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ANALYSIS OF ARABICA COFFEE CULTIVATION PRACTICES IN SIPIROK BY COFFEE FARMERS IN SIPIROK

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Abstract

Coffee is a major commodity in Sipirok, South Tapanuli Regency, with potential national and international markets. The implementation of Good Agricultural Practices (GAP) in coffee cultivation is still limited, resulting in suboptimal quality and competitiveness of Sipirok coffee. This study aims to analyse farmers' knowledge, attitudes, and practices (KAP) towards GAP and examine local government policies supporting coffee development. It also aims to identify challenges and barriers to GAP implementation. The theoretical foundations used include Pierre Bourdieu's habitus theory, the KAP model, and Rogers' innovation adoption theory. This study employed a qualitative method with a descriptive approach through field observations, in-depth interviews, and literature studies. Data validation was performed using triangulation techniques. The study area covered three sub-districts in South Tapanuli: Sipirok, Arse, and Saipar Dolok Hole. The results showed that most farmers still rely on traditional practices passed down through generations and have not fully understood or implemented GAP. The main inhibiting factors are limited capital, limited access to information, and resistance to change. A small group of farmers and local companies have adopted GAP more effectively. Local government policies are considered suboptimal in providing farmer education and mentoring. This study confirms that the transformation towards GAP implementation requires structural and institutional support, as well as changes in farmer habits to enable Sipirok coffee to compete in the global market. This study shows that the adoption of Good Agricultural Practices (GAP) by coffee farmers in Sipirok remains low and partial. In terms of knowledge, most farmers are not yet systematically familiar with GAP and still rely on inherited traditions. In terms of attitudes, they demonstrate caution towards new practices, with doubts persisting because GAP is considered expensive, difficult to implement, and does not guarantee better prices. In practice, most farmers are still at the pre-GAP stage and are GAP literate. Comprehensive implementation is only seen in groups fostered by institutions such as the Darul Mursyid Islamic Boarding School.

Keywords: *Sipirok Coffee, Good Agricultural Practices, Analysis of Cultivation Practices, Coffee Farmers, Habitus.*

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INTRODUCTION

The development of the global coffee industry has driven increased quality standards that emphasise not only brew quality but also cultivation practices, harvesting methods, and post-harvest processing. These standards, known as Good Agricultural Practices (GAP), serve to ensure environmental sustainability, consistent quality, and farmer welfare (International Coffee Organization, 2023).

However, the implementation of GAP at the smallholder level in Indonesia, including in Sipirok, South Tapanuli Regency, remains limited and has not been optimally implemented. Most coffee farmers in this region still rely on traditional practices passed down through generations and sell their produce as coffee cherries, resulting in low added value and product competitiveness (Author's Observations, 2025).

Coffee is a strategic global commodity, produced by more than 70 countries and a source of livelihood for millions of farmers (ICO, 2023). Indonesia holds a significant position as the fourth-largest coffee producer after Brazil, Vietnam, and Colombia, with approximately 96% of its production coming from smallholder plantations (Ministry of Agriculture, 2022).

Indonesia's agro-climatic advantages allow for the development of two main varieties, Arabica and Robusta, with diverse flavour characteristics. Successful improvement of national coffee quality depends heavily on the ability of smallholder farmers to adopt good cultivation practices in accordance with GAP standards.

Locally, Sipirok coffee holds a strategic position in the economic structure of South Tapanuli. According to the Indonesian Geographical Indications (2018), Sipirok Arabica coffee has an average physical quality score of 83.55 and is categorised as a high-quality speciality coffee. Arabica coffee plantings in Sipirok cover 1,652 hectares, producing 2,466 tonnes annually, while Robusta coffee is planted on 141 hectares, producing 114 tonnes (South Tapanuli Plantation Recapitulation, 2023).

The ideal agro-ecological conditions, at an altitude of approximately 900 metres above sea level, give Sipirok coffee significant potential for development. This potential has not yet been fully implemented by GAP. Only a small number of actors, such as the Darul Mursyid Islamic Boarding School, have implemented it effectively.

Several studies have shown that the success of coffee commodities in the global market is significantly influenced by consistent quality and geographic identity. The success of Gayo coffee as a superior Sumatran coffee, for example, demonstrates that the implementation of GAP, institutional strengthening, and geographic differentiation strategies can increase competitiveness (Tambunan, 2021).

This situation suggests that Sipirok coffee has a significant opportunity to strengthen its image and selling value through the sustainable implementation of GAP. GAP implementation at the farmer level is not only related to technical aspects but also to social and structural factors. Previous research (Inandara, 2020; Adinandra & Pujianto, 2020) confirmed that the success of GAP is significantly influenced by farmers' knowledge, attitudes, and ability to access production facilities such as superior seeds, fertilisers, and agricultural tools.

