Profile of the production landscape of Pagar Alam:
towards sustainable upland agriculture

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Authors: Sacha Amaruzaman, Isnurdiansyah,
Mohamad Nugraha, Betha Lusiana, Beria Leimona

Language editor: Robert Finlayson

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FOREWORD

Agricultural Policy Research To Support Natural Resource Management In Indonesia's Upland Landscapes (IndoGreen) is an action-research project conducted in three upland areas of Sumatra and Java, Indonesia. IndoGreen aims to provide evidence-based recommendation on policy interventions that would enhance long-term agricultural productivity, reduce negative environmental externalities and improve household welfare in Indonesia's upland catchments.

In the upland regions across Indonesia, many smallholder farmers live within or close to the resource-rich forest area, cultivating agroforestry or intensive system, often on steep slopes. Most of these farmers utilise mixed-farming practices, which can simultaneously provide food and crops as well as generate various ecosystem services for the broader population. However, productivity is generally low, and market access is a serious barrier.

Farmers' strategies to manage their livelihood will be influenced by policy and programs that affect their agricultural practices and further shape their landscape. An in-depth understanding of the farmers' agricultural practices and the influence of policy and programs towards their landscape management strategy in the upland is necessary to formulate policy recommendations that target both the local welfare and the sustainability of the upland area.

This book compiles the results from the IndoGreen's first-year activities in Pagar Alam, Indonesia, implemented by the World Agroforestry (ICRAF) in collaboration with the Centre for Global Food and Resources at the University of Adelaide. Pagar Alam is the upstream catchment of South Sumatra, and is targeted by various policies with various development agendas focusing on the economy and environment. The Green Growth Strategy of South Sumatra Province elicits Pagar Alam as one priority area for increasing agricultural production while maintaining and restoring the forests landscape.

The report elaborates the characteristics of land-use and farming practices in four forest border clusters in Pagar Alam, particularly the local farming practices and the potential impact of development programs and policies on their livelihood and landscape. Systematic household data has been the basis of understanding farmers' livelihood strategies. Two national policies, namely the Community Forestry and Irrigation for Reservoir, are also being implemented in the Pagar Alam forest borders. These policies influence local agricultural practices separately and further shape the upland landscape quality and its ecosystem services. By understanding the land-use practices and the policies in Pagar Alam, we can influence the upland landscape management through appropriate recommendations on interventions. The target should be in balancing the conservation and development agenda, therefore, improve the sustainability and social welfare in the upland.

Bogor, 10 August 2021

Dr Sonya Dewi
Indonesia Country Coordinator
ICRAF Indonesia Country Program

ACKNOWLEDGEMENT

EXECUTIVE SUMMARY

This book presents descriptive results of land-cover-change analysis and focus-group discussions with farmers in Pagar Alam, Indonesia. The research aimed to understand the characteristics of land use and farming practices in four upland clusters located on the forest border of Pagar Alam. World Agroforestry (ICRAF) and the Centre for Global Food and Resources at the University of Adelaide, Australia collaborated in the research within the Agricultural Policy Research to Support Natural Resource Management in Indonesia's Upland Landscapes project, also known as IndoGreen, funded by the Australian Centre for International Agricultural Research.

Pagar Alam City is a peri-urban upland in the upper catchment of Musi Watershed, the largest watershed in South Sumatra Province. Two national policies are implemented in the upland of Pagar Alam: the national Social Forestry programme (*Hutan Kemasyarakatan*); and the food security programme, which is overseeing the construction of an irrigation reservoir that will affect the farming practices and ecological conditions of the landscape.

Land-cover analysis 2010–2017 indicated that the forest and coffee agroforest areas in Pagar Alam were decreasing while the areas of logged-over forest, mixed tree gardens, vegetable crops, cleared land

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and settlements increased. Undisturbed, high and low logged over forest reduced by 30%, largely due to the 20% conversion of the undisturbed forest. Tree-based farming systems increased by 4%, and the landscape is dominated by coffee and rubber systems, with vegetable systems as emerging land-use systems.

The Pagar Alam production landscape is grouped into 4 clusters: North Dempo 1, North Dempo 2, Central Dempo 1, and Central Dempo 2 based on its landscape biophysical conditions and proximity to the forest. The North Dempo cluster represent villages that are potentially affected by the Social Forestry Programme, while the Central Dempo are villages that are potentially affected by the social forestry and irrigation reservoir programmes.

The FGDs indicated that most farmers in the four clusters managed their agricultural lands. Much of the agricultural land was located within the forest administrative boundaries due to various reasons, such as unclear forest administrative boundary, or farmers who cultivated their lands before the forest boundary was enacted.

Female and male smallholders in Pagar Alam still considered coffee as their primary crop but they also seized the opportunity of complementing the perennial income from coffee with short-term income from vegetable farming. Coffee was always mixed with other crops, particularly, timber and fruit trees that shade the coffee. Vegetable farming provided the smallholders with daily/short-term income opportunities,

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which were not available before vegetable farming was introduced. Male farmers have slightly more roles in managing coffee compared to females, while the opposite occurs in seasonal crop farming. Nevertheless, both male and female farmers are involved in managing their farms. Besides the 'market availability' criterion, most of the groups indicated the complementary aspect of short-term and perennial incomes was the other important consideration in deciding which crop to cultivate.

Vegetable farming practices that were brought by in-migrants from West Java indicated the influence of infrastructure development and migrants' introduction of new farming practices that stimulated

innovation in Pagar Alam. The discussion of land-use history in the four clusters showed some pattern that migrants came when road improvement occurred in a village, which was probably related to improved market access. The presence of migrants in the clusters intensified vegetable farming that previously was only practised for subsistence by the local smallholders.

The overall results from the focus groups indicated that Pagar Alam smallholders were largely market-driven. Many commodities brought by the Government, such as cacao, eucalyptus, and vanilla, were not successful and were abandoned by locals due to price falls or the complete absence of markets. Market availability was highly considered by locals when they decided to cultivate a commodity. About market shocks, all four clusters indicated price fluctuations as a frequent shock with a large impact on smallholders.

Discussion of the major shocks and stressors revealed various biophysical shocks that were related to the landscape of each cluster. For example, volcanic ash would frequently disturb farming activities in clusters ND1 and ND2, which were located close to Mount Dempo, while limited water supply for agriculture only occurred in CD2. All clusters pointed to changes in climate patterns, such as prolonged droughts and rainy seasons, which had started to have an impact on farming activities. However, while some of these biophysical shocks and stressors were perceived only by some of the groups, all the groups noted markets and price fluctuations of major commodities as prominent shocks that frequently had a negative impact on their livelihoods.

Based on the findings, we recommend that agriculture and conservation policies in Pagar Alam should focus on maintaining and improving sustainable land-use practices, such as coffee agroforestry, particularly in the buffer zones of state forestlands. Coffee is cultivated in different farming systems, ranging from simple to complex/multi-strata agroforestry systems. Income from coffee in all agroforestry systems is relatively stable and continuous compared to other tree-based commodities within the agroforestry system in this area. Vegetable farming is an important support for the livelihood of farmers in the upland area but has a high risk of inducing erosion and landslides. Technology and knowledge on conservation farming in the areas, avoiding the pitfall of landscape degradation due to unstainable practices are crucial and must be practised by the farmers. Policies should also focus on facilitating market access for farmers, particularly for coffee, and mitigating price fluctuations during harvests of vegetable crops. Along with these policy recommendations, in the last chapter, we provide further research questions on the farming practices, markets, and landscape to assist with policy formulation.

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CHAPTER 1
INTRODUCTION

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Indonesia's agricultural development is facing challenges in meeting the strong demand for products of food crops, horticulture, livestock, and plantations, including commercially exported raw materials. The challenges of the Indonesian agricultural sector are fundamental and systemic, such as underperforming smallholders, low productivity of crop systems, low quality of commodities, underdeveloped infrastructure, inadequate investment, suboptimal extension programmes, and restrictive, unsupported government policies. To overcome such challenges, decisions and policies based on evidence are essential for creating incentives to adopt 'good agricultural' and sustainability practices. Decisions and policies must be supported by robust and contextualized data and information to ensure that

interventions address the basis of the supply chain, that is, smallholders, who are the major producers of the commodities, and that provision of ecosystem services is properly accounted.

Focusing on Indonesia's uplands, IndoGreen has examined how local and national policies make an impact on land and crop management. Between 2018 and 2022, the research team is evaluating the decline in productivity and agriculture-related externalities associated with ongoing cropping practices in upland catchments. The project provides alternative policy pathways to improve the environmental and long-term performance of agriculture in upland catchments.

