ANALYSIS OF PINE SAP QUALITY BASED ON SIEVE VARIATIONS AND ITS EFFECT ON ECONOMIC VALUE

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ABSTRAK
Getah pinus merupakan salah satu hasil hutan bukan kayu (HHBK) yang memiliki nilai ekonomi tinggi. Namun, kualitas dan nilai jual getah pinus sangat dipengaruhi oleh media penampung yang digunakan saat penyadapan. Penelitian ini bertujuan untuk menganalisis pengaruh variasi saringan pada alat penampung terhadap kualitas getah dan nilai ekonomi yang dihasilkan. Metode yang digunakan adalah kuantitatif deskriptif melalui eksperimen lapangan dan analisis nilai penjualan dari hasil penyadapan menggunakan dua jenis alat, yaitu alat tradisional (tempurung kelapa) dan alat inovatif dengan dua tingkat saringan dan penutup. Percobaan dilakukan selama lima belas hari pada dua kelompok pohon pinus yang disadap secara paralel. Hasil penelitian menunjukkan bahwa meskipun volume getah yang dihasilkan serupa, nilai jual getah dari alat inovatif meningkat hingga tiga kali lipat karena kualitas yang lebih bersih dan minim kontaminasi, Hasil penelitian menunjukkan bahwa meskipun volume getah yang dihasilkan serupa, nilai jual getah dari alat inovatif meningkat hingga tiga kali lipat karena kualitas yang lebih bersih dan minim kontaminasi, dengan total pendapatan yang meningkat dari Rp72.000 menjadi Rp216.000 untuk enam pohon selama lima belas hari. Masyarakat juga memberikan respons positif terhadap kepraktisan, keamanan, dan efektivitas alat. Inovasi ini berkontribusi pada peningkatan pendapatan petani dan dapat menjadi solusi strategis untuk mendukung efisiensi penyadapan getah pinus oleh Perhutani.
Kata Kunci: Getah Pinus; Alat Penampung; Variasi Saringan; Kualitas Getah; Nilai Ekonomi.

ABSTRACT
Pine resin is one of the non-timber forest products (NTFPs) that has high economic value. However, the quality and selling value of pine resin are greatly influenced by the container media used during tapping. This study aims to analyze the effect of filter variations on the container tool on the quality of the resin and the resulting economic value. The method used is quantitative descriptive through field experiments and analysis of the sales value of the tapping results using two types of tools, namely traditional tools (coconut shells) and innovative tools with two levels of filters and covers. The experiment was conducted for fifteen days on two groups of pine trees that were tapped in parallel. The results showed that although the volume of resin produced was similar, the selling value of the resin from the innovative tool increased up to three times due to the cleaner quality and minimal contamination, The results showed that although the volume of sap produced was similar, the selling value of the sap from the innovative tool increased threefold due to cleaner quality and minimal contamination, with total income increasing from IDR 72,000 to IDR 216,000 for six trees over fifteen days. The community also responded positively to the practicality, safety, and effectiveness of the tool. This innovation contributes to increasing farmers' income and can be a strategic solution to support the efficiency of pine resin tapping by Perhutani.
***Keywords**: Pine Resin; Collection Tools; Filter Variations; Resin Quality; Economic Value.*

INTRODUCTION
Pine resin is one of the non-timber forest products (NTFPs). In general, the Non-Timber Forest Products (NTFPs) industry is a labor-intensive industry, and does not require sophisticated technology, but can produce high-value and environmentally friendly products (Waluyo et al., 2012). Therefore, pine resin is one of the NTFPs that really needs

to be developed at this time because pine resin has commercial value and makes a significant contribution to state revenues and the welfare of communities around the forest (Lempang, M., 2017). In Indonesia, especially in Wonosobo Regency, Central Java, it is included in the working area of Perum Perhutani Forest Management Unit (KPH) North Kedu which has an area of 9,928.46 Ha with a forest area based on administrative areas of 8,476.53 Ha (19.0%) (Perhutani, 2021). The main commodity of this forest is pine trees that produce resin.