Poor access to information and extension services, coupled with resistance to change, are major obstacles to the adoption of agricultural innovations. Understanding farmers' perceptions and readiness levels is a crucial step in encouraging effective GAP implementation.

In the context of this research, the Knowledge, Attitude, and Practices (KAP) model was used to analyse the knowledge, attitudes, and practices of Sipirok coffee farmers toward GAP.

The KAP model allows for an integrated analysis of the extent to which farmers understand the benefits of GAP, their attitudes toward implementing these standards, and actual practices in the field (Yunita, 2017). This approach also helps identify the relationship between farmers' knowledge levels and good cultivation practices and uncovers gaps between theory and practice.

Furthermore, this research is grounded in Habitus theory (Bourdieu, 1990), which explains that farmers' actions and choices in farming are not solely determined by rational knowledge but also by historically internalised habits and values. Habitus shapes farmers' perceptions of innovations such as GAP, and resistance to change often reflects the reproduction of old practices that are socially and culturally entrenched. Therefore, the transformation to GAP-compliant cultivation requires not only technical outreach but also

more fundamental structural and cultural changes.

The research area covers three main sub-districts: Sipirok, Arse, and Saipar Dolok Hole, which represent the entire Sipirok coffee production area. The research focused on three main aspects: (1) analysis of farmers' knowledge, attitudes, and practices regarding GAP; (2) evaluation of local government policies supporting local coffee development; and (3) identification of social, economic, and institutional barriers to GAP implementation.

The research findings are expected to inform the formulation of coffee agricultural development policies that are more responsive to farmer needs, strengthening the competitiveness of Sipirok coffee in national and international markets. Theoretically, this research contributes to the development of studies on innovation adoption and community-based economic development in the agricultural sector.

METHODOLOGY

This study uses a descriptive qualitative approach to understand the knowledge, attitudes, and practices (KAP) of coffee farmers regarding the implementation of Good Agricultural Practices (GAP) in Sipirok District, South Tapanuli Regency. This approach was chosen to explore the meaning, experiences, and socio-cultural dynamics of farmers in the coffee cultivation process.

The research location was selected purposively because Sipirok is a centre for Arabica coffee production and an area with a diversity of business actors, ranging from smallholder farmers and seed entrepreneurs to cafe owners and companies such as Filo Coffee and the Darul Mursyid Islamic Boarding School. This diversity provides a rich social context for understanding variations in the understanding and implementation of GAP.

Informants were selected using a purposive sampling technique (Creswell, 2018) based on their direct involvement in coffee cultivation activities. Five categories of informants were established: (1) young, innovative farmers; (2) traditional farmers with inherited knowledge; (3) experienced farmers who reject GAP; and (4) professional implementers of formal GAP. (5) local farmer-traders involved in the coffee supply chain.

Data were collected through participant observation, in-depth interviews, and field documentation. Triangulation was applied to maintain data validity by comparing the results of observations, interviews, and documentation and conducting member checks with informants.

Data analysis used the interactive model of Miles and Huberman (in Sugiyono, 2014), which includes three stages: data reduction, data presentation, and conclusion drawing.

Through this design, the research not only describes the implementation of GAP but also explains the relationship between local knowledge, economic conditions, and social dynamics that shape coffee farming practices in Sipirok.

RESULT AND DISCUSSION

1. General Overview of the Research Area

Sipirok District is one of the main agricultural areas in South Tapanuli Regency, North Sumatra Province, covering an area of 40,936.52 hectares, or approximately 9.4% of the regency's total area. This area lies at an altitude of 300–1,825 metres above sea level and is dominated by hilly topography, making it suitable for Arabica coffee production. Administratively, Sipirok borders Arse District to the north, East Angkola and Marancar to the south, Batang Toru to the west, and North Padang Lawas Regency to the east (BPS, 2023).

Governmentally, Sipirok comprises six sub-districts and 34 villages with a relatively complex institutional system, reflecting the social heterogeneity of its community. The population is 35,987, with a nearly equal male (49.94%) and female (50.06%) ratio (BPS, 2023). This demographic structure supports the availability of labour in the agricultural sector.

The social sector shows quite good development. There are 46 elementary schools, 9 junior high schools, and 4 senior high schools/vocational high schools, and health facilities include 1 hospital, 1 main community health centre, and 12 sub-community health centres. The majority of the population is Muslim, with 100 active mosques (Ministry of Religious Affairs of South Tapanuli, 2023). Family planning programmes and high educational participation are social indicators supporting the stability of rural communities.

The agricultural sector is the backbone of the local economy, dominated by food crops such as rice and corn, as well as horticultural crops

such as chillies and tomatoes. Arabica coffee occupies a strategic position, with an area of 1,935 hectares and an annual production of 2,147 tonnes (BPS, 2023). Coffee cultivation has been ongoing since the 19th century, with superior varieties such as Typica and Sigararutang.