World Agroforestry (ICRAF) in collaboration with the University of Adelaide, Australia researched upstream areas in Pagar Alam City, South Sumatra Province, Indonesia, to better understand agricultural development and its impacts on rural livelihoods and ecosystem services. ICRAF focused its activities in Pagar Alam because this landscape is the upper catchment of Musi Watershed, one of the largest watersheds in the country, covering most of South Sumatra Province. Pagar Alam is a peri-urban upland area in South Sumatra, with more than 30% of its area designated as protected forest. The city is famous as one of the major coffee-producing areas in Sumatra, with 70% of its workforce being smallholders (BPS Pagar Alam 2019).

Pagar Alam is also a target implementation area of two national policies: the community or Social Forestry programme (*Hutan Kemasyarakatan/* HKm); and the food security programme, under which an irrigation reservoir is being created. HKm is a national programme of the Ministry of Environment and Forestry's Sub-directorate of Social Forestry and plays a key role in Indonesia's national priority of reform of the forestry sector, targeting rural development and poverty alleviation in areas surrounding forests. As part of the national food security programme, the irrigation reservoir is a joint development work of the Pagar Alam City Government, Ministry of Public Works and Community Housing, and Ministry of Environment and Forestry, targeted to irrigate 3,000 hectares.
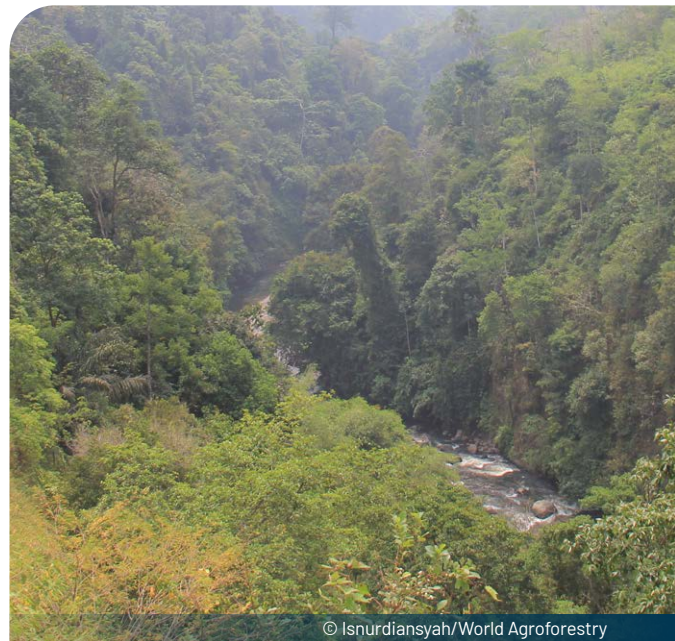
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In 2018, the research team conducted key informant interviews and FGDs with farmers, village leaders, and other key stakeholders; confirmed land cover through site visits and spatial analysis; surveyed female- and male-headed farm households; and analysed farm profitability. The research targeted the upland area of Pagar Alam in which the HKm and reservoir were underway, to better understand the characteristics of land use and farming practices.

This book presents the descriptive results of 1) land-use- and land-cover-change analyses of Pagar Alam; and 2) socioeconomic information of the clustered villages that will be affected by the national policy and programmes in Pagar Alam. We structured the book as

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follows: chapters 2 and 3 provide general information on the Pagar Alam landscape, selection of the village clusters, and methods used to understand the socioeconomic dynamics of farmers and others within the production landscape. Chapters 4 to 7 present the landscape information of the village clusters, characteristics of the farming systems and farmers, and the types and selection criteria of commodities, ordered by cluster: North Dempo 1 and 2; and Central Dempo 1 and 2.

The book supplies data and information on land dynamics, socioeconomic conditions of smallholders segregated by gender, their preference, roles, and perceived shocks. These key findings provide the basis of analyses on this production landscape towards strategic policy to support sustainable agricultural development in the upland of Pagar Alam.

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CHAPTER 2
LAND USE, LAND COVER, AND THEIR DYNAMICS

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This chapter describes the land-use and land-cover changes in Pagar Alam, 2010–2017. The total area of Pagar Alam is 63,352 hectares. Land-use and land-cover changes were analysed by using spatial data classified from LANDSAT-TM imageries of 2010, 2015, and 2017. A 'ground-truth' or field verification survey was conducted in April 2018 to collect reference data for spatial analysis.

During 2010–2017, undisturbed forest showed a decrease of 22%, from 19,787 hectares in 2010 to 15,444 hectares in 2017 (Figure 1). The overall, logged-over forest-density area showed an increasing trend of about 37% from 2010 to 2017, adding around 1,287 hectares of logged-over forest.

The size of the coffee agroforestry area in Pagar Alam fluctuated: it increased from 26,000 hectares in 2010 to 29,871 hectares in 2017. In the same period, the irrigated rice and other crops (mostly vegetables) areas also showed increasing trends: 21% (536 hectares) and 193% (1,057 hectares) increase, respectively. Rubber agroforest showed an 86% decrease, from 3,511 hectares in 2010 to 493 hectares in 2017.
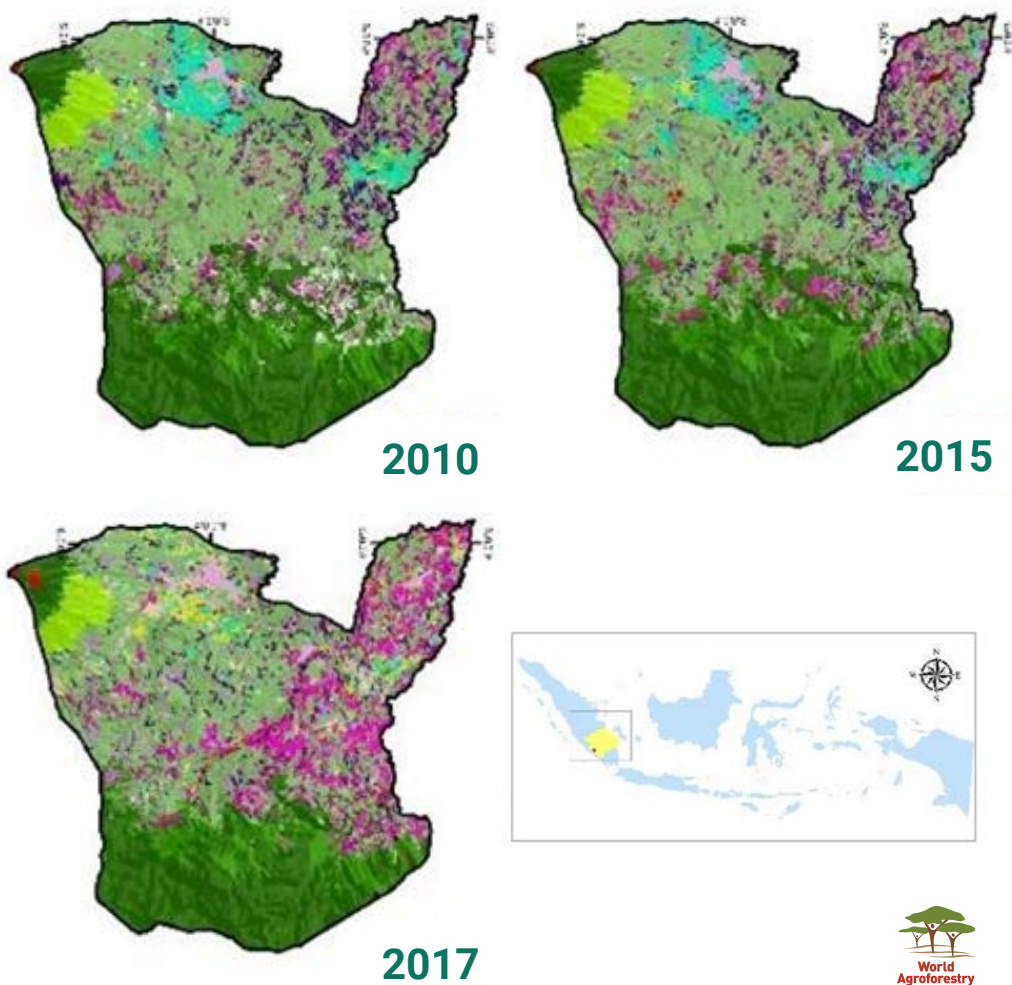
Land use/cover Pagar Alam

- ◼ Undisturbed forest
- ◼ Logged over forest-high density
- ◼ Logged over forest-low density
- ◼ Industrial timber
- ◼ Mixed garden
- ◼ Coffee agroforest

- ◼ Rubber agroforest
- ◼ Rubber
- ◼ Small scale oil palm
- ◼ Tea
- ◼ Irrigated rice
- ◼ Other crops

- ◻ Shrub
- ◼ Mining
- ◼ Cleared land
- ◼ Settlement
- ◼ Water body
- ◻ Cloud

Figure 1. Land-use and land-cover changes, Pagar Alam, 2010–2017

The area of settlements in Pagar Alam significantly expanded, from 485 hectares in 2010 to 1,752 hectares in 2017; a 261% increase. The amount of land classified as shrubs and cleared also significantly increased. About 1,493 hectares of shrub land was identified in 2017, a 616% increase from 2010. Cleared land was 78 hectares in 2010 but had increased to 729 hectares in 2017 (Table 1).

