine rubber trees that were around 5 years old. Then, division for each corner; 35° angles are 3 trees, 45° angles are 3 trees and 60° angles are 3 trees, the thickness and depth of the tapping are set 1.5-2 mm with the same length of tapping grooves for all 38 cm trees. The procedures in field testing are as follows.

Before numbering is done on rubber trees that have not been tapped, the tree number and tilt angle are given first so that the tree is not swapped during data collection during measurement. The numbering of rubber trees from 1-9 trees shown in Figure 3.

Then, attach the tilt angle adjustment tool. This tool serves to homogenize all tapping angles. In this study, the angles chosen are angles of 35°, 45° and 60° which function to determine the optimal angle in tapping rubber trees. The installation of tapping angle tilt aids is shown in Figure 4.

![Figure 3. Rubber tree](image)

![Figure 4. Installation of regulatory aids tilt angle of the tapping](image)
The next step is to make a tapping groove line. This is done to give a mark on the rubber tree before the tree is tapped. If it is finished, then the tilt angle tilt aids are released from the rubber tree. The process of scraping a rubber tree using a tapping angle tilt auxiliary tool is shown in Figure 5.

Rubber trees are ready to be tapped if there are scratches on the rubber tree. For the next tapping or the next day, the tapping angle tilt tool is no longer used. With the wool cloth, this tool is only used at the beginning of the tapping process and for the next process to follow the existing tapping path. The process of tapping rubber trees using a rubber tapping device is shown in Figure 6.

![Figure 5. Marking scratches of tapping grooves](image1)

![Figure 6. The process of tapping rubber trees](image2)

The things that must be considered in the tapping process of rubber trees using tapping tools are the thickness and depth of the tapping groove. They must be arranged in accordance with the thickness of the rubber tree bark and must not touch the wood from the rubber tree. The process that must be considered to adjust the thickness and depth of rubber tapping trees is shown in Figure 7.

The retrieval of the latex data from the tapping results is obtained when all rubber trees have been tapped according to the number and slope of the lead angle that has been determined at point 2. The next day, the latex in the holding bowl is taken and labeled so as not to be confused in the data collection. All labeled latex is put in a transparent plastic bag so that they are easily visible.

![Figure 7. Setting depth and thickness](image3)

After the latex collection process is completed, the tapping process is carried out again on the same tree and the same angle for three days. Then, the tilt angle position of the rubber tree is replaced with
the other position. Six days later, the tilt angle position was replaced again. Thus, all trees experience all tilt angles for three consecutive days.

Measurement of the results of rubber leads is measured by weighing every latex that has been tapped one by one. This weighing process is carried out using a digital scale with an accuracy of 0.01 grams.

3.5. Rubber Test Equipment Testing Results

Each tree is subjected to 3 tapping times with the same angle and the number of trees that are the object of testing the equipment is nine rubber trees. In other words, the tapping test is carried out on three rubber trees with the same angle, with the same thickness and tapping depth of 7 mm (from the outer bark), and the same tapping path length of 38 cm. The test results are shown in Figure 8.

![Figure 8](image)

Figure 8. Test results of rubber tapping on the first, second and third day

Figure 8 shows that under the same tree conditions, with three tapping shows fluctuating results. In general, it indicates that the tapping process on the rubber trees with 60°, 45° and 35° in the first, second and third day demonstrate that in 60° angles produce heavier latex (in average 1.51 grams) than tapping angle of 45° (in average 1.05 grams) and 35° (in average 0.78 grams).

Tests for the fourth, fifth and sixth days are done on the same tree, but the tilt angle is changed. If the first test uses variations 60°, 45° and 35°, then the second test uses variations of angles 45°, 35° and 60°. The second test results are shown in Figure 9.

Graph data from Figure 9 shows that in general the results of rubber leads are dominated by the tilt angle of 60° (in average 1.35 grams). Fluctuations in test results occur almost on average on all trees in each test, this can cause due to the quality of the rubber tree so that when tapping many latex vessels are closed, and the humidity around the tree also affects the amount of latex produced.
The seventh day of testing with variations in angles of $35^\circ$, $60^\circ$ and $45^\circ$. They are presented in Figure 10.

The test results are shown in Figure 10 also show that the tilt angle of the lead is $60^\circ$ (in average 2.62 grams) resulting in more latex when compared to the other angle, average 1.15 grams for angle slope $45^\circ$ and angle slope $35^\circ$ average latex of 0.75 grams.
If the data from the first day to the ninth day are classified according to the slope of the tapping angle, a graph will be generated as shown in Figure 11.

![Figure 11](image)

**Figure 11.** Grouping of latex production based on tilt angle

Figure 11 shows that the latex distribution for angle slope 60° produces an average latex of 1.83 grams, for the slope of the lead angle 45° produces an average latex of 1.11 grams, and with 35° tilt angles produces an average latex of 0.74 grams. From the data above, it shows that rubber tapping at intervals between 09.00-10.00 WIB should use a tapping angle of 60° because the angle is effective and fast to drain the latex on the tapping groove. The greater the slope of the tapping angle, the faster the flow of the latex in the tapping groove, but if the tilt angle of the tapping is greater, the latex will come out of the tapping groove and spill over the rubber stem. The slope of the 35° and 45° rubber lead angles is not suitable for use at the time interval above 9.00 WIB and the dry season. This is caused by a network of latex vessels that are quickly closed due to the slow flow of latex flowing in the tapping groove. In addition, this can also cause latex clotting.