In the last decade, the development of smallholder coffee has been supported by institutional initiatives such as the Darul Mursyid Islamic Boarding School (PDM) and the South Tapanuli Coffee MPIG, which strengthen quality standards through the implementation of Good Agricultural Practices (GAP) and the protection of Geographical Indications (MPIG, 2022; Bank Indonesia, 2019). Collaboration between farmers, educational institutions, and financial institutions is a crucial foundation for the sustainability of Sipirok coffee as a superior community-based commodity.

2. Sipirok Coffee Farmers' Knowledge, Attitudes, and Practices Regarding Good Agricultural Practices (GAP)

Sipirok farmers' knowledge of coffee cultivation is the primary foundation for driving changes in agricultural behaviour and practices. Without adequate understanding, any technological intervention, policy, or physical assistance will not yield optimal results (Rogers, 2003; Mosher, 1987). This is fully reflected in the condition of coffee farmers in Sipirok District, who still have limited understanding of the principles of Good Agricultural Practices (GAP). GAP has become a global standard for ensuring sustainable production, resource efficiency, and the quality of agricultural products (FAO, 2016).

During field observations from June to July 2025, it was found that the majority of coffee farmers in Sipirok lacked basic knowledge of GAP. Most had never heard of the term, and coffee cultivation activities were still carried out based on inherited customs without standard technical references. This is similar to research findings in other areas such as the Gayo Lues and Toraja Regencies, where farmers still rely on local knowledge and family experience in coffee cultivation (Nasution et al., 2020; Nurhasanah et al., 2022).

3. Knowledge of Coffee Management among Sipirok Coffee Farmers

One informant, Siregar, said, "Coffee farmers in Situmba Village admitted to having heard the term 'GAP' from farmers outside the area but considered its implementation 'unsuitable' in Sipirok because it required significant costs and effort."

This perception reflects the barriers to innovation adoption, which are often caused not only by a lack of information but also by socio-economic and psychological factors among farmers (Leeuwis & van den Ban, 2004).

The lack of extension activities exacerbates the situation. Most farmer groups in Sipirok are only active when receiving government assistance and do not carry out ongoing technical guidance. This situation indicates the weak role of farmer institutions as a vehicle for knowledge transformation (Harahap, 2021). Based on interviews, there has been no training related to sustainable coffee cultivation or GAP practices in the past two years.

Interviews with several farmers, including Budiardi (24), Ritonga (24), Batubara (50), Gultom (32), and Abdi (27), showed that on average, they had been farming coffee for more than 10 years. They possessed traditional technical knowledge, such as plant spacing (2 x 2.5 m), applying 1 kg of manure per planting hole, fertilising every three months with Ammophos fertiliser, and pruning branches after fruiting. Local knowledge, such as the term "mate bujing", which means the death of a plant after flowering abundantly at a young age, indicates an empirical understanding of plant physiology, although it is not yet connected to a scientific approach (Sibarani, 2015).

This knowledge has not yet met GAP standards, for example, in aspects of soil conservation, crop rotation, the use of certified seeds, or recording harvest yields (FAO, 2016). Furthermore, most farmers did not understand the importance of shading from the start of planting, resulting in a shortened productive lifespan. Only a small number of farmers began using lamtoro shade after participating in the MPIG South Tapanuli comparative study in Takengon.

The Darul Mursyid Islamic Boarding School (PDM) is an example of a local institution that has consistently implemented GAP (Growth Achievement Approval). PDM begins by selecting certified superior seeds, measuring soil pH, applying mature organic fertiliser, and planting shade trees from the outset. Fertilisation is based on plant needs, not habits,

and pruning is carried out in a planned manner to maintain productivity.

Pest control is carried out using Integrated Pest Management (IPM) principles, and selective harvesting is carried out only on perfectly red fruit. These practices align with the GAP coffee guidelines issued by the Directorate General of Plantations (Ditjenbun, 2015; Coffee Quality Institute, CQI, 2019). The implementation of GAP at PDM demonstrates that improving technical knowledge and plantation management can produce high-quality, globally competitive coffee. However, these practices remain limited to the Islamic boarding school's institutional framework and have not yet spread to surrounding farmers.

In general, the low level of knowledge among farmers in Sipirok is not due to a lack of willingness but rather to the absence of an effective knowledge dissemination system. The absence of active extension workers, weak farmer institutions, and limited access to information mean that GAP remains an unfamiliar term for many farmers. Urgent improvements aren't just about facilities and equipment but rather about reorienting farmers' perspectives and strengthening their knowledge base. Without changes in these areas, GAP will remain a policy slogan devoid of real meaning in Sipirok's coffee plantations.