Table 1. Land-use and land-cover changes, Pagar Alam, 2010–2017

Land use or cover	2010	2015	2017
Undisturbed forest	19,787	18,990	15,444
Logged-over forest	3,458	4,202	4,745
Industrial timber	6	8	5
Mixed garden	1,037	1,186	1,413
Coffee agroforest	26,000	26,610	29,871
Rubber agroforest	3,511	2,945	493
Rubber monoculture	2,886	2,773	762
Small-scale oil palm	44	44	44
Tea plantation	1,625	1,571	1,522
Irrigated rice	2,504	2,148	3,040
Other crops	549	531	1,606
Shrub	208	256	1,493
Grass land	4	4	218
Cleared land	78	114	729
Settlement	485	1,752	1,752
Water body	217	217	217
Cloud	953	0	0
Total	63,352	63,352	63,352

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CHAPTER 3
SOCIOECONOMIC CONDITIONS AND PERCEIVED GENDER ROLES IN THE PRODUCTION LANDSCAPE

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Policies and other interventions to promote increased productivity and tackle agriculture-related externalities require an understanding of the complexity of social, economic, and political processes in a landscape. This knowledge of local conditions includes the perspectives of farmers on the history of land-use changes, shocks to their livelihoods caused by natural and socioeconomic factors, characteristics of farming systems, and their preferred commodities. The research to compile all this information was conducted in the village clusters.

3.1. Village clusters: understanding the landscape's context

We applied a 'landscape approach' for the selection of four village clusters. The clustering method allows a greater understanding of the relationship between people and their landscape (Minang et

al 2015). Each cluster consists of two upstream villages located within one agriculture–forest transition landscape. The two villages within a cluster share similar physical and socioeconomic characteristics, such as elevation, farming system, infrastructure, environmental challenges, ethnicity and market access (Table 2). Located on the border of the forest, the clusters play important roles in maintaining environmental functions that support the livelihoods of the broader population in Pagar Alam and South Sumatra Province.

The four clusters are targeted areas for the HKm scheme and construction of the irrigation reservoir. Two clusters are located in North Dempo municipality ('Kecamatan Dempo Utara') — North Dempo 1 (ND1) and North Dempo 2 (ND2) — and the other two are in Central Dempo municipality ('Kecamatan Dempo Tengah'): Central Dempo 1 (CD1) and Central Dempo 2 (CD2).

Table 2. Clusters in Pagar Alam

No.	Cluster	Policy	Population type	Sub-district	Village
1	Cluster North Dempo 1(ND1)	Social Forestry	Native and temporary migrants	Agung Lawangan	Gunung Agung Pauh
2					Kerinjing
3	Cluster North Dempo 2 (ND2)	Social Forestry	2nd and 3rd generation Javanese migrants of the colonial period	Burung Dinang	Tanjung Taring
4					Tanjung Keling
5	Cluster CD1	Social Forestry Irrigation reservoir	Transmigrants	Candi Jaya	Rimba Candi
6				Jokoh	Semidang Alas
7	Cluster CD2	Social Forestry Irrigation reservoir	Native and local migrants	Jokoh	Jokoh
8				Jokoh	Genting Jaya
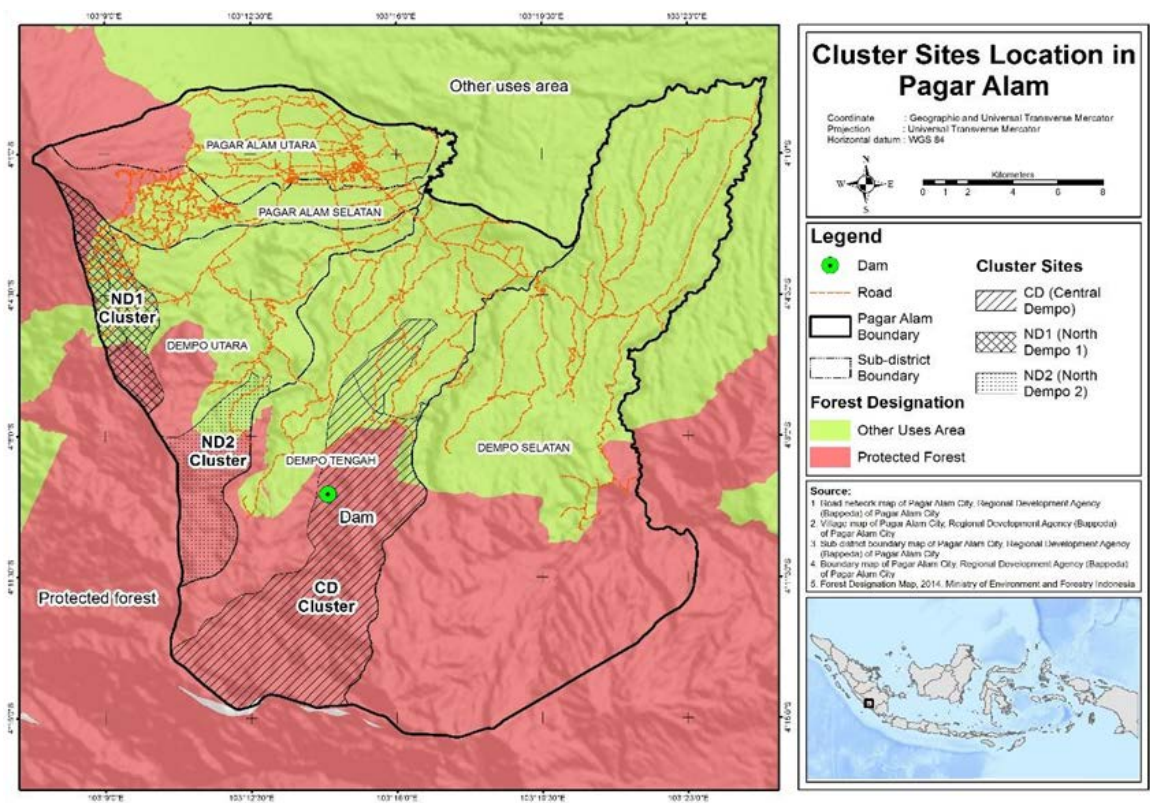
Figure 2. Village clusters in Pagar Alam, South Sumatra

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3.2. Methods used to compile information about the smallholders

In September 2018, a series of FGDs with groups of male and female smallholders was held in eight villages affected by the two policies; a total of 16. Each group consisted of 10–13 smallholders, excluding community leaders, who were interviewed in separate sessions to avoid bias.

FGDs were used to capture the perspectives of different actors regarding local natural resource policies. In the groups, smallholders discussed the local history of land opening and agriculture, community perceptions regarding socioeconomic and biophysical shocks and stressors that can affect livelihoods, and the implications of natural resources' policies for each village. The results from the interviews and FGDs were translated from Indonesian to English. The results are presented in summary and quotation forms. The compiled qualitative results of female and male smallholders from the series of FGDs on local perceptions regarding historical land use, farming system, and environmental shocks are presented using a descriptive-qualitative approach.

For the commodity criteria and rank within the same group discussions, the researchers asked the participants to list the commodity that they preferred to cultivate. They could choose any plant, including those that they had already planted and/or desired to plant. In the second step, the smallholders listed the criteria they had considered when choosing the commodity. Then they scored each plant against the criteria that they had just set. The Analytical Hierarchical Approach (AHP) was used to estimate the relative importance of each criterion and the rank of the commodity, based on the criteria that they had selected.

CLUSTER NORTH DEMPO 1: KERINJING AND GUNUNG AGUNG PAUH

ND1 is located in Agung Lawangan Municipality ('Kelurahan') of the North Dempo Sub-district. This cluster covers Kerinjing and Gunung Agung Pauh villages, which are located on the border of protected forest at the foot of Mount Dempo, a stratovolcano of around 3,000 masl. These villages were considered old settlements in Pagar Alam and were targeted for the Social Forestry programme of the Ministry of Environment and Forestry.