In 2021, Gondorukem and Terpentine which are derivative products of pine resin with a total production capacity of 92,550 tons spread across Central Java, East Java and West Java, through contributions from eight Gondorukem and Terpentine Factories (PGT), namely Sukun (18,000 tons), Garahan (16000 tons), Cimanggu (13,500 tons), Rejo Winangun (12,000 tons), Sindangwangi (10,500 tons), Winduaji (9,000 tons), Paninggaran (6,750 tons) and Sapuran (6300 tons) (Perhutani, 2021). These results show that PGT in Sapuran, Wonosobo Regency still ranks lowest in its pine resin production. PGT Sapuran is usually supplied by 10 Perum Perhutani BKPH, one of which is BKPH Kebumen which is located in Ngadisono, Kaliwiro.

About 107 types of pine species are found in Europe, America, Africa, and Asia. There are about 28 types of pine in Asia, with 3-7 types in Southeast Asia, including Pinus merkusii, P. khaysia, and P. insularis (Alrasjid et al., 1983). The Pinus merkusii Jungh. et de Vriese tree is a type of two-needle pine that grows naturally in Southeast Asia. They grow naturally in northeastern India through Burma, Thailand, Laos, Cambodia, and Vietnam. They grow at elevations between 300 and 2,000 meters above sea level on the islands of Sumatra, Luzon, and Mindoro in the Philippines (Tantra, 1983; Satjapradja, 1983). The Pinus merkusii species is naturally found in Indonesia only in northern Sumatra (Alrasjid et al., 1983). Three strains of Pinus merkusii can be found in Sumatra: Tapanuli, Kerinci, and Aceh (Tantra, 1983). Pine trees are usually round and straight with brown to blackish bark and rough, deeply grooved and flaky bark that resembles long pieces (Sastrapraja, 1980). Pine trees can reach a height of 70 meters, with a branch-free trunk length of about 70% of its height (Lempang, M., 2018; Cunningham, A., 2012).

Pinus merkusii is a type of plant used for reforestation and is able to thrive in various environmental conditions in Indonesia. This plant is a favorite in forest, land, and water source conservation projects, especially in reforestation and greening activities that have been carried out by the government through the Ministry of Forestry since the 1960s (Rahmadani, R., 2021). The Pinus merkusii tree has a straight, round trunk, and generally has no branches. The shape of the crown resembles a cone, while the leaves are needle-shaped. The size of this tree trunk is classified as medium to large, with a height of between 20 and 40 meters and a maximum diameter of 100 cm. The bark is rough, does not peel, and has wide and deep grooves. Pinus merkusii also produces NTFPs in the form of resin (Yeriana SP, et al., 2023). Natalia (2010) explains that this type of pine can grow well in dry and humid places, as well as in hot and cold climates, such as in Wonosobo. Mirawati (2017) added that although many varieties of Pinus merkusii do not require certain conditions to grow, their growth is still influenced by a number of factors, such as soil characteristics, climate, and location altitude (Rahmadani, R., 2021).

The pine tree merkusii Jungh. Et de Vriese is a type of pine that was first found in Indonesia and is known as Tusam. Pine tree sap is processed into gondorukem, which is a solid, and turpentine, which is a liquid. Gondorukem is used in many industries, such as paper, ceramics, plastics, paint, batik, soap, pharmaceuticals, and cosmetics. On the other hand, turpentine is used as a raw material in the cosmetics, paint oil, solvent mixture, antiseptic, camphor, and pharmaceutical industries, especially as a thinner in the paint industry (Koloy, 2021). Indonesia ranks third globally in pine resin production, only above Brazil and China (Intan K D, Suryawati S, et al., 2023). Because of the market prospects for gondorukem, forest managers must understand the behavior of pine stands in producing resin (Tatik S and Yogenta A, 2021). In general, clean and fresh pine resin contains 60% gondorukem, 17% turpentine and 23% water (Silitonga T., 1983). In the mechanical processing process (distillation) of pine resin produces gondorukem as residue and turpentine as distillate (Kasmudjo 2010). Until 2021, pine resin processing reached 81,788 tons, or 90 percent of the RKAP, down 4% from 2020. This is due to the lack of pine resin supply from the planned 90,676 tons to 81,788 tons (90%) (Perhutani, 2021).