4. The Role and Knowledge of Coffee Cultivation by Local Actors: Darul Mursyid Islamic Boarding School

According to interviews with administrators of Darul Mursyid Islamic Boarding School, such as Pahmul (32) and Panindoan (32), the establishment of PDM Coffee in 2018 was inseparable from the grand vision of the Islamic boarding school, which has existed since 1993. Initially, the Islamic boarding school functioned purely as an educational institution, but over time it evolved into an institution for community empowerment. This shift in orientation stemmed from the realisation that the utilisation of natural resources, particularly coffee, was not optimal in supporting the welfare of the surrounding community (Mawardi, 2019; Suharyanto & Damanik, 2020).

Concrete steps began in 2014, when the Islamic boarding school opened a coffee plantation covering approximately 3 hectares. During this phase, the Islamic boarding school management implemented Good Agricultural Practices (GAP) principles with the support of learning from the Indonesian Coffee and Cocoa Research Center, including through the guidance of Prof. Surip Mawardi. These efforts paid off when coffee prices reached their highest level on the global market in 2017 (ICO, 2018). This success prompted the Islamic boarding school to initiate educational activities for farmers in 2016, although at that time it was limited to field outreach and not yet structured into a programme (Coffee and Cocoa Research Center, 2019).

The momentum of the 2017 harvest sparked internal discussions with the foundation's leadership regarding the need for downstream processing. The main problems faced by farmers were not solely cultivation-related but also within the economic chain, particularly dependence on middlemen, which depresses selling prices (Daryanto, 2021).

As a solution, in 2018 the Islamic boarding school established PDM Coffee as a business unit operating in the downstream sector. A coffee factory was then built, equipped with production equipment and supported by various certification training programmes. Production began with green bean processing and expanded to roasted beans and ready-to-drink ground coffee. In parallel, the Community Empowerment Institute (LPU) was established as a division integrating community economic programmes with a primary focus on coffee. That same year, PDM Coffee began providing assistance to villages with potential coffee plantations at altitudes of 900–1,300 metres above sea level.

The strategy employed was to partner with local figures (local heroes) to introduce them to sustainable coffee cultivation practices, appropriate growing conditions, variety selection, and the implementation of agroforestry patterns with shade trees (Hairiah et al., 2020). As an incentive, PDM Coffee guaranteed a higher purchase price for coffee cherries than the market. By 2020, the number of assisted farmers partnered with PDM Coffee reached 76, although these partnerships remained individual.

The COVID-19 pandemic presented significant challenges as coffee prices plummeted, forcing most farmers to shift to other commodities such as corn and horticulture (FAO, 2021). However, post-pandemic, coffee

prices recovered in 2022. Based on this experience, PDM Coffee repositioned its strategy by shifting its partnership model from individual to farmer group-based. Each group is required to sign a Memorandum of Understanding (MoU) affirming their commitment to implementing standard operating procedures for coffee cultivation in accordance with PDM Coffee guidelines. In return, PDM Coffee is obligated to provide training, education, technical assistance, superior seeds, and access to capital through a loan scheme for production facilities that is repaid at harvest time (Mawardi, 2022).

To date, 36 assisted farmer groups have been registered across the SDH and Arse Districts. PDM Coffee's mentoring programme sets strict requirements, including a maximum of 500 coffee trees per farmer initially. This policy is intended to ensure commitment and consistency in plantation management before farmers are allowed to expand their planting capacity.

Through this approach, PDM Coffee serves not only as a business unit but also as an empowerment institution that prioritises sustainability. This strategy positions farmers not simply as suppliers of raw materials but as partners in the coffee production ecosystem, focused on improving quality, productivity, and the community's economic competitiveness (Barokah et al., 2022; Giovannucci et al., 2020).

5. Farmers' Attitudes Toward Coffee

In addition to technical and economic factors, socio-cultural dimensions significantly influence farmers' attitudes toward this cultivation model. Coffee cultivation in Sipirok is a hereditary tradition that is viewed not only as a profession but also as a family identity. Therefore, innovations that deviate from established practices often generate social resistance (Chambers, 1997; Sulaiman & Feder, 2019). Farmers who try new methods risk being labelled "know-it-alls" or being accused of abandoning traditional wisdom. In communities with strong solidarity, these social norms act as a control mechanism that indirectly slows adoption (Pretty, 1995).

Furthermore, farmers' attitudes are also strongly influenced by their position in the production chain. Ordinary farmers who only sell their harvests, such as red cherries or fresh grain, do not feel market pressure to adopt this cultivation model. As long as local buyers remain available and prices are acceptable, they see no urgency in changing their farming practices (Daryanto, 2021; Giovannucci et al., 2020). As a result, GAP is perceived as "distant" from daily needs.

Different attitudes are seen among seed entrepreneurs or farmers with more established businesses. Field data shows that seed farmers like Malau are actually more open to Good Agricultural Practices (GAP). He explained that he frequently participates in training activities because he is concerned about the reputation and sustainability of his seed business. This means that when there is a direct link between innovation and economic value, farmers' attitudes become more positive (Rogers, 2003; Leeuwis & van den Ban, 2004).

