Improving Arabica Coffee Quality: Examining Post-Harvest Practices among Farmers in Bener Meriah District, Aceh, Indonesia

R. Hamdani Harahap *, Yeni Absah , Farid Aulia

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Article

Improving Arabica Coffee Quality: Examining Post-Harvest Practices among Farmers in Bener Meriah District, Aceh, Indonesia

R. Hamdani Harahap *, Yeni Absah and Farid Aulia

Universitas Sumatera Utara, Medan, Indonesia; yeni.absah@usu.ac.id (Y.A.); faridaulia79@gmail.com (F.A.)
* Correspondence: r.hamdani@usu.ac.id

Abstract: Coffee has become a significant commodity for the people of Indonesia, including in Bener Meriah Regency. However, the quality of coffee remains low, partly due to deficiencies in the post-harvest process. This study aimed to analyze coffee farmers' post-harvest process in the Permata Sub-district and identify strategies to enhance coffee quality through farmers' institutions. The research method was qualitative, with data collection techniques comprising in-depth interviews and observation. The findings indicated that most coffee farmers in the Permata Sub-district lacked comprehensive post-harvest processing, impacting the coffee quality. The recommendations of this study emphasize the importance of strengthening coffee farmers' institutions, such as coffee farmer groups, to improve farmers' knowledge and skills in conducting optimal post-harvest processing following specialty coffee standards.

Keywords: post-harvest practices; coffee quality; farmer institutions; specialty coffee; Indonesia

1. Introduction

Indonesia is the world's fourth largest producer of coffee, after Brazil, Vietnam, and Columbia. Indonesia's fourth position is due to the relatively low productivity of Indonesian coffee farmers, which is 711.3 tons per year, compared to Brazil's production of 3,103.5 tons per year, Vietnam's 1,587.1 tons per year, and Colombia's 838.2 tons per year[1]. According to the Interim Plantation Statistics of Indonesia from the Directorate General of Plantation, Indonesia's coffee production 2017 reached 668.68 thousand tons. Of the total output, 95.37% came from smallholder plantations, 2.48% from large private plantations, and 2.25% from large state plantations. Robusta coffee dominated Indonesian coffee production in 2017 regarding the types of coffee cultivated. Out of the total Indonesian coffee production of 668.68 thousand tons, 72.35%, or 483.82 thousand tons, is robusta coffee, while the remaining 27.65%, or 184.86 thousand tons, is arabica coffee. On average, in the last five years, the centers of robusta coffee production in Indonesia have been located in South Sumatra, Lampung, Bengkulu, East Java, and Central Java. The main areas for arabica coffee production in the same year are in Aceh, North Sumatra, South Sulawesi, West Sumatra, and West Java, known for their suitable climate and soil conditions for arabica cultivation [2].

The cultivation of coffee plants in Aceh Province is distributed across the Bukit Barisan mountains, encompassing three districts: Gayo Lues, Aceh Tengah, and Bener Meriah. The main issue on coffee plantations in Indonesia is the low productivity of coffee farmers, resulting in suboptimal yields. The low productivity of coffee occurs during the cultivation and post-harvest stages, resulting in challenges in producing high-quality coffee[3]. In addition to climate change, the challenges of coffee cultivation also include issues related to the management of aging plants, all of which impact farmers' productivity [4].

Facing similar challenges in coffee cultivation, one can take steps such as providing training and mentoring to farmers to improve productivity, encouraging agricultural technology innovation to simplify the process of coffee cultivation, and offering financial incentives to farmers to enhance the

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quality of their coffee harvests[5]. Countries facing low productivity in coffee may be due to a lack of knowledge of policies related to the coffee sector, weak organizational links, poor access to alternative technologies, and high vulnerability to climate change. In Kenya, despite efforts to improve coffee productivity through the introduction of innovations and recommended technologies, there is still a gap between actual and feasible productivity levels. Factors such as off-farm income, access to credit, land tenure, and land size can significantly impact coffee productivity. Adoption of recommended application rates of manure, fungicides, and pesticides can also positively affect coffee productivity at the farm level[6,7]. Furthermore, collaboration between the government, agricultural research institutions, and the coffee industry can help address the challenges faced by coffee farmers[8–10]. This collaborative effort can increase the productivity of coffee farmers, resulting in more optimal yields[11,12].