Indonesia's pine resin production produces 900,000 tons annually, with 50,000–60,000 tons exported to other countries (Lempang, M. 2017). Eight Gondorukem and Terpentine (PGT) factories are located in Central Java, East Java, and West Java to produce 92,550 tons of Gondorukem and Terpentine in 2021. Sukun (18,000 tons), Garahan (16000 tons), Cimanggu (13,500 tons), Rejo Winangun (12,000 tons), Sindangwangi (10,500 tons), Winduaji (9,000 tons), Paninggaran (6,750 tons), and Sapuran (6300 tons) are among these factories (Perhutani, 2021). The results show that in terms of pine resin production, PGT in Sapuran, Wonosobo Regency, still ranks the lowest. PGT Sapuran is usually supplied by ten Perum Perhutani BKPH, one of which is located in Ngadisono, Kaliwiro. One of the problems faced in pine resin production is low pine resin production. Tree production in other countries such as China, India, Portugal, and Spain reaches 2.50 to 4.00 kg per tree per year. In Indonesia, the average production is 1.50 kg per tree per year (Perhutani, 2021).

The low productivity of pine resin is due to the fact that the containers used to collect the tapping results are still traditional, namely using coconut shells and plastic pots. The disadvantage of using coconut shells and plastic pots is that rainwater and sap become one because both containers are open. This will cause a decrease in the quality of pine resin and it is difficult to obtain premium quality, because rainwater and dirt enter. The impurities found are in the form of leftover twigs, dry pine leaves, grass, soil and gravel. This occurs during the tapping renewal. Many of the remaining trunks or cracked skins fall into the sap collection area. In addition, when the coconut shell is easily released by the wind because the binding is not strong enough with the pine tree. The pores of the shell are finally easily eroded by rain and due to the tapping process.

Figure 1. Coconut Shell Container
Gambar 1. Wadah Tempurung Kelapa

Another use of containers is with plastic bags. Plastic bags can reduce impurities that enter the sap so that the resulting sap is cleaner compared to coconut shells (Sukadaryati, S., 2014). In addition, the cost required to buy plastic is also relatively cheaper. However, the use of plastic is only for single use and then thrown away so that it will produce a lot of plastic waste and pollute the environment because plastic is difficult to decompose. On the other hand, coconut shells can be used repeatedly and if they cannot be used again, they will not produce hazardous waste, because coconut shells or coconut shells are easily decomposed naturally. However, open containers for storing sap will greatly affect the results of pine sap and have an impact on farmers' less than optimal acquisition and reduce the economic value of the sap.

One of the supporting media for the creation of the best quality sap production is located in the sap container which is located right under the drops of sap flowing from the tapping. In addition, the slope of the tapping gutter also affects the mass of pine sap obtained so that it falls right into the container. Until now, the tapping gutter still uses curved and open zinc so that during the rainy season, the sap certainly does not fall right into the container. The sap container has an important role in improving production results because the only container and storage of sap from the tree that is the first is located in the container, the container currently used at Perum Perhutani Ngadisono, Kaliwiro is a bowl with a diameter of 8-10 cm and a height of 5-7 cm made of plastic without a cover on top and a coconut shell with an average diameter of 10 cm and a height of 6 cm so that rainwater or dirt will be very easy to enter, the sap that has been collected can also spill because the container is very light so it is very easily blown away by the wind.