More established institutions such as Pesantren Darul Mursyid (PDM) Coffee and several local Filo Coffee cafes demonstrate a much more progressive attitude. They implement GAP standards because they directly connect with downstream markets and consumers who demand quality (Barokah et al., 2022). This positive attitude has great potential to be a catalyst for change, but to date, the social and economic distance between established institutions and smallholder farmers has prevented its impact from being widely felt (Suharyanto & Damanik, 2020).

The emotional dimension also has a significant influence on how farmers assess good coffee cultivation practices. Many feel anxious and afraid of making mistakes when hearing new recommendations, especially those that differ significantly from traditional methods. For example, pruning branches is thought to reduce fruit yields, when in fact, it is beneficial for long-term productivity (Mawardi, 2019). This concern leads some farmers to prefer maintaining traditional practices as a form of protection against the risk of loss (Mulasari, 2021). This fear stems from limited experience and the lack of intensive technical assistance.

Their level of trust in the government and agricultural extension workers also shapes their attitudes. Based on field notes, many farmers believe that the outreach provided is often merely formal and rarely addresses real needs. The material presented emphasises theory rather than direct practice in the fields. This creates the impression that good cultivation standards are difficult to achieve, leading them to rely more on community experience or the

examples of fellow farmers (Leeuwis, 2004; Dwiastuti et al., 2020).

Within close-knit farming communities, social norms are also a crucial determinant. Many farmers stated that they would only try new methods if a fellow villager had already succeeded. This principle aligns with Rogers' (2003) Diffusion of Innovation theory, which states that groups that tend to be slow to adopt innovations typically wait for concrete evidence in their own environment. This attitude is not a form of absolute rejection but rather a way of maintaining household economic security (Feder et al., 1985).

Despite these doubts, there is also hope in their perspectives. Several farmers stated that if the government could provide consistent assistance, provide price incentives, and demonstrate successful examples from their local communities, they would be more open to standardised agricultural practices. This means that farmers' attitudes currently oscillate between a fear of risk and a desire to progress (Hairiah et al., 2020).

Sipirok coffee farmers' perspectives on agricultural innovation cannot be simplified into a single, homogenous voice. The research results show a multi-layered pattern of attitudes among them, reflecting differences in experience, access to information, and socioeconomic status.

The conservative group, namely farmers who tend to resist changes in coffee cultivation. This resistance stems not from mere ignorance but from limited resources and a fear of risk. They stick to traditional methods and prefer safety over experimentation (Rogers, 2003).

The hesitant group (late majority) waits for concrete evidence from their surroundings. They will only try new methods if a neighbour or relative has already succeeded. This attitude reflects a social strategy for coping with economic uncertainty (Feder & Umali, 1993).

The progressive group, which generally consists of seed entrepreneurs, trained farmers, and established institutions like PDM Coffee, is supported by access to information, market connections, and a quality orientation (Giovannucci et al., 2020; Suharyanto & Damanik, 2020).

These three patterns demonstrate that acceptance of good coffee cultivation practices is determined not only by technical aspects such as fertiliser availability or pruning methods, but also by emotional factors, social trust, and community norms. Therefore, efforts to introduce innovations in Sipirok need to consider this diversity of attitudes, rather than assuming all farmers are at the same level of readiness (Rogers, 2003; Leeuwis, 2004).

6. Farmer Practices in Sipirok Coffee Cultivation

Coffee cultivation in Sipirok District remains firmly rooted in traditional knowledge systems passed down through generations. Farmers learn empirically from experience and observation, rather than through technical training or written literature (Panggabean & Ali, 2023). As a result, cultivation practices tend to be intuitive and unstandardised.

The seed selection process is simple, selecting fruit from trees deemed healthy without genetic testing or pre-treatment as required by Good Agricultural Practices (GAP). Plant spacing varies between 1 and 1.5 metres without systematic measurements, in contrast to the GAP recommendations for Arabica coffee (2 × 2.5 m) and Robusta (2.5 × 2.5 m) (Puslitkoka, 2017). This situation has the potential to reduce land efficiency and increase the risk of disease.

Fertilisation is generally based on financial capacity, not soil analysis. Farmers use manure or inorganic fertilisers (urea, NPK) at fixed rates and without liming. Pest control is carried out reactively based on visual signs of disease. In general, the cultivation system is still reactive and based on local experience, not yet orientated towards prevention and efficiency as per the GAP principles.