Post-harvest processing is a crucial stage following the cultivation of coffee or production management, as it determines the added value and market worth of the harvest[13,14]. This stage is vital because the outcome of post-harvest processing directly influences the harvest's added value or market value. Post-harvest processing is also crucial for enhancing the quality of coffee[15–20]. Post-harvest processing is crucial due to the market demand for specialty coffee. Specialty coffee is defined by its processing after harvest. It includes sorting, pulping with a pulper machine, washing, drying, and grading to produce defect-free, quaker-free, appropriately sized, dried coffee beans served in cups without errors or blemishes and possess distinctive attributes. Practically, coffee must pass the grading and cupping tests[21]. Research findings indicate that post-harvest processing affects 60% of the quality of green coffee beans[19]. Buclatin also discusses the significance of post-harvest processing in coffee production[22]. The research indicates that harvesting ripe fruits, drying, sun-drying, pulping, and sorting in post-harvest processes using machines will yield higher income and profits for coffee farmers.

Post-harvest research on coffee is crucial in enhancing the coffee industry's product quality, efficiency, and environmental sustainability. For example, it can lead to the development of innovative processing methods and sustainable practices. Therefore, enhancing qualitative research is crucial for understanding how social, cultural, and economic factors influence post-harvest coffee processes. Qualitative methods provide a detailed exploration of these complex interactions. Varied research endeavors can enhance methodologies and technologies, guaranteeing the long-term sustainability of the coffee sector by continually improving and adapting.

2. Literature Review

2.1. Quality of Coffe Product

The post-harvest processing of coffee beans significantly impacts the final coffee's quality. Each step, from cherry picking and sorting to husking, washing, drying, and storage, must be done correctly to produce high-quality beans. Maintaining quality throughout production, from planting to processing, ensures delicious taste, distinctive aroma, and high market value. Therefore, coffee farmers must carefully manage each stage to deliver high-quality, satisfying coffee to consumers.

Currently, the Specialty Coffee Association of America (SCAA) has set standards for specialty coffee bean quality. These standards encompass not only physical testing criteria but also sensory aspects. Additionally, they include traceability requirements, ensuring the coffee's journey from plantation to consumer is documented, including details like bean variety origin and processing methods[23].

SNI quality standards aim to ensure consumers receive safe and good quality products that taste good. For producers, these standards serve a dual purpose: grading coffee bean quality and providing a reference point for quality control during production, guaranteeing adherence to established criteria. The general quality requirements for specialty coffee include the absence of live insects, no foul or moldy odors, a maximum moisture content of 12.5%, and a non-coffee impurity level below 0.5%. These criteria ensure coffee beans are free from potentially harmful contaminants like insects, microorganisms, and foreign solid substances. Additionally, a higher percentage of giant

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beans is considered a mark of good quality. Research suggests that producing specialty coffee offers coffee farmers the opportunity to increase their selling price and contribute to biodiversity conservation efforts[24].

2.2. Premium and Specialty Coffee Standard

The classification standards for premium and specialty coffee beans are determined by the SCAA (Specialty Coffee Association of America)[25]. The Standard SCAA is a method for ranking the quality of coffee beans based on the relationship between bean defects and flavor. For bean size analysis, SCAA uses sifters with sieve hole sizes 14, 15, 16, 17, and 18. The sieve result for each sieve size must be consistent with a maximum deviation of 5%. After sifting, the coffee bean samples were defect-tested by SCAA standards. Unlike SNI, SCAA divides the defective bean criteria into two groups, namely primary and secondary defects. Primary defects are bean defects that negatively affect the flavor of the coffee beans. Meanwhile, secondary defects are considered to have no adverse effect on the flavor of the coffee beans.

A group of panelists with the Coffee Quality Institute (CQI) certification further analyzes the coffee beans that pass the size and defect tests for their flavor profile. The panel of coffee experts specializing in Arabica coffee is referred to as Q, which can assess the quality of coffee beans through organoleptic methods. On the other hand, the certified panelists for robusta coffee are referred to as R. The scoring assessment of Q will provide a correlation between the number of detected defects in coffee bean samples and their flavor. The fewer the type and quantity of defects in the sample, the higher the taste test score will be (approaching 100).