Along with the increasing interest of farmers in processing pine plants, there are still many challenges faced by farmers in addition to the problem of resin containers. One of them is weather conditions, which have an impact on poor pine resin harvests. If the weather is sunny, pine resin tapping can be done every day, but if the weather is bad such as rain, pine resin tapping will be disrupted, even tapping cannot be done. Bad weather, such as rain, can cause low and unstable income for pine farmers. Low purity of pine resin will affect the price of pine resin, which can affect the income of pine farmers. Low purity of pine resin will affect their salaries. Therefore, technology that can handle the problems faced by pine farmers is needed. Currently, technology is often used together with other sciences to find or utilize solutions to problems that occur in society.

Figure 2. Results of harvesting pine resin mixed with soil
Gambar 2. Hasil pemanenan Getah Pinus Menggunakan Alat Tradisional

Based on the problems that have been explained above, this study aims to analyze the effect of variations in filtering tools on the quality and economic value of pine resin. By comparing sales results between the use of traditional tools and tools with a filter system during six sales periods, this study will provide an empirical picture of the effectiveness of the innovation. To see the effectiveness of the innovation of pine resin collectors with this filter system, a field trial was conducted by asking resin farmers to try this pine resin container as a substitute for plastic bowls and coconut shells. This study also seeks to answer the challenge of low competitiveness and contribution of resin processing factories such as PGT Sapuran in Wonosobo, which has so far been recorded as the lowest production unit compared to other factories in Java (Perhutani, 2021).

MATERIALS AND METHODS

This study uses a quantitative approach with a descriptive method (Creswell, 2015; Sugiyono, 2006; Zulfikar et al., 2024). The approach used in this study is quantitative because the data collected are in the form of numbers from the results of measuring the volume and quality of sap and the sales value of pine sap collected during the harvest. The method chosen is descriptive because this study aims to describe and compare the results of pine sap sales between using traditional collection tools and collection tools based on filter variations. Pine tree samples were selected randomly in Kaliwiro District.

The experiment was conducted directly in the field by installing the innovative tool on pine trees that were actively tapped in the Perhutani KPH Kedu Utara working area, especially in Wonosobo Regency, Kaliwiro District. A total of six innovative sap collection tools were installed simultaneously with six traditional coconut shell containers as a comparison, on different pine trees that had similar physical characteristics and environmental conditions. Observations and data collection were carried out for fifteen days of tapping to ensure consistency and reliability of the sap collected. The amount of sap and its selling value from both types of containers were recorded and compared, as shown in Table 1, to analyze differences in economic outcomes and quality of resin based on the collection method.

Each innovative container used in the experiment was equipped with a two-stage filtering system designed to enhance the purity of collected pine sap. The first filter was responsible for capturing large contaminants such as bark, leaves, and twigs. Sap that passed through the first filter would continue into the second filter, which had a higher density and served to remove finer particles and moisture. This sequential filtering ensured that the sap was clean and met high-quality standards. Additionally, each container included a rainwater drainage outlet that allowed excess water to flow out, preventing contamination and dilution of the resin during wet conditions..

RESULTS AND DISCUSSION

Pine resin is one of the export commodities that has a major influence on the community's economy, so many innovations are needed for storing pine resin. Pine resin has been included in international trade as one type of NTFP. According to Bina (2014), Perum Perhutani is the largest producer of gondorukem and turpentine derivatives in the world, ranking third in the international market, after China (70%) and Brazil (11%). Perum Perhutani also ranks third in the trade of Indonesian pine resin in the international market, after China and India. Indonesian pine resin production is around 900,000 tons per year, with a price of 50,000-60,000 tons in the global market, while China is able to penetrate 800,000 tons per year (Bina, 2012). According to Perum Perhutani, Indonesian pine resin products in 2010 were exported to several countries, such as the United States, India, South Korea and Europe (Sukadaryati and Dulsalam, 2015). The use of pine resin by Perum Perhutani has increased in recent years (Sukarno et al., 2015). According to Bina (2014), the price of pine resin derivative products ranged from $2,000 to $4,000/ton in 2014. With some cases the price reaching $15,000/ton.