The average rubber tapping time calculated on each rubber tree as many as nine trees per day is shown in Figure 12.

Figure 12 shows the total time needed for nine rubber trees to be tapped every day. Using equation (1), the average rubber tapping capacity for each tree is 5.59 seconds (tapping time between 5-6 seconds of application). Hence, tapping capacity using tapping aids is better when compared without using a tapping tool, which is between 6-8 seconds of application [7]

Bark consumption with tapping path length of 38 cm, tapping depth of 7 cm from outer bark and thickness of tapping 0.2 cm. Consequently, the consumption of rubber bark by using equation (2) is 5.32 cm³
4. Conclusion

Based on the results discussed above, it can be concluded that:

i. Test results data at intervals between 09.00 - 10.00 WIB for the slope angle of 60°, 45° and 35° obtained an average mass of latex of 1.83 grams, 1.11 grams, and 0.74 grams respectively.

ii. Rubber tapping capacity 5-6 seconds per tree is better when compared to rubber tapping devices without using a tapping tool, which is between 6-8 seconds with 5.32 cm³ bark consumption.

iii. Rubber tapping at intervals between 09.00 - 10.00 WIB should use a tapping angle of 60° because the angle is effective to drain the latex on the tapping groove. The greater the slope of the tapping angle, the faster the flow of the latex in the tapping groove. But if the tilt of the tapping angle is greater, it can also cause the latex to come out of the tapping groove and spill over rubber.

References

[1] Kunjet S Thaler P Gay F Chuntuma P Sangkhasila K and Kasemsap P 2013 Effects of drought and tapping for latex production on water relations of Hevea brasiliensis trees *Kasetsart Journal Natural Science* vol 47 pp 506-515.

[2] Ginting R Siregar I and Ginting T. 2015 Perancangan Alat Penyadap Karet di Kabupaten Langkat Sumatera Utara dengan Metode Quality Function Deployment (QFD) dan Model Kano *Journal J@ti Undip* vol 10(1) pp 33-40

[3] Lacote R Gabla O Obouayeba S Gohet E Doumbia A Gnagne M and Eschbach J M 2006 Some Considerations Concerning The Panel Management in Rubber Tapping (Hevea Brasiliensis) *International Natural Rubber Conference* pp 3-15.

[4] Ritung S Wahyunto Agus F and Hidayat H 2007 Paduan Evaluasi Kesesuai Lahan (dengan contoh peta arahan penggunaan lahan Aceh Barat) *Balai Penelitian Tanah dan World Agroforestry Centre* chapter 3 pp 21
[5] Susanto H 2018 Desain dan Manufaktur Teknologi Tepat Guna Pedesaan Bandar Publishing chapter 2 pp 15
[6] Vinayaka N N Athul S N Madhuraj M N and Nandana S P 2017 Project Report on Automated Rubber Tapering Machine Visvesvaraya Technological University chapter 1 pp 2
[7] Wibowo SA 2011 Disain dan Kinerja Pisau Sadap Elektrik Untuk Tanaman Karet (hevea brasiliensis) Institut Pertanian Bogor chapter 2 page 4
[8] Sutardi 1991 Sistem sadap karet kearah atas Pusat Penelitian Perkebunan Getas pp 67
[9] Gohet E 1996 The production of latex by Heveabrasiliensis Relation with growth Influence of different factors: clonal origin, hormonal stimulation, carbohydrate reserves Université Montpellier II, pp 343
[10] Unakorn S Philippe T Poonpipope K Andre L Arak C Boris A Eric G Sornprach T and Thierry A Effect of tapping activity on the dynamics of radial growth of Heveabrasiliensistrees Tree Physiology Vol 26 Heron Publishing pp 1579–1587
[11] Herlinawati E and Kuswanhadi 2012 Beberapa Aspek Penting pada Penyadapan Panel Atas Tanaman Karet E-Journal Warta Perkaretan vol 31 pp 66-74
[12] Ritonga A I 2016 Tehnik Penyadapan Tradisional pada Tanaman Karet di Tapanuli Selatan Jurnal Nasional Ecopedon vol 3 pp 17-20
[13] Andry dan Suprianto J 2009 Teknologi Penyadapan Tanaman Karet Balai Pengkajian Teknologi Pertanian Jambi pp 16
[14] Ulfah D Thamrin G A R and Natanael T W 2015 Pengaruh Waktu Penyadapan dan Umur Tanaman Karet Terhadap Produksi Getah (Lateks) Jurnal Hutan Tropis vol 3 pp 247-252
[15] Wicaksono M S Ahmad H and Siswoyo S 2015 Modifikasi Alat Penyadap Karet (Lateks) Semi Mekanis Berkala Ilmiah Pertanian vol 4 pp 1-4
[16] Susanto H and Hanif 2017 Rancang Bangun Alat Sadap Karet dengan Pengaturan Kedalaman, Ketebalan dan Kemiringan Sudut Sadap Seminar Nasional Sains dan Teknologi TM-009 Universitas Muhammadiyah Jakarta pp 1-9
[17] Susanto H and Hanif 2017 Desiminasi Alat Sadap Karet dengan Pengaturan Kedalaman, Ketebalan dan Kemiringan Sudut Sadap Seminar Nasional Teknologi Terapan Jilid II Universitas Gajah Mada pp 54-63