7. Stages of Coffee Cultivation by Sipirok Farmers

a. Nursery

Nursery practices show variations in techniques among actors. Farmers like Budiariadi and Samsudin cultivate manually from seeds or coffee cherries using soil and manure, while others purchase ready-to-plant seedlings. Rahmad Gultom utilises seeds from civet droppings, while institutions like Filo Coffee and PDM Coffee implement standardised nurseries with superior varieties (Gayo 1, Gayo 2, and Ateng Super). PDM Coffee follows the GAP protocol with germination tests, sterile media, regular watering, microfertilisation, and seedling distribution only after land readiness is verified.

b. Planting

Farmers prepare the land with holes of varying sizes (40–60 cm^3), add manure, and then transplant the seedlings manually. Planting spacing ranges from 2.5 to 3 m, and some use natural shade trees such as banana trees. At the institutional level, Filo Coffee and PDM implement standard plant spacing, hole size, and more measured base fertiliser application to maintain uniform growth.

c. Fertilisation

Most farmers use manure and chemical fertilisers (urea, TSP, KCl) without a standard schedule. At the institutional level, fertilisation is carried out in a balanced and scheduled manner according to the plant's growth phase. PDM Coffee divides the fertilisation period into two stages (at the beginning and end of the rainy season) with measured doses, using a combination of mature organic fertiliser and NPK according to the age of the plant. This method is more efficient and aligns with the GAP principles (FAO, 2016; ICO, 2017).

d. Maintenance

Maintenance activities include pruning, weeding, watering, follow-up fertilisation, and pest control. Pruning is done to maintain air circulation and stimulate the growth of productive branches, while weeding and watering are carried out according to weather conditions. At the institutional level, maintenance follows GAP guidelines with an Integrated Pest Management (IPM) system and routine pruning (Puslitkoka, 2017). Farmers' practices are reactive, while institutions like PDM and Filo employ a preventative and sustainable approach.

e. Shading

Farmers use natural shade trees such as banana leaves, dadap trees, and banana trees to reduce direct light exposure. PDM Coffee regularly plants permanent shade trees such as lamtoro and kaliandra, in accordance with GAP guidelines, maintaining a light intensity of 40–60% and stable microhumidity (FAO, 2016; ICO, 2017). This shading system not only serves as protection but also regulates the microclimate that supports productivity.

Coffee cultivation practices in Sipirok demonstrate the duality between local wisdom and institutional innovation. Smallholder farmers still rely on empirical traditions that are adaptive but technically inefficient, while institutions like PDM and Filo Coffee have implemented GAP principles in a structured manner. This difference reflects a gap in capacity and access to modern knowledge. Efforts to improve cultivation quality need to be directed at ongoing mentoring, technical training, and the integration of local values with GAP standards to achieve sustainable production.

8. Barriers to the Implementation of Good Agricultural Practices (GAP)

The implementation of Good Agricultural Practices (GAP) by coffee farmers in Sipirok District still faces a number of structural and cultural obstacles. Based on interviews and field observations, four main obstacles were identified:

(1) Lack of ongoing government extension and mentoring,
(2) Concerns about rising production costs,
(3) Lack of price differentiation between GAP and non-GAP products,
(4) Weak farmer institutional functions.

These obstacles demonstrate that GAP adoption depends not only on technical factors but also on suboptimal institutional support systems and market incentives (Rogers, 2003; Ruben & Fort, 2012).

9. GAP Adoption Rate in Coffee Cultivation in Sipirok

Research results indicate that the adoption rate of GAP among farmers remains low. Based on a combination of the Diffusion of Innovations model (Rogers, 2003) and FAO guidelines (2016), the majority of farmers are at Level 0–1 (traditional–aspirational), while groups assisted by institutions such as PDM Coffee and Filo Coffee have reached Level 2 (partial adoption). In the planning and land preparation stages, most farmers still clear land using slash-and-burn methods, which are not in accordance with conservation principles (ICCRI, 2017). In contrast, the assisted groups have implemented land management without burning and the provision of organic matter, in line with GAP principles (Ministry of Agriculture Regulation No. 49/2014).

When selecting seeds, most farmers still use local, uncertified planting material. Only assisted farmers have begun using superior varieties such as Gayo 1 and Gayo 2, although not

all of them are certified. This indicates that traceability of planting material remains a major obstacle (FAO, 2016).

10. Land Maintenance and Management Practices

During the crop maintenance phase, pruning and fertilisation are generally carried out without standard operating procedures and without soil analysis results. Assisted farmer groups have begun implementing seasonal calendars and pesticide rotations in accordance with Integrated Pest Management (IPM) principles, demonstrating progress toward Level 2 GAP implementation (ICCRI, 2017).

Natural resource management practices also vary. Most farmers still grow coffee monocultures, but there are agroforestry initiatives using shade trees such as gamal (Gliricidia sepium) and petai cina (Leucaena leucocephala) to maintain soil moisture. Ecological awareness is growing among farmers partnering with institutions, although it has not yet been fully quantified.

11. Harvesting, Post-Harvest, and Product Quality

During the harvest phase, most farmers still pick coffee cherries en masse without considering ripeness. This impacts the quality of the beans and their flavour. In contrast, farmers assisted by institutions like PDM Coffee have implemented selective harvesting, only picking fully red cherries, and implementing hygienic post-harvest procedures with standardised fermentation and drying. This system is supported by a premium pricing policy and traceability mechanisms, demonstrating the adoption of GAP at Levels 2–3 (ICCRI, 2017; Ministerial Regulation No. 49/2014).