In this study, we developed an innovative design for a semicircular pine sap container, made of aluminum and equipped with a lid and two types of filters inside. This tool is also equipped with a closed tapping gutter made of iron plate, which is designed to increase productivity and effectiveness of its use. This semicircular aluminum container greatly facilitates the process of collecting pine sap. The available cover functions as a protector, keeping the sap clean from dirt from the tree and the surrounding environment. With various types of filters used, we ensure that the collected sap is truly clean. The closed tapping gutter made of iron plate plays an important role in protecting the sap from dirt that may fall from the tree, while the belt used to attach the pine sap container ensures that the tree is not injured during the sap collection process. In addition, this pine sap container is also equipped with a channel for rainwater to drain out.

Figure 3. Innovation of Pine Sap Container Tools Based on Filter Variations
Gambar 3. Inovasi Alat Penampung Getah Pinus Berbasis Variasi Sraingan

This tool innovation is the result of the development of Mody Lempang's research, which utilizes a closed sap container and a tapping channel as the sap entrance. This approach aims to maximize the quality of the sap obtained and reduce the water content, because turpentine will be more easily separated from water. In addition, with a small sap entrance and a very tight container, dirt will have difficulty entering the container. In contrast to Mody Lempang's research 2017, Perhutani in Kaliwiro, only uses the koakan method to obtain sap, because this method is more economical and efficient in terms of time. This research provides innovation in the development of the tool created by Mody Lempang by adding various types of filters to the closed container, as shown in Figure 4.

Figure 4. Sieves with different diameters
Gambar 4. Saringan dengan diameter berbeda

The implementation of a two-stage filtration system in the innovative container proved to be highly effective in maintaining resin purity. The harvested sap appeared clearer and more homogeneous, free from contaminants such as soil, bark fragments, or insects commonly found in traditional collection methods. This improvement in quality directly influenced the selling price, demonstrating the tool’s success in enhancing both technical and economic outcomes.

Getah Hasil Batok Tempurung Kelapa

Getah Hasil Alat Penampung Getah

Figure 5. Comparison of Pine Sap Harvest Results
Gambar 5. Perbandingan Hasil Panen Getah Pinus

Based on initial research conducted during the development of this tool, it was found that the sap produced was of very good quality. This is primarily due to the two-stage filtration process, which allows for gradual separation of contaminants—large debris such as bark or leaves are trapped in the first filter, while finer particles and excess moisture are removed in the second, denser filter. As a result, the sap collected appears visually clearer, more homogeneous in texture, and free from impurities such as insects or soil particles that often contaminate sap collected using traditional open containers. Furthermore, the closed design of the container, combined with a rainwater drainage channel, prevents dilution of the resin, which often occurs in traditional tapping during the rainy season.

The effectiveness of this filtration-based container tool was validated through laboratory observations, which confirmed its ability to produce high-purity sap suitable for premium-grade processing. To assess the practical utility and economic benefit of this tool, a field trial was conducted in the local community. In this trial, six pine sap collector tools using filter variations were compared to six traditional coconut shell containers. The results, summarized in Table 1, showed that even though both methods yielded the same amount of sap (3 kg per tree), the selling price of the filtered sap was three times higher due to its superior quality.

When compared to previous studies, such as Lempang (2017), who also used a closed resin collection system to reduce water content and external contamination, this study adds an important advancement through the integration of double-layer filtration. Meanwhile, Sukadaryati (2014) found that although plastic bags could reduce contamination compared to coconut shells, they contributed to environmental waste and were less durable. In contrast, the tool developed in this research is reusable, environmentally friendly, and provides higher quality sap without generating plastic waste. Therefore, this innovation not only offers technical advantages in quality control but also addresses environmental and economic sustainability.