The forest in the villages represents a segregated area, being a transition zone between intensive agriculture and agroforest. The village area is dominated by land with 15–30% slopes. The settlement and agricultural land are located in the Mount Dempo volcanic area.

The population in 2018 of Kerinjing was about 250 people while Gunung Agung Pauh was about 370. The cluster communities were mostly native residents of Pagar Alam with some spontaneous migrants from West Java.

The cluster is located 30–45 minutes' drive from Pagar Alam City. The cluster has relatively good access: both villages are passed by a major road that connects South Sumatra with Bengkulu Province.

The main road in the villages was asphalted to the forest border area. Both villages have good proximity to markets and access to cellular phone infrastructure. The area also has access to water for agricultural and domestic activities.

The overall good accessibility supports agricultural development in ND1; smallholders' activities in this cluster were already integrated with markets and development programmes. Most farmers groups' members were actively involved, with a few 'champion' or leading farmers using information technology (for example, YouTube) to develop their agricultural practices and market access.

4.1. Historical land-use and land-cover changes

Table 3 shows communities' perceptions of important events that might have affected land-use and land-cover changes in ND1. Gunung Agung Pauh is the older village; until 1978, Kerinjing was a part of Gunung Agung Pauh. The smallholders were familiar with cultivating arabica coffee since its introduction during the Dutch colonial era but the commodity was abandoned owing to pests and diseases.

At the end of the 1950s, smallholders began cultivating robusta coffee, which is less prone to attack by pests and diseases and relatively simpler to maintain. Coffee farming in this cluster was mostly in the form of agroforestry, with at least two or more other tree and crop species for shade and income diversification.

The smallholders in ND1 had experienced a few periods of conflict over land tenure with the authorities because many of the coffee and vegetable farms were located within the forest area. In the early 2000s, roadsides within the forest area were developed for agricultural land, which brought more complexity to forest management. In 2013, the conflicted forest in ND1 was targeted for the Social Forestry programme, so that smallholders would have the opportunity to continue cultivating their land albeit only with permitted tree crops.

The smallholders abandoned commodities when the price or market trend declined. For example, in the 1980s, ND1 smallholders stopped cultivating quinine because the price dropped significantly. The same happened in the 1990s, when farmers decided to stop cultivating cloves. More recently, the smallholders started to experiment with monocultural fruit orchards, such as orange (*jeruk gergah*), pepino, and avocado. The good access to farm plots provides opportunities for additional income through agro-ecotourism.

Table 3. Land-use history and major events in Cluster ND1

Period	Event	
	Kerinjing	**Gunung Agung Pauh**
1940s	Forest area, with abandoned coffee plantation from the Dutch colonial era. The Japanese occupation force also asked smallholders to cultivate cassava and quinine in the area.	Settlement area since Dutch colonisation period (1900s). Coffee (arabica), quinine and a tea plantation had been developed by the Dutch and later mostly abandoned by the smallholders. Coffee arabica was abandoned owing to pests and diseases. Quinine was maintained until the 1980s.
1950s	Farmers built temporary huts (*talang*) in the forest, from which they cultivated quinine, cassava, and coffee. Rice and seasonal crops were grown for subsistence. Old coffee trees were replanted.	President Soekarno's speech when he visited Pagar Alam encouraged farmers to open new land from the Dutch plantation area. Soon after, the tea plantation and its surrounding forests were converted into a robusta coffee plantation.
1960s	Kerinjing was a part of Gunung Agung Pauh Village.	The first harvest of coffee was planted by Gunung Agung Pauh residents.
1970s	Kerinjing became a separate village from Gunung Agung Pauh in 1978. Started planting orange ('jeruk gergah').	–

Period	Event	
	Kerinjing	**Gunung Agung Pauh**
1980s	Quinine was fully abandoned due to the unattractive low price.	Quinine was fully abandoned by the local farmers due to its price fall; Clove was cultivated by the local farmers at the end of the 1980s.
1990s	The army removed the settlement and local communities that resided within the claimed official forest area.	Local native community of Pagar Alam with the migrant workers from the tea plantation started to expand agricultural land into the forest area. There was conflict between the authorities (army) and smallholders in the early 1990s. Smallholders who cultivated in the official forest area were forced to move from their farm plots. A big forest fire in 1997 and smallholders abandoned the forest land. A temporary road to access the forest was established. Smallholders cultivated cinnamon but it was soon abandoned due to theft problems. Clove was abandoned by smallholders due to price drop.
2000s	The communities started to build a temporary road in the forest area. Flash floods in the forest area due to deforestation and illegal logging. Intensive seasonal crops began to be cultivated by spontaneous migrants from West Java. Forest replantation programme (2004) in the forest area with *bambang lanang* tree (*Michelia champaca*) and mahogany (*Swietenia mahagoni*) was considered unsuccessful.	Smallholders started to invite seasonal migrants from West Java to cultivate seasonal crops on their land. Smallholders and new migrants from West Java started to reoccupy forest area and cultivate seasonal crops.
2010s–present	Asphalt road development in the forest area. More intensive coffee plantations, more trees per hectare, smallholders began to apply grafting to improve productivity.	Asphalt road development in the forest area. Social forestry programme in the forest area. More intensive coffee plantations, more trees per hectare, smallholders began to apply grafting to improve productivity. New commodities developed by the smallholders, such as orange, pepino, and monocultural avocado. The new commodities are not only intended for harvest but also for ecotourism.

4.2. Farming systems

Most of the smallholders in Gunung Agung Pauh cultivated coffee while in Kerinjing vegetable growers were dominant. Based on female smallholders' perceptions in Gunung Agung Pauh, incomes from vegetables and coffee were more or less equal (Figure 3). Different from their female counterparts, Gunung Agung Pauh's male smallholders perceived that coffee was still a major source of incomes in their village. In Kerinjing, female and male smallholders agreed that most of their village's farm incomes were provided by cultivating vegetables.

The smallholders grow various vegetable crops, such as cabbage, chili, onion, cucumber, eggplant, long bean, carrot, and potato. Most of the products are sold to traders within the cluster and external markets in Pagar Alam City. Potato-farming contracts with Indofood, a national company, have appeared in the cluster (Table 4).

In their coffee agroforestry systems, the smallholders also cultivate durian, cinnamon, jackfruit, avocado, mango, banana, mahogany, 'petai' (*Parkia speciosa*), and ginger. Farmers sell most of their harvest from their coffee plots while keeping small amounts of coffee, fruit, and firewood for household consumption. At the time of the FGD, a group of smallholders had initiated monocultural fruit farms, growing crops such as avocado and orange ('jeruk gergah') to serve the increasing demand for agro-tourism and fruit.

The types of agricultural land management in Kerinjing and Gunung Agung Pauh were similar. In both villages, households managed their own coffee farms or other people's land through profit-sharing schemes, mortgages or, in some cases, just borrowed land from the owners. Borrowing usually occurred between relatives. For seasonal crops, the majority were managed by migrants who rented from, or shared profit with, the landowner (Table 5). The land-renters/sharecroppers
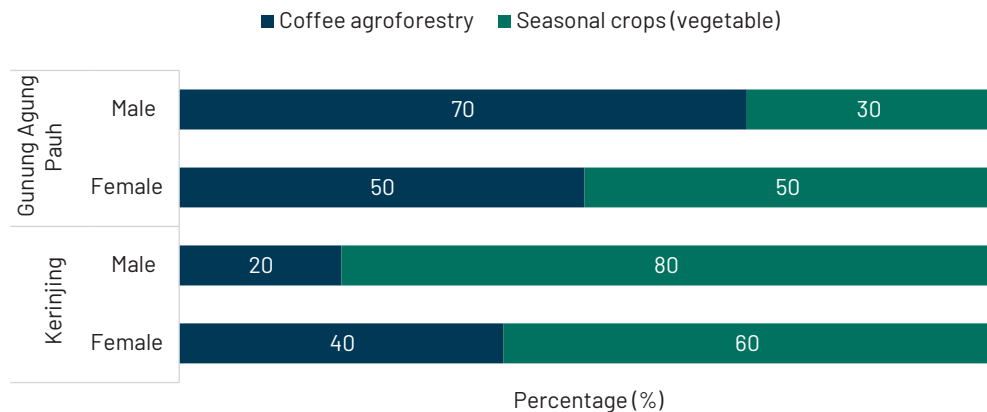
Figure 3. Perceived contributions of farming systems to local incomes in Cluster ND1

Table 4. Farming systems in Cluster ND1

Farming systems	Commodities	
	For sale	**For own consumption**
Coffee agroforestry	Coffee (*Coffea robusta*), cinnamon (*Cinnamomum verum*), jackfruit (*Artocarpus heterophyllus*), banana (*Musa* sp), avocado (*Persea americana*), chili (*Capsicum* sp), pepper (*Piper nigrum*).	Timber on private land for construction and other harvested commodities were also used by farm households.
Seasonal crop (vegetables)	Cabbage (*Brassica oleracea*), chili, onion (*Allium* sp), cucumber (*Cucumis sativus*), eggplant (*Solanum melongena),* long bean (*Vigna unguiculata),* carrot (*Daucus carota),* mustard green (*Brassica chinensis*), tomato *(Solanum lycopersicum*), potato (*Solanum tuberosum*), 'taruk gumai'/'leunca' (*Solanum nigrum*).	Small amounts of the harvested commodities were consumed by farm households.
Fruit crop (monoculture)	Avocado, orange (*Citrus* sp).	Small amounts of the harvested commodities were consumed by farm households.
Forest land	Coffee agroforestry and vegetable crops.	Harvested commodities were also consumed by farm households.