Most traditional farmers still use simple wet milling methods, without grading or controlled fermentation. Nevertheless, they demonstrate integrity in their trading practices by avoiding fraudulent sales of their crops. This is an important social value that can serve as a foundation for post-harvest practices.

12. Capacity Building and Institutional Role

The low adoption of GAP in Sipirok is also due to limited access to information and formal training. Extension services still rely on initiatives from private institutions such as PDM Coffee and Filo Coffee. Farmer institutions generally do not function as technical learning platforms but rather serve only administrative purposes. Practical training conducted in the field has proven more effective in improving farmer understanding (Rogers, 2003).

These findings support the opinion (Ruben and Fort, 2012) that the success of GAP adoption is largely determined by the existence of local institutions capable of bridging knowledge transfer, market access, and ongoing development. Overall, the research results indicate that GAP implementation in Sipirok District is still in its early stages. The main obstacles include a weak extension system, limited capital, and the absence of price incentives. There are positive indications of the role of local institutions in driving the transformation towards sustainable agricultural practices. Participatory development-based approaches and economic incentives have proven effective in accelerating GAP adoption at the smallholder level.

An analysis of the eight stages of Good Agricultural Practices (GAP) indicates that coffee farmers in Sipirok remain at Level 0–1, characterised by traditional practices and limited access to knowledge. However, the existence of local institutions such as Pesantren Darul Mursyid (PDM Coffee) and Filo Coffee demonstrates the potential for transformation toward a more comprehensive implementation of GAP through knowledge, institutional support, and market access. This aligns with findings (Sanginga et al. 2007) that the adoption of sustainable agricultural practices is strongly influenced by institutional support and access to innovation.

13. Local Government Policy Analysis

The implementation of GAP in Sipirok has not been supported by concrete and systematic regional policies. Minister of Agriculture Regulation No. 49/Permentan/OT.140/4/2014 mandates local governments to facilitate training, certification, and the provision of supporting facilities; its implementation in South Tapanuli has not yet been realised. There is a policy gap between national directives and regional implementation, where GAP has not yet been prioritised for agricultural development.

The lack of strategic initiatives is also evident in the absence of regional programmes that position GAP as a basic framework for coffee

development. Assistance programmes remain incidental, such as the distribution of seeds and fertiliser, without ongoing development. This weakness is exacerbated by fragmented interagency coordination between the agricultural office, village governments, extension workers, and educational institutions. There is also the absence of a quality-based coffee development roadmap. This situation prevents innovation from reaching the farmer level, as evidenced by the inactivity of farmer groups, which serve more of an administrative function than as a forum for collective learning.

14. The Function of Extension Workers in GAP Implementation

Agricultural extension workers in Sipirok have not yet fulfilled their ideal role as facilitators of knowledge transformation. Most farmers reported receiving no assistance in coffee cultivation, so they acquired GAP knowledge through traditional practices. Extension workers' capacity is also limited due to their cross-commodity workload and a lack of supporting facilities. This is despite Presidential Regulation No. 35 of 2022 emphasising the strategic role of extension workers in strengthening farmer capacity. This lack of intensive assistance means that GAP remains an abstract concept that is difficult to implement practically in the field.

15. Structural and Socio-Cultural Challenges

Most coffee farmers in Sipirok are smallholders with land holdings of less than one hectare, relying on household resources and family inheritance. This situation places coffee as both a social identity and a source of subsistence income. Farmer group institutions are weak and not functioning optimally, so farmers tend to operate individually. According to Harahap (2023), the main challenges to implementing Good Agricultural Practices (GAP) in coffee farming communities in North Sumatra stem not only from technical limitations such as capital and infrastructure but also from socio-cultural factors inherent in farmers' habits, such as reliance on traditional practices and low participation in farmer institutions.

Community initiatives such as PDM and Filo Coffee have emerged, acting as local champions in knowledge diffusion. PDM, through a religious and social approach, mentors 36 farmer groups with training and GAP-based cultivation practices. Filo Coffee, meanwhile, introduces value-added dimensions through post-harvest processing and youth entrepreneurship. These two actors serve as bridges between modern knowledge and local practices, demonstrating the potential for transformation born from community initiatives themselves.

The community mentoring model still faces limited reach. Islamic boarding schools (Pesantren) are more successful in mobilizing farmers who are already enthusiastic about learning, while some conservative farmers persist with old practices. This situation highlights the need for a synergistic strategy between formal government institutions and community actors to expand the implementation of GAP at the grassroots level.

Overall, the research confirms that the main obstacle to GAP implementation in Sipirok lies not in farmer resistance, but rather in a weak institutional support system, the absence of extension workers in their ideal role, and the absence of regional policies that support coffee quality development. Local initiatives such as PDM and Filo Coffee demonstrate bottom-up innovation, but their sustainability depends on policy support and strengthening institutional capacity at the regional level.