Table 1. Specialty and Premium Coffee Bean Quality Requirements.

Quality Grade	Requirements	Analysis Conditions
Specialty		
Primary Defects	Nil	300g sample
Secondary Defects	Maximum 5	
Moisture Content	10-12%	
"Quaker" Bean Defects	Nil	300g sample
Cup Tasting Score	≥80	300g sample
Premium		
Primary + Secondary Defects	Maximum 8	300g sample
Moisture Content	10-12%	
"Quaker" Bean Defects	Maximum 3	100g sample
Cup Tasting Score	≥80	100g sample

Source: SCA[25].

3. Materials and Methods

This study employed a qualitative research methodology to understand coffee farmers' knowledge and practices regarding post-harvest processes and identify strategies for improving coffee quality through knowledge strengthening. This approach allows researchers to gather in-depth and rich data on coffee farmers' experiences and perspectives. The research took place in Permata District, Bener Meriah Regency, Aceh Province, chosen for being a leading coffee production center with a 10,373.57 ha coffee planting area[26]. Coffee farmers in the Permata District served as the informants. Purposive sampling was employed to select informants with extensive knowledge and experience in the coffee post-harvest process. A total of 25 informants participated, with an average age range of 35–60 years. Interviews were conducted naturally without a rigid guide, allowing location adjustments based on informant preferences. Interviews typically lasted 1-2 hours and were conducted fluently in Bahasa Indonesia.

Additionally, key informants, such as officials from the Bener Meriah District Plantation Office, were utilized for their crucial information. Researchers employed an inductive qualitative data

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analysis technique, conducting iterative analysis to identify patterns and themes emerging from the data. The results of this analysis were then used to address research questions and formulate research conclusions.

4. Results and Discussions

Farmers are the main gateway to exports since the supply begins with farmers; thus, if farmers can cultivate and post-harvest properly, it will also create good quality. After the coffee harvest, the farmer performs the following processing:

3.1. Red Cherry Fruit Coffee

The most optimal coffee cherries to be harvested are those that are fully ripe and have a deep red color. In the Permata District, after the harvest, a small portion of farmers sort freshly harvested coffee fruits. Most farmers do not engage in cherry fruit sorting. The farmer delegated the task of harvesting coffee fruits to the workers. The coffee pickers are remunerated based on the cherries they harvest. Firstly, uniform red picking refers to paying pickers specifically for harvesting only red cherries, as farmers are unwilling to pay for cherries that are not red. This method will provide high-quality cherries that are only red, but it has a drawback: the coffee picker will yield fewer cherries compared to the second method, as only the red cherries are picked (sorted). The workers are paid a higher wage for each kilogram of red cherries they pick, whereas non-red cherries are not compensated. The second method is indiscriminate picking, when farmers pay the same amount for both ripe and unripe cherries that are picked. The weakness is in the poor quality of the coffee due to its mixture of red and non-red cherries. Workers prefer the second method because it is unnecessary to do the red fruit sequencing process when picking it. The workers receive a higher yield despite being paid less per kilogram of coffee cherries picked. The farmers and coffee pickers consider the method of evenly picking the ripe ones to be exhausting and slow. This is in line with a study by Budianto, where farmers consider spitting red cherries on coffee harvests troublesome and time-consuming because, in one visit to the garden, they only pick up fully ripe coffee[29]. The farmer has yet to be fully aware of the benefits of evenly picking red fruits because, according to the farmer, the important thing is to obtain a large quantity of fruits. Research done by Nature shows that the best hedonic value of aroma, aftertaste, and concentration is Arabica coffee with a red maturity rate (ripe)[27].

Farmers in the Permata Subdistrict generally pick coffee secondhand, whereas workers prefer to do it carelessly. Research conducted by Anggarawati states that the profit obtained by farmer groups is higher from haphazard picking coffee than from picking red[28].