Table 5. Types of agricultural land management in Cluster ND1

Land management	Gunung Agung Pauh		Kerinjing	
	Coffee agroforestry	**Seasonal crops**	**Coffee agroforestry**	**Seasonal crops**
Self-managed	√	√	√	√
Profit-sharing	√	√	√	√
Rented	-	√	-	√
Mortgaged	√	√	√	√
Borrowed	√	√	√	√

"√" = Being practised, "–" = Not being practised

were predominantly seasonal migrants from West Java who would temporarily stay in ND1 to grow vegetables and leave Pagar Alam after the harvest season to return to their homes.

Within coffee-farm households in ND1, agricultural labour was mostly divided between female and males, with more involvement of males in preparation (land opening, planting, spraying) and a more balanced male–female contribution to fertilising, harvesting, and selling the coffee beans. Coffee smallholders in Gunung Agung Pauh and Kerinjing used a lot of non-family labour, except in the postharvesting and selling stages (Table 6 and Table 7).

The vegetable farms in Kerinjing were mostly managed by migrants from West Java through a profit-sharing scheme

Table 6. Perceived gender roles in coffee farming in Gunung Agung Pauh

Coffee farming activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	2	√	3	1
Land clearing	√	3	2	√	3	2
Seedlings	√	3	2	√	3	2
Planting	√	3	2	√	3	2
Weeding	√	2	3	√	3	3
Spraying	√	3	1	-	3	1
Fertilising	√	2	2	-	3	3
Harvesting	√	2	2	-	3	3
Postharvesting	-	2	2	-	3	2
Marketing	-	2	2	-	3	2

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Table 7. Perceived gender roles in coffee farming in Kerinjing

Farming activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	2	√	3	1
Land clearing	√	3	3	√	3	2
Seedlings	√	3	2	√	3	3
Planting	√	3	2	√	3	3
Weeding	√	3	3	√	3	3
Spraying	√	3	1	-	3	1
Fertilising	√	3	1	-	0	0
Harvesting	√	3	3	√	3	3
Postharvesting	-	2	3	√	3	2
Marketing	-	3	1	-	3	2

√ = Using non-family labour; "-" = Not using non-family labour; 0: Not relevant for the gender
1 = No involvement; 2 = Limited involvement; 3 = High involvement

with the local landowner. For all vegetable-farming activities, the migrant households usually managed their plots with family labour. However, according to the female smallholders, land opening, planting, weeding, and harvesting in the large vegetable-growing area could also involve non-family workers, usually females, from the village as day labourers (Table 8).

Vegetable-farming households in Gunung Agung Pauh preferred involving external labourers for all farming activities (Table 9). The role of female and male smallholders in managing their vegetable farms was balanced, particularly in land-clearing, seedlings, planting, fertilising, and harvesting.

4.3. Forest contribution and extreme events

Some of the smallholders in ND1 were located far inside the forest and could take hours — even almost a whole day — to reach. Many plots were only accessible on foot or with a motorcycle modified for

Table 8. Perceived gender roles in seasonal crop farming in Gunung Agung Pauh

Seasonal farming activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	-	3	2	√	3	1
Land clearing	-	3	3	-	3	2
Seedlings	-	3	3	-	3	3
Planting	-	3	3	√	2	3
Weeding	-	2	3	√	1	3
Spraying	-	3	1	-	3	1
Fertilising	-	2	3	-	3	3
Harvesting	-	3	3	√	3	3
Marketing	-	3	3	-	3	2

√ = Using non-family labour; "–" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Table 9. Perceived gender roles in seasonal crop farming in Kerinjing

Seasonal farming activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	2	√	3	1
Land clearing	√	2	2	√	3	2
Seedlings	√	2	2	√	3	3
Planting	√	2	2	√	3	3
Weeding	√	2	3	√	2	3
Spraying	√	3	2	-	3	1
Fertilising	√	3	2	-	3	3
Harvesting	√	2	2	-	3	3
Marketing	-	2	2	-	3	2

√ = Using non-family labour; "–" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Legend: ■ Private land ■ Forest land

		Percentage (%)
Gunung Agung Pauh	Male	Private 90 / Forest 10
Gunung Agung Pauh	Female	Private 40 / Forest 60
Kerinjing	Male	Private 90 / Forest 10
Kerinjing	Female	Private 70 / Forest 30
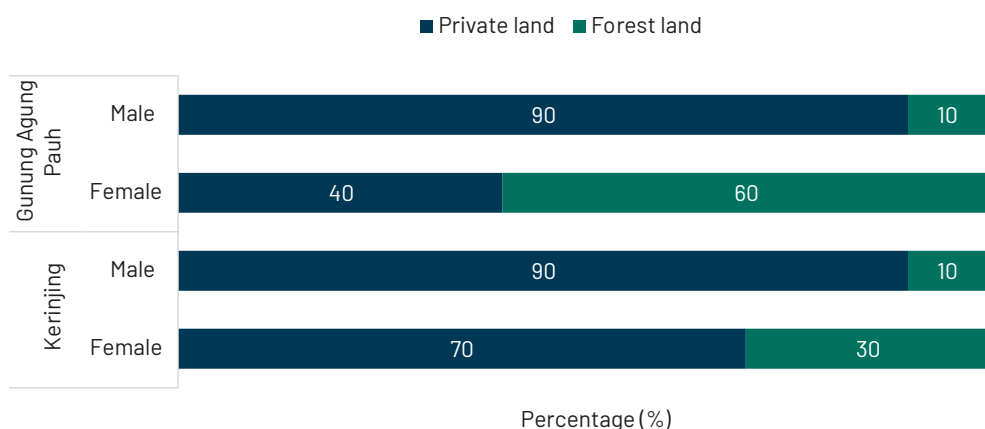
Figure 4. Perceived proportions of land contributions to local incomes in Cluster ND1

hilly trails. Thus, smallholders would build temporary shelters from which to manage their farms and return to their village after a few days.

The male smallholders in ND1 and female smallholders in Kerinjing perceived that private land provided more contribution to local livelihoods and incomes. The land conflict in the 1990s and 2000s caused many smallholders to leave their farms that were located inside the protected forest area. However, female smallholders in Gunung Agung Pauh still perceived that the number of farm areas within the forest area was still significant, providing 60% of the community's livelihoods (Figure 4).

All smallholders in ND1 perceived that prolonged drought during the last 5–10 years was a major stressor, having a negative impact on their villages (Table 10). The female smallholders of Gunung Agung Pauh and male smallholders in

Table 10. Perceived shocks and stressors in Cluster ND1

		Gunung Agung Pauh				Kerinjing			
Shocks and stressors		**Male**		**Female**		**Male**		**Female**	
		I	F	I	F	I	F	I	F
1	Prolonged droughts	5	1	5	3	5	3	5	1
2	Hailstorms	-	-	5	2	-	-	-	-
3	Pests and diseases	4	2	-	-	3	3	3	1
4	Strong winds	-	-	-	-	-	-	3	2
5	Volcanic ash	-	-	3	1	-	-	-	-
6	Flash floods	5	1	-	-	-	-	-	-
7	Price fluctuations	4	1	-	-	5	3	4	3
8	Subsidized fertilizer scarcity	-	-	-	-	4	3	-	-

Impact (I) score: 1= Very low impact, 5 = Very high impact
Frequency (F) score: 1= Infrequently, 3= Very frequently

Kerinjing believed that drought had become more frequent, particularly affecting vegetable farming. However, drought had a positive impact for coffee farmers in higher elevations because drier seasons caused the coffee trees to become more productive. The majority of the smallholders in ND1 felt that drought mostly caused a decrease in productivity.