16. Traditional and Modern Agricultural Innovation

The implementation of Good Agricultural Practices (GAP) in Sipirok faces an epistemic clash between traditional knowledge passed down through generations and modern, science-based knowledge. Farmers generally acquire farming skills orally from their parents through hands-on practice on the farm. This system fosters confidence and continuity but also creates vulnerability due to a lack of technical updates. The practice of close plant spacing and the use of reactive pesticides, for example, demonstrates limited adaptation to GAP standards, which require preventive measures and systematic management.

The term mate bujing, or the death of young coffee trees after flowering heavily, demonstrates an empirical awareness that aligns with GAP principles. However, because it lacks a scientific framework, this knowledge remains at the level of experience and has not yet become a verified technical standard. Furthermore, strong social norms contribute to resistance; farmers

who attempt innovations are often perceived as "different" and at risk of disrupting community harmony. This often results in technical innovation being held back in the realm of discourse.

This conflict is not only technical but also epistemological. Local knowledge is intuitive and reactive, while modern knowledge demands record-keeping, procedures, and scientific evidence. This gap is further widened by low levels of formal education and limited access to information.

The experience of the Darul Mursyid Islamic Boarding School (PDM) demonstrates that translating modern knowledge into local languages and contexts can reduce resistance. Through demonstration gardens, PDM demonstrates the tangible benefits of GAP practices, making local empirical evidence a key factor in changing farmer behaviour.

In the social context, coffee shops serve as venues for informal knowledge exchange, where technical information is disseminated through casual conversation. While this mechanism is effective in strengthening social networks, it also produces homogenous and not always valid information. New initiatives, such as the use of WhatsApp groups for PDM partner farmers, demonstrate the emergence of a faster and more open pattern of knowledge diffusion. Comparative study experiences between communities, such as visits to Takengon, also strengthen the peer learning process, enriching the local knowledge base.

However, this learning process is not yet supported by adequate formal institutions. Farmer groups in Sipirok often serve administrative functions rather than collective learning spaces. The absence of demonstration plots or farmer field schools limits the space for collaborative experimentation, so innovation tends to stagnate within small circles without generating systemic change.

17. Knowledge Reproduction at the Farmer Community Level

The farmer knowledge reproduction system in Sipirok demonstrates both traditional continuity and opportunities for transformation. The younger generation is becoming an agent of change, bringing new characteristics to learning and market orientation. Data from the 2023 Agricultural Census shows that nearly half of farmers in South Tapanuli are millennials (19–39 years old), offering the potential for agricultural knowledge regeneration.

Young farmers utilise digital technology to share information through social media and online groups, accelerating the flow of knowledge among farmers. They also display a stronger agribusiness orientation, viewing coffee not just as a crop but as part of a value chain that connects to downstream sectors such as cafes and export markets. This new awareness broadens the meaning of cultivation from mere production to coffee quality management and added value.

Tensions between generations persist. Older farmers tend to maintain old practices based on experience, while the younger generation brings new information from interactions with training institutions or comparative studies. This conflict often generates resistance but also opens up space for negotiation and mutual learning. This process has the potential to generate hybrid knowledge, a combination of local wisdom and modern science, serving as the basis for contextual agricultural innovation in Sipirok.

This phenomenon is evident in the younger generation's ability to connect local terms like 'mate bujing' with modern plant physiology concepts. If facilitated through collective learning institutions, such as community-based field schools, this knowledge transfer process can strengthen the sustainable diffusion of GAP. Knowledge transformation at the farmer level depends not only on external interventions but also on internal social dynamics and the regeneration of agricultural actors themselves.

CONCLUSION

This research shows that the adoption of Good Agricultural Practices (GAP) by coffee farmers in Sipirok remains low and partial. In terms of knowledge, most farmers are not yet systematically familiar with GAP and still rely on traditional practices.

In terms of attitudes, some farmers are wary of new practices, but hesitance persists because GAP is perceived as expensive, difficult to implement, and does not guarantee better prices. In practice, most farmers are still at the pre-GAP to GAP-literate stage, with comprehensive implementation only seen in groups supported by institutions such as the Darul Mursyid Islamic Boarding School.

The delay in adoption is also influenced by weak local government support, which still focuses on physical assistance without training, mentoring, and certification strategies. Social and cultural factors, fear of failure, and strong community norms also slow the acceptance of innovation. GAP implementation needs to be viewed as both a social and technical process.

It is recommended that the government strengthen its extension function and create economic incentives for farmers who implement GAP. Strengthening farmer institutions is crucial to create a space for shared learning. Future research should examine the coffee value chain more broadly. Examining the relationship between GAP and environmental sustainability aspects to support sustainable agricultural development in the mountainous region of Sipirok.

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