3.2. Sorting Cherries through Mining and Pulping Coffee

The farmers often harvest ripe cherries in the morning and afternoon. They begin separating or peeling the cherry skin from the coffee beans later in the evening, then pulping and washing. A small fraction of farmers engage in the process of peeling the coffee themselves, whereas the majority of farmers directly submit their coffee cherries to the coffee mill. The drawback is that they will obtain a lower price. All coffee cherries must be harvested promptly, as cherries left unharvested will rot on the tree and attract pests. The mentioned drought will impact harvest quality in the next year. Before peeling, farmers sort coffee fruits by submerging them in water, causing the good beans to sink and the bad beans to float. The good and bad beans are then separated. The farmer propagated coffee at home after harvesting coffee fruits from the plantation. Sorting and sieving are performed at home because there is no water on the coffee plantation. Some farmers need more water supply to sort the beans. Some revealed that they peeled the coffee beans directly in the garden. This is because it is late afternoon, and the farmer has to return home from the farm immediately. According to farmers, peeling (pulp) cherries is advisable once they are picked immediately. If left for too long, they may become contaminated with bacteria, resulting in poor-quality coffee. The maximum time allowed after picking is 24 hours. The faster cherries are peeled with a pulper, the better.

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Several farmers also do not fully understand the process; sometimes, they start picking coffee in the morning but do not process it until the afternoon or the following day because of the invitation to a party or other activity. Some farmers use a peeling machine to peel the cherries, while others do the peeling manually. Farmers who have a grinding machine usually grind coffee seeds themselves. However, if they do not have a peeling machine, some people sell the cherries directly to the village peacock who owns the peacocks, and some also sell their cherries to the owner of the peaches. After that, the coffee beans are sunbathed and then sold to the wrappers.

The purpose of coffee peeling is to separate the outer skin from the inner bean. A farmer felt dissatisfied with the output of the pulp machine because there were still lots of fruits that needed to be perfectly grated. Farmers believe that the peeling of coffee leather impacts the popularity or success of coffee sales. Workers assist in the process of peeling coffee fruit into wet parchment. When farmers harvest 10 kg of coffee cherries, they will obtain approximately 2–3 kg of wet paddy rice. Subsequently, the farmers sold wet coffee beans and some sun-dried coffee. Many farmers only process it until it becomes wet paddy. Generally, farmers sell coffee cherries directly to coffeemakers. Few farmers sort by separating coffee seeds from their skins by mining and pulping. Generally, farmers who continue the sorting and cleaning process use pulper machines and labor. Most farmers do not pulp coffee according to the proper standards. For example, farmers peel coffee using a simple machine. Sometimes, there are defective coffee beans due to the peeling machine. Typically, farmers separate the good and defective results.

3.3. Coffe Washing and Drying

Coffee is washed after peeling. Farmers who wash and dry are those with pulper equipment and labor. The drying process is done after the coffee is peeled and washed. However, some farmers do not wash the coffee after peeling it; they dry it immediately, especially those needing water access. Usually, farmers peel the coffee in the garden and wash it immediately if there is water, then dry it at home. If there is no water supply in the garden, the coffee beans will not be washed immediately and brought directly to the house for drying. Some farmers wash the shelled coffee beans in a barrel instead of running water. An essential aspect of this process is washing the coffee with clean water, as the quality of the coffee will deteriorate if the water is contaminated, for example, by soap. Washing coffee beans with unclean water will result in an unpleasant taste, causing the coffee to be rejected by exporters. It is advantageous for farmers to have a continuous flow of water from the mountains. During the coffee drying process, if weather conditions are favorable, with even heat and no clouds, it only takes 4 hours or half a day to dry the coffee beans. Usually, workers assist in coffee drying. It is recommended to lay the coffee on a thick tarp on the ground or on racks specially made for drying coffee. Some farmers with large harvests use drying machines.

Farmers in mountainous areas face challenges due to the unstable mountain weather. Meanwhile, unprocessed rice still contains about 80% moisture, so sufficient sunlight is needed to reduce the moisture content to 30–40%, and this process can take 1-3 days. Therefore, dried coffee beans, known as parchment or wet husk, still have a high moisture content. The challenge lies in the unstable and fluctuating climate in the mountains and the little sunlight, which is crucial for reducing the moisture content of the rice. Drying coffee using tarpaulin to cover the coffee beans during rain will result in evaporation and contamination, leading to the growth of bacteria and mold on the coffee. Sun-drying coffee is of utmost importance due to its reliance on sunlight. If the weather is unfavorable, farmers will incur losses. To overcome dependence on sunlight, research was conducted using an infrared-based electromechanical system to dry coffee. The results show that the quality of coffee dried using infrared drying has a higher cupping score of 82.39% compared to traditional sun drying, which achieves a cupping score of 81.34% [29].