The other stressors that were mentioned by most of the smallholders were pests and diseases, which particularly affected vegetable farms, and price fluctuations, which affected both coffee and vegetables, mostly in the harvesting season. Several shocks had occurred in Gunung Agung Pauh, such as a flash flood that took the lives of several community members in the upstream in early 2000, frequent hailstorms, which could prevent coffee from producing beans, and volcanic ash from Mount Dempo, which occurred several times and negatively affected vegetable growers with farms near the mountain.

4.4. Commodity criteria and rank (AHP)

The male smallholders' group in Gunung Agung Pauh identified criteria related to economic value as the major consideration when selecting crops. The two major criteria were 'market availability' and 'high market price', which represented 56% of the total importance relative to the other criteria. The fourth and fifth criteria represented a combination of income considerations for short-term cash crops (vegetables) and perennial crops (coffee). The other criteria were related to practicality, such as 'seedling availability' and 'simple maintenance', which represented 7.3% and 6.1% of the total importance respectively. The last criterion was 'investment' with a low relative importance score compared to all criteria. 'Investment' here mainly refers to timber crops that would be harvested years after the planting period, such as *bambang lanang* and mahogany trees. Such timber crops were considered as investments by the smallholders, which would be useful to support their children's education or other special needs in the future.

According to the female group, practical and market considerations were the most important criteria when selecting which commodity to cultivate. The 'land and climate suitability' criterion came out as the most considered (31.3%) while 'market availability' was the second-most important for female smallholders in Gunung Agung Pauh. The third criterion, 'coffee shading', indicated that the female group still perceived coffee as an important crop for their livelihoods. 'Coffee shading' refers to taller trees with broader canopies providing shade for the coffee trees. This criterion was considered important because the provision of proper shade trees for coffee crops was perceived to help improve coffee productivity. The 'short harvest period' criterion was the fourth-most important criterion, which also reflected the vegetable-farming characteristics of the short-term cash crops in Gunung Agung Pauh. The commodity selection criteria in Gunung Agung Pauh are shown in Figure 5.
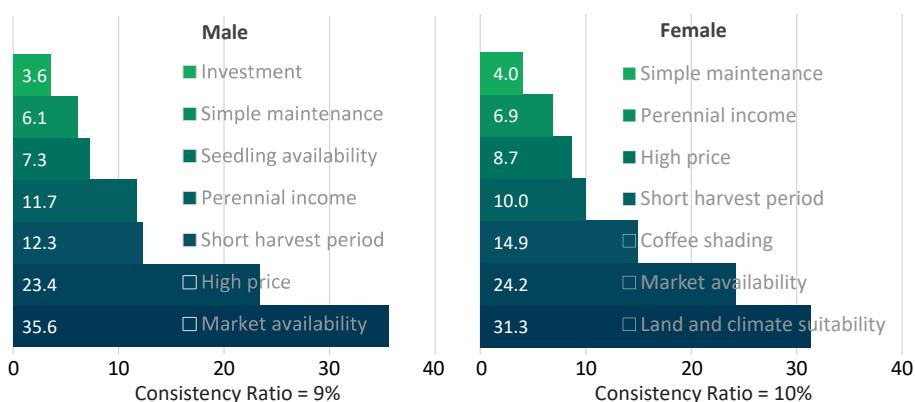
Figure 5. Smallholders' commodity selection criteria scores in Gunung Agung Pauh

Note: Higher score percentage indicates higher priority

In Kerinjing, the male and female smallholders selected the 'land and climate suitability' criterion as the major consideration when selecting crops. This was likely due to the landscape and climate in Kerinjing, which was more challenging for cultivation. The village is located at a higher elevation with lower temperatures compared to Gunung Agung Pauh (Figure 6).

For the male smallholders, the next criteria were still related to the practicality of farming, with 'short harvest period' and 'farming knowledge' as the second- and third-most important considerations. On the market side, 'market availability', 'high price', and 'perennial income' were considered important. Male smallholders in Kerinjing also considered 'multi-functionality of crops' as one of the considerations, although with limited relative importance score.
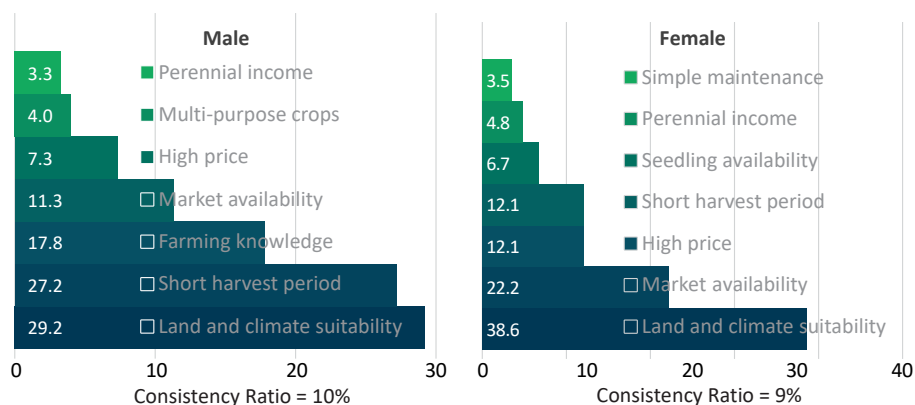
Figure 6. Smallholders' commodity selection criteria scores in Kerinjing

Note: Higher score percentage indicates higher priority
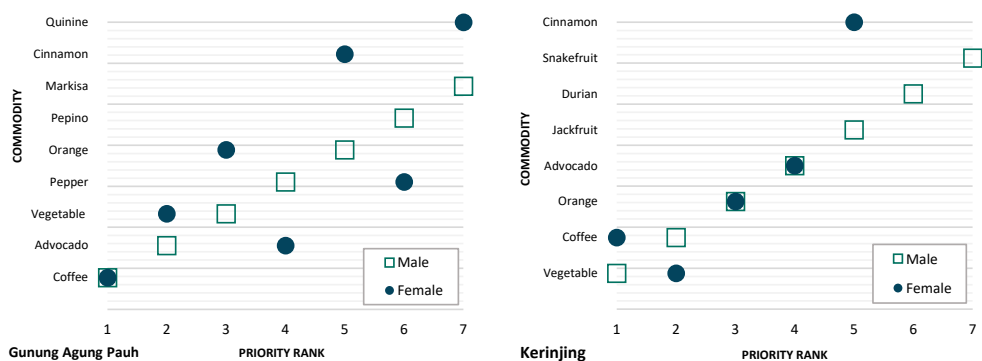
Figure 7. Smallholders' commodity priority ranking in Cluster ND1
Rank 1 = Highest priority; Rank 7 = Lowest priority

Kerinjing female smallholders stated 'market availability', 'high price', and 'short harvest period' as other important considerations. The female group also mentioned 'seedling availability' and 'simple maintenance'. However, considering the score of relative importance, 'land–climate suitability' and 'market availability' were the most important considerations for the female group.

Male and female groups in ND1 selected similar commodities, with both villages considering coffee and vegetable crops in the top rank of prioritised commodities. Coffee was the primary commodity selected by all groups in Gunung Agung Pauh and the female group in Kerinjing. Fruit trees, such as avocado and orange, were considered as priority crops to be developed in Gunung Agung Pauh because the demand for these commodities was considered to be growing, including from agrotourism. The male group in Kerinjing included orange, avocado, durian, jackfruit and snake fruit to be cultivated within their social forestry areas and on private land. Observing the growing market opportunities and land suitability in ND1, female groups in both villages mentioned the potential of cinnamon to be cultivated within the coffee agroforestry systems (Figure 7).

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CLUSTER NORTH DEMPO 2: TANJUNG TARING AND TANJUNG KELING

Cluster North Dempo 2 (ND2) includes Tanjung Taring Village and Tanjung Keling Village in Burung Dinang Municipality ('Kelurahan') of North Dempo Sub-District ('Kecamatan'). Previously a forest and abandoned tea-plantation area from the Dutch colonial period, the villages in ND2 were initially established as an area for temporary huts for local and Javanese migrants who cleared the forest/tea plantation area for coffee farming. The villages gained official administrative status in the 1980s. Settlements and farms in ND2 are located next to the forest, at the foot of Mount Dempo. This cluster is dominated by land with more than 30% slope.

The population of Tanjung Taring in 2018 was 112 persons while Tanjung Keling Village was 95. The cluster is dominated by the descendants of tea-plantation workers from Java who had migrated during the Dutch colonial period.

The cluster is located 1.5–2 hours' drive from the city. The cluster had poor proximity to markets and lacked other required agro-infrastructure for transporting crops. Cellular data coverage was limited, and the village road was unsealed (non-asphalt). Farmers' group members were less active and more dependent on a few local elites.