The results of the pine sap harvest produced from each of these collector tools are summarized in table 1 below.

Table 1. Pine Sap Harvest Data
Tabel 1. Data Hasil Panen Getah Pinus

Description	Coconut Shell	Pine Sap Collector Tool
Number of Trees	6 trees	6 trees
Tapping Time	15 days	15 days
Sap Yield per Tree	3 kg	3 kg
Total Sap Yield (6 Trees)	18 kg	18 kg
Price per Kilogram	Rp4,000	Rp12,000
Total Income	Rp72,000	Rp216,000
Income Difference	—	Rp144,000 higher

Based on the data above, the amount and quality of sap produced from each tapping method are the same, which is 3 kg per tree for 15 days. However, the striking difference lies in the selling value of the sap which is influenced by the type of container used. Sap collected using a pine sap container based on a variety of filters has a selling price three times higher than sap collected using coconut shells. This is most likely due to the cleaner quality of the sap and minimal contamination when using special tools. The innovative container is designed with a closed lid and two-stage filtration system, which prevents the entry of rainwater, insects, twigs, and soil particles—contaminants commonly found in traditional methods such as using coconut shells. As a result, the sap harvested is clearer and classified as higher grade, making it more valuable in the market. Clean sap can be processed more efficiently into derivative products such as gondorukem and turpentine, which are priced higher due to their purity and ease of refining.

In terms of income, the use of special containers generates a total income of IDR 216,000 for six trees over fifteen days, while coconut shells only produce IDR 72,000 under the same conditions. Thus, there is a net income difference of IDR 144,000, representing a threefold increase. This indicates that the economic gain is not from volume, but from quality enhancement which directly affects pricing.

These findings align with the study by Lempang (2017), who found that closed and well-filtered containers resulted in higher-grade sap with lower moisture content, leading to higher market prices. Likewise, Sukadaryati (2014) observed that unfiltered sap, especially when collected in open containers, was prone to contamination and often rejected by collectors or priced lower due to additional processing costs. By using technology to control quality at the point of collection, farmers reduce post-harvest losses and improve selling power, which contributes to increased income and sustainability in resin production.

The results of this study provide a significant contribution to increasing the income of pine resin farmers in Indonesia through the exploitation of Non-Timber Forest Products (NTFPs), especially for Perhutani BKPH in an effort to improve the quality of the harvested pine resin. The performance of the tool used is very effective, with a container design equipped with a lid to protect against large dirt and two filters of different sizes to filter small dirt that may enter the container. The shape of the container which resembles a semicircular bowl makes it easier to collect sap, and is equipped with a filter that can be lifted when collecting sap. However, this tool has a drawback in the installation process, which is slightly longer than the previous tool. Therefore, it is advisable to understand how to install the tool properly and correctly, and ensure that the tool is installed properly and not tilted.

CONCLUSION

This study shows that a pine resin collection tool based on a variety of filters can significantly improve the quality of the tapping results and have a positive impact on the economic value of pine resin. The resulting resin has a higher purity, so that the selling price increases up to three times compared to using traditional tools. The public response to this innovative tool is also very good, especially in terms of durability, effectiveness, safety, and ease of use and maintenance. Thus, this innovation has great potential to be implemented widely in order to increase the productivity and income of pine farmers and support the sustainability of non-timber forest products in Indonesia. The impact of using this tool, Perhutani no longer needs to look for or replace the collection tool routinely because this tool is durable and can be used repeatedly. In addition, the quality of the sap harvested with this filter-based container is unquestionable. With the increasing quality of the harvested sap, the income of the pine farmer community also increases. Thus, this innovation has great potential to be implemented widely in order to increase the productivity and income of pine farmers and support the sustainability of non-timber forest products in Indonesia.

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