The simple treatment carried out by farmers has a crucial role in affecting the quality that will be achieved by exporters in the future. A farmer needs to get a good education in managing post-harvest. Farmers' role in the product quality cycle is approximately 60%, from cultivation to post-harvest. This is in line with Kembaren's view that the quality of coffee is determined by its handling during harvest and post-harvest[30].

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Many farmers need to learn the concept of specialty coffee to feel that specialty and non-specialty coffee are the same price. The largest local specialty market is in Java and abroad. Gayo farmers, in general, are still unfamiliar with technology and need more access to information, so they are less competitive with coffee farmers in Java. According to farmers, exporters should play a role in improving coffee quality, but the role of exporters is done through collectors or collectors. The government only plays a role in cultivation, such as overcoming coffee plant diseases.

Most farmers in Permata Subdistrict sell coffee in the form of cherries and wet grain, with only a tiny number selling green beans. This is due to farmers' need for more human resources, such as skills and knowledge in post-harvest processing, the lack of capital to buy coffee processing equipment such as pulper machines and the distance of water sources for washing coffee.

Furthermore, while examining the four fundamental components of the Small and Medium-Sized Producers framework inside the global value chain, one of these pillars is access to funding. This pillar encompasses infrastructure, equipment, certification, and standardization. The ordinary coffee farmer in Permata District has not yet attained this pillar to its maximum potential. For instance, as a result of insufficient and steep road infrastructure that leads to coffee plantations, it is frequently necessary for farmers to spend the night when unexpected weather changes happen. Additionally, with regard to equipment, there is still a manual pulper machine. Only a limited number of farmers have sufficient equipment for the processing procedure. The following represents the coffee quality obtained from standard processing methods without any additional treatment.

Table 2. Post-harvest treatment and processing.

Processing Stage	Sorting	Grinding	Washing	Drying	Defect Condition
Treatment	None	Regular	Regular	Regular	<35%

Based on the table above, it is known that farmers who only do regular post-harvest processes without any special treatment generally obtain coffee of rather poor quality, with a yield percentage below 35%. The table above illustrates the low quality of coffee processed by coffee farmers in Permata District, Bener Meriah Regency. The low yield is due to the subpar coffee processing methods employed. Hal ini sesuai dengan penelitian yang dilakukan oleh Hardi yang menyatakan nilai rendemen kopi beras berbasis kopi labu adalah 35%[31]. This is due to the constraints of the relatively cold local temperature in Central Aceh and the simple technology used for the coffee drying process, with an average daily temperature ranging from 23-29°C. The drying process of pumpkin coffee until it can be ground takes 12 hours, with 8 hours on the first day and 4 hours on the second day. The farmers engage in independent efforts to carry out post-harvest processes. As a result, the harvest quality becomes low. The treatment and assistance patterns carried out by farmers in cultivation and post-harvest processes can be seen in the following table:

Table 3. Treatment and Assistance on Post-Harvest Processing Process.

The role of farmers to improve quality	Actions	Constraints	Solutions	The actors
Quality	• Fruit Sorting • Milling • Washing • Drying • Percentage Yield	• Limited Access to Training • Working Conditions • Limited Equipment	Join a farmer group or cooperative to expand knowledge	Plantation Office and Exporters

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Furthermore, the farmer's role in the coffee value chain lies in post-harvest coffee processing, such as fruit sorting, grinding, washing, and drying. In this scenario, small-scale farmers with limited financial resources may experience some difficulties at this stage, resulting in output quality that is far below average. At this stage, the role of institutions is indispensable, especially for farmers with financial limitations. Strong farmer group institutions will provide knowledge and skills to improve coffee quality. In addition, these organizations will provide various options for improvement, including providing Quality Assurance services. In addition, the government will further assist companies by offering legal assistance and infrastructure to farmers. Some actions that farmers can take to improve coffee quality at the post-harvest stage are as follows:

Table 4. Post-Harvest Processing Treatments to Improve Arabica Coffee Quality in Permata District.