5.1. Historical land-use and land-cover changes

This chapter notes important events related to the landscape as perceived by the communities in ND2 (Table 11). In the 1940s, Tanjung Taring was predominantly a forested and tea-plantation area while Tanjung Keling was a temporary settlement area that consisted of huts for tea-plantation workers from Java. During this period, the lower part of the forest in this cluster was part of a tea plantation. After the independence of Indonesia in 1945, most of the settlements in this cluster were abandoned and the tea-plantation workers moved to the city or other villages to work as labourers.

In the 1950s, the first President of Indonesia, Sukarno, visited Pagar Alam and urged residents to use what the Dutch had abandoned, including land. Hence, the forest began to be cleared and the tea plantation replaced with robusta coffee. The smallholders in this cluster were predominantly the Javanese who were brought by the Dutch to work on the tea plantations. Since then, coffee farming has been practised, with at least one or more tree crops on plots to provide shade. The cluster was still a temporary settlement for

smallholders. Besides coffee, smallholders in ND2 also cultivated dryland rice for subsistence.

From 1960 to the 1970s, due to population growth, more forested areas were cleared for coffee farms. Smallholders started to claim the forest area that was previously a 'land bank' for the tea plantations, maintained to buffer the border with the protected forest. During this period, Tanjung Keling became a village while Tanjung Taring was still a temporary settlement with huts.

In the 1980s, the Government established a new protected forest border located below the previous border, which saw many smallholders' farms included within the protected forest area. As a result, a conflict arose between the community and the authorities. Many smallholders decided to abandon their land and left the area due to the conflict. However, there were still a few who decided to continue cultivating their land although continuously in conflict with the authorities.

The smallholders would abandon a commodity when the price or market trend dropped. In the 1990s, ND2 smallholders stopped cultivating cloves due to a significant price fall. In the 2000s, a Government-endorsed vanilla development programme was abandoned by the smallholders due to a similar price fall. In this period, Tanjung Taring officially became a separate village from Tanjung Keling.

Further road enhancement in the 2010s improved accessibility in ND2 and seasonal migrants came to the area to grow vegetables. The improved accessibility provided a new opportunity for marketing vegetables and since then these crops have gradually become more significant for local livelihoods. A few smallholders are still cultivating within the forest border although with less intensive practices. The ND2 area was appointed a target area of the Social Forestry programme in mid-2010.

Table 11. Land-use history and major events in Cluster ND2

Period	Event	
	Tanjung Taring	**Tanjung Keling**
1940s	Forest area.	Tanjung Keling was a settlement since the Dutch period.
		Mixed between local native and Javanese brought by the Dutch to work in the plantation.
		The tea plantation was bordered by the forest in the upperpart as the 'tea land bank'.
		The Dutch created the border between the protected forest area and the forest area as the land bank.
1950s	Sukarno's speech when he visited Pagar Alam encouraged people to open new land from the Dutch plantation area.	Migrants, who were the plantation workers, converted the tea plantation into coffee plots. Initially, they planted dryland rice for subsistence.
	Soon after, the tea plantation and its surrounding forest were converted into coffee farms.	Coffee was planted as a simple agroforestry system with shade trees and subsistence crops.

Period	Event	
	Tanjung Taring	**Tanjung Keling**
1960s 1970s	Farmers started to open the forest area for coffee cultivation up to the forest border area. First coffee harvest in the 1960s; simple coffee agroforestry (only with fruit and shade trees). Local migrants from nearby villages (Bumi Agung and Agung Lawangan) settled in the area. More forest was opened for coffee cultivation.	The forest was opened for coffee cultivation up to the forest border sign.
1980s	The authorities started to target communities who cultivated within the forest area. Smallholders gradually abandoned their land in the forest area.	Smallholders gradually abandoned cultivating dryland rice in their farming systems. The new forest border was enacted far below the old one, encompassing farms. The communities were still cultivating their own land.
1990s	-	Land conflict with the authorities over the 'new forest' land escalated, with some smallholders gradually leaving their land. Gradually, clove was abandoned due to decreasing prices.
2000s	Village road quality was improved to be more accessible for cars. Tanjung Taring was still part of Tanjung Keling village. Seasonal crops were mixed with coffee agroforestry. Tanjung Taring became a separate village from Tanjung Keling. Intensive seasonal crops for commercial purposes.	Several smallholders (less than five households) began growing seasonal crops. Village road improvement made it accessible for cars. The Government provided vanilla seedlings but the vanilla price dropped and the smallholders stopped growing it.
2010s–present	First HKm programme came, with the first 275 hectares cultivated by Javanese migrants in the forest area. These Javanese migrants moved from their huts and started living in Pagar Alam City.	Seasonal crops commercialization, initially brought by Sundanese sharecroppers. About 50 households cultivated seasonal crops in the mid-2010s. Village road improvement. Presently, 95% of village communities own or manage seasonal crops. Most of the crops are managed by the owners.

5.2. Farming systems

Previously dependent on coffee farming, vegetable crops gradually became the dominant commodity in ND2. Female and male smallholders in Tanjung Keling Village perceived that both coffee and vegetables provided similar contributions to their incomes, while in Tanjung Taring the male smallholders perceived that vegetables gradually contributed more to local incomes compared to coffee. However, the female smallholders in Tanjung Taring still perceived that coffee was the dominant commodity, providing a higher contribution to the livelihoods of their village communities (Figure 8).

Farmers in this cluster grew various vegetable crops, such as cabbage, chili, onion, cucumber, eggplant, mustard greens, long bean, carrot, and potato. Most of the harvested crops were sold to local traders or external buyers who harvested on-farm, while the smallholders kept only small portions of their vegetable harvests to be consumed by their families.

In the coffee agroforestry system, the smallholders also cultivated durian, cinnamon, jackfruit, avocado, mango, banana, mahogany and chili. Smallholders in this cluster still collected firewood from their coffee plots. Some of the coffee and vegetable farms were located within the forest area (Table 12).
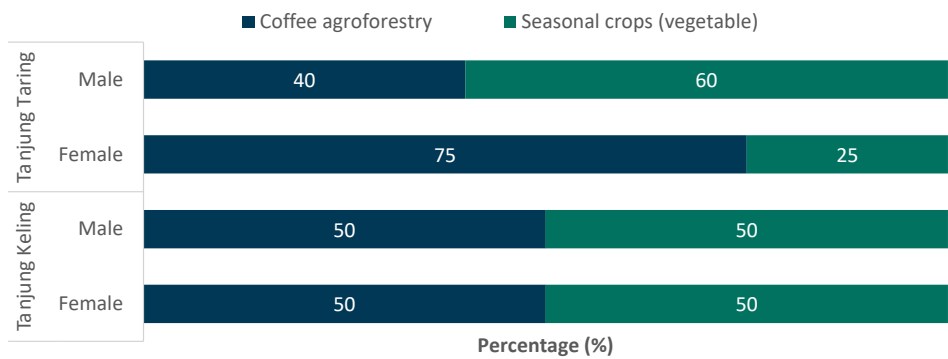
Figure 8. Perceived contributions of farming systems to local incomes in Cluster ND2

Table 12. Farming systems in Cluster ND2

Farming systems	Commodities	
	For sale	For own consumption
Coffee agroforestry	Coffee, avocado, cinnamon, pepper, hot chili, 'bambang lanang' (*Michelia champaca*), African timber tree (*Meisopsis eminii*), jackfruit, banana.	Timber on private land for construction and other harvested commodities also used by farm households.
Seasonal crops (vegetables)	Cucumber, cabbage, mustard greens ('sawi'), carrot, eggplant, tomato, chili, celery (*Apium graveolens*), 'cabe setan', 'cabe kriting', onion, garlic, bean (*Arachis hypogaea*), long bean, potato.	Small amounts of the harvested commodities consumed by farm households.
Forest land	Coffee agroforestry and vegetable crops.	Small amounts of the harvested commodities consumed by farm households.

The types of agricultural land management in ND2 were quite similar. In both Tanjung Taring and Tanjung Keling, the households managed their own farms or other people's land through profit-sharing, schemes, mortgages or, in some cases just borrowed the land from the owners. For seasonal crops, the growers also rented plots from their neighbours who did not have the resources to grow vegetables themselves (Table 13).

Within coffee-farm households in ND2, the work was mostly divided between the female and male smallholders.

Males tended to be a little more involved compared to females in all farming stages. However, females actively participated in coffee-farming activities.

In coffee farming, women were perceived as highly involved in the planting, weeding, fertilising, and harvesting stages. Spraying was the only activity in which all groups agreed that women were not too involved. With the exception of seedling preparation and marketing (selling) of the coffee beans, coffee farmers in Tanjung Taring and Tanjung Keling would involve non-family labourers (Tables 14 and 15).