Processing Stage	Treatment	Supporting Actors
Fruit Sorting	Floating cleaning	Quality Assurance (QA)
Hulling	Wet Hull	QA
Washing	Flowing water	QA
Drying	Greenhouse	QA
Defect Condition	12% - 15%	QA

Furthermore, the research findings indicate that all participants in this study are not involved or affiliated with any farming groups or cooperatives. This finding deserves attention as it may have severe consequences if it continues. Farmers can easily access information and markets for their agricultural products by joining a farmer group or similar organization. Additionally, being part of a farmer group allows farmers to easily receive assistance in improving the productivity and quality of their harvests.

Based on the Small and Medium-Sized Producers model proposed by Stark, which consists of access to training, capital, collaboration and coordination, and market access [32]. The stages of cultivation, such as planting, harvesting, and processing, can be integrated into the training program. This integration allows farmers to develop technical skills for each stage, including planting techniques, harvesting methods, and post-harvest processing knowledge. This is also similar to the stages found in post-harvest coffee processing. Effective coordination is vital to improve the quality of coffee production among farmers. This entails establishing solid relationships with cooperatives or farmer groups, which provide essential institutional support and resources to enhance farming practices and productivity. These farmer groups will provide knowledge and skills to improve production. A strong relationship between the institutional framework and farmers is essential for successful trade practices. This relationship ensures mutual understanding, cooperation, and support in various trade-related aspects. Institutionalization offers diverse forms of assistance, including the deployment of agronomists. Moreover, the government contributes to supporting institutions and farmers by providing training and infrastructure, ensuring comprehensive support for agricultural development. The research conducted by Kassaye demonstrates the influence of cooperative institutions, certification, private traders, farmers, sorting methods, and processing on the quality of Arabica coffee[33].

The research findings indicate that coffee beans from cooperative institutions are of higher quality. Additionally, the dry processing method enhances the quality of coffee by processing ripe red cherries. Sorting cherries by quality also enhances the overall quality of coffee. Only a small portion of farmers in Permata District engage in post-harvest processing. This process includes sorting, husking, peeling, washing, and sun-drying the red paddy before selling it as wet rice according to market demand. Some farmers also continue separating the coffee beans from the huller and sun-drying them until they become green. Many farmers still face challenges in processing coffee beans during post-harvest processing, such as inadequate drying facilities and limited access to processing equipment. All stakeholders must take additional actions per their specific roles and responsibilities to address this issue. The ultimate goal of coffee processing is to achieve a flavor that consumers recognize and prefer.

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In addition, when considering the four pillars of the small and medium producer model in the global value chain, there is the pillar of access to finance, which consists of infrastructure, equipment, and certification and standardization. Due to inadequate infrastructure, informants often have to stay overnight in response to sudden weather changes. Some informants lacked essential tools, particularly those required for processing. Most key informants emphasized the need for standardization in coffee farming on their farms to uphold a high-quality and efficient value chain.

Post-harvest processing is the second stage in coffee cultivation or production management, following the cultivation process or production management. This stage is crucial because the quality of coffee, which is determined during post-harvest processing, significantly influences its market value and added value. Effective coordination among stakeholders, such as farmers, institutions, and government bodies, is essential to improve coffee quality. Farmer groups play a vital role in imparting knowledge and skills to enhance coffee quality, while farmers must also cultivate deep relationships with traders in the trade. Institutions offer various forms of support, such as providing Quality Assurance services. At the same time, the government plays a crucial role in offering support through training, education, and infrastructure development for both institutions and farmers.

4. Conclusions

Most coffee farmers in Permata Subdistrict directly sell coffee cherries to collectors without conducting any post-harvest processing. However, some farmers carry out several stages of processing as follows: First, the harvesting of coffee cherries is done by pickers using two methods, namely haphazard picking (paying based on the number of cherries picked regardless of the maturity level) and even red picking (paying workers who only pick red cherries). Second, some farmers do sorting with mining, while others grind the whole coffee without sorting to obtain a larger quantity of coffee beans. Third, coffee hulling generally uses a pulper machine, although some do it manually. Fourth, the washing of pulped coffee beans varies depending on water availability. Fifth, drying coffee beans is done using special tarpaulins or plastic mats. Some also use exceptional lofts or dry the coffee in greenhouses. Nevertheless, the post-harvest processing carried out by coffee farmers in the Permata Subdistrict has not been able to produce coffee following the specialty coffee standard.

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