Table 13. Types of agricultural land management in Cluster ND2

Land management	Tanjung Taring		Tanjung Keling	
	Coffee agroforestry	Seasonal crops	Coffee agroforestry	Seasonal crops
Self-managed	√	√	√	√
Profit-sharing	√	√	√	√
Rented	-	√	√	√
Mortgaged	√	√	√	√
Borrowed	√	√	-	√

"√" = Being practised, "-" = Not being practised

Table 14. Perceived gender roles in coffee farming in Tanjung Taring

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	2	√	3	1
Land clearing	√	3	2	√	3	3
Seedlings	-	3	2	-	3	3
Planting	√	3	2	-	3	3
Weeding	√	2	3	√	3	2
Spraying	√	3	1	-	3	1
Fertilising	√	3	3	-	3	2
Harvesting	√	3	3	√	2	3
Postharvesting	√	2	2	√	2	2
Marketing	-	3	2	-	3	3

√ = Using non-family labour; "-" = Not using non-family labour

1 = No involvement; 2 = Limited involvement; 3 = High involvement

Table 15. Perceived gender roles in coffee farming in Tanjung Keling

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	2	√	3	2
Land clearing	√	3	3	√	3	2
Seedlings	-	3	2	-	3	2
Planting	√	3	2	-	3	3
Weeding	-	3	3	√	3	3
Spraying	-	3	1	√	3	2
Fertilising	-	3	2	√	3	3
Harvesting	√	2	3	√	3	3
Postharvesting	√	2	2	-	2	3
Marketing	-	3	3	-	3	1

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Vegetable-farming activities in ND2 also involved non-family labourers although the female and male groups' perceptions were different. The males in Tanjung Taring stated that most activities would involve external labourers while the female group perceived that non-family labourers were only involved in land opening, clearing, and weeding.

In Tanjung Keling, vegetable growers would involve external labourers except in the fertilising, harvesting, and selling stages. Women's involvement was regarded as high in vegetable-farming activities, with balanced roles of men and women across all activities, except in spraying and land opening. (Tables 16 and 17).

Table 16. Perceived gender roles in seasonal crop farming in Tanjung Taring

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	2	√	3	1
Land clearing	√	3	2	√	3	2
Seedlings	√	3	3	-	3	3
Planting	√	2	3	-	3	3
Weeding	√	2	3	√	2	3
Spraying	√	3	1	-	3	1
Fertilising	√	3	3	-	3	3
Harvesting	√	3	2	-	3	3
Marketing	-	3	2	-	3	3

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Table 17. Perceived gender roles in seasonal crop farming in Tanjung Keling

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	2	√	3	1
Land clearing	-	3	2	√	3	2
Seedlings	√	2	3	-	3	3
Planting	√	2	3	-	3	3
Weeding	√	3	3	√	2	3
Spraying	√	3	1	√	3	1
Fertilising	-	3	3	-	3	3
Harvesting	-	2	3	-	3	3
Marketing	-	3	1	-	3	1

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

5.3. Forest contribution and extreme events

The smallholders in ND2 cultivated private and forest land. Some of the farms in ND2 were located far inside the forest and could take hours to reach, only accessible by walking or using a motorcycle modified for the hilly trails. Thus, smallholders built temporary huts from which to manage their farms and return to their village after a few days.

There was a significant difference between female and male perceptions in Tanjung Taring. Tanjung Taring's female group perceived that forest land provided about 70% contribution to their livelihoods because many coffee and vegetable farms were located within the forest area. However, their male counterparts perceived that only a few people still cultivated within the forest, contributing only 10% to local livelihoods. In Tanjung Keling, female and male smallholders perceived that forest land contributed only 10–20% of local livelihoods and most of the productive farms were located outside of the forest area (Figure 9).
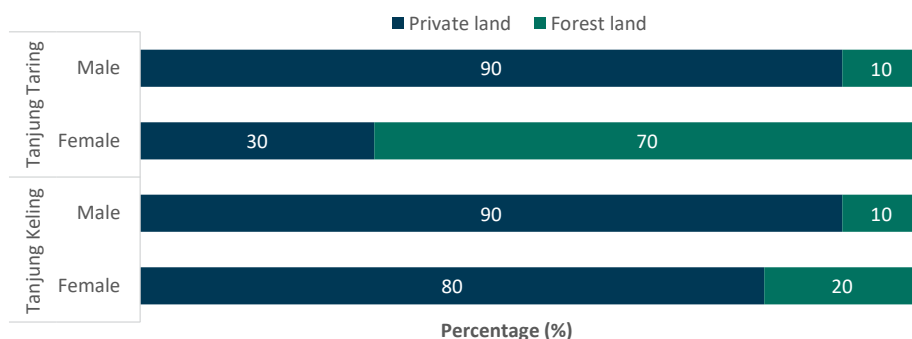
Figure 9. Perceived proportions of land contributions to local incomes in Cluster ND2

Table 18. Perceived shocks and stressors in Cluster ND2

Shocks and Stressors		Tanjung Taring				Tanjung Keling			
		Male		Female		Male		Female	
		I	F	I	F	I	F	I	F
1	Prolonged droughts	-	-	-	-	3	1	5	2
2	Hailstorms	-	-	2	2	-	-	-	-
3	Prolonged rain	4	1	-	-	5	1	-	-
4	Decreased water supply	5	3	-	-	-	-	-	-
5	Pests and diseases	4	1	-	-	-	-	3	2
6	Strong winds	-	-	5	1	-	-	-	-
7	Volcanic ash	-	-	2	2	-	-	-	-
8	Price fluctuations	5	1	5	1	5	1	5	3

Impact (I) score: 1= Very low impact, 5 = Very high impact
Frequency (F) score: 1= Infrequently, 3= Very frequently

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All smallholders in ND2 perceived that price fluctuations had negative impacts on their villages in the last 5–10 years (Table 18). All the groups in Tanjung Keling mentioned prolonged drought and female smallholders perceived that drought had significantly affected agricultural activities. The male smallholders' group in Tanjung Taring also observed decreasing water supply trends over the last decade.

Both male groups in Tanjung Taring and Tanjung Keling perceived that prolonged rainy seasons had occurred in the last few years, with the seasons became more difficult to predict. Only female groups in Tanjung Taring mentioned the volcanic ash from Mount Dempo as a shock that damaged their vegetable crops, as well as hailstorms and strong winds. The male group in Tanjung Taring and the female group in Tanjung Keling considered pests and diseases of vegetable crops as the most significant shocks, negatively affecting their livelihoods.

5.4. Commodity criteria and rank (AHP)

The male farmers' group in Tanjung Taring highlighted three criteria as their major consideration for selecting crops: 'short harvest period', 'market availability', and

Male
■ Seedling availability — 3.1
■ For own consumption — 3.6
■ High price — 6.4
□ Perennial income — 15.1
□ Erotion prevention — 20.0
□ Market availability — 23.3
□ Short harvest period — 28.5

Consistency Ratio = 9%

Female
■ Coffee shading — 2.6
■ Simple maintenance — 5.3
■ For own consumption — 6.0
■ High price — 13.8
□ Short harvest period — 19.1
□ Perennial income — 19.1
□ Market availability — 34.1

Consistency Ratio = 8%

Figure 10. Smallholders' commodity selection criteria scores in Tanjung Taring
Note: Higher score percentage indicates higher priority

'role in preventing erosion'. The first and second criteria were related to vegetable markets that had started to develop in the area while the third criterion was related to the hilly agricultural landscape in Tanjung Taring that was prone to erosion. The other important criterion was 'perennial income' — to complement the short-term income from vegetables — which represented coffee and fruit trees. Other criteria were deemed less important, such as 'high price', 'for own consumption', and 'seedling availability' (Figure 10).

For the female group in Tanjung Taring, 'market availability' was the most important criterion in selecting a commodity. The next two major criteria were 'short harvest period' and 'perennial income', both of which received an equal relative importance score of 19.1.

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This reflected the equal importance of coffee and vegetable crops for female smallholders as sources of livelihoods. The fourth criteria, 'high price', also related to the commodity market. The other criteria mentioned were 'for own consumption', 'simple maintenance', and 'coffee shading'.

In Tanjung Keling, males highlighted 'land and climate suitability', 'market availability', and 'seedling availability'

as the most important. These three criteria represented 70% of the total importance score from the whole criteria list. Tanjung Keling Village was remote; far from markets, with hilly agricultural landscapes. The other important criterion for selecting crops was 'perennial income' while 'high price', 'for own consumption', and 'seedling availability' were considered less important (Figure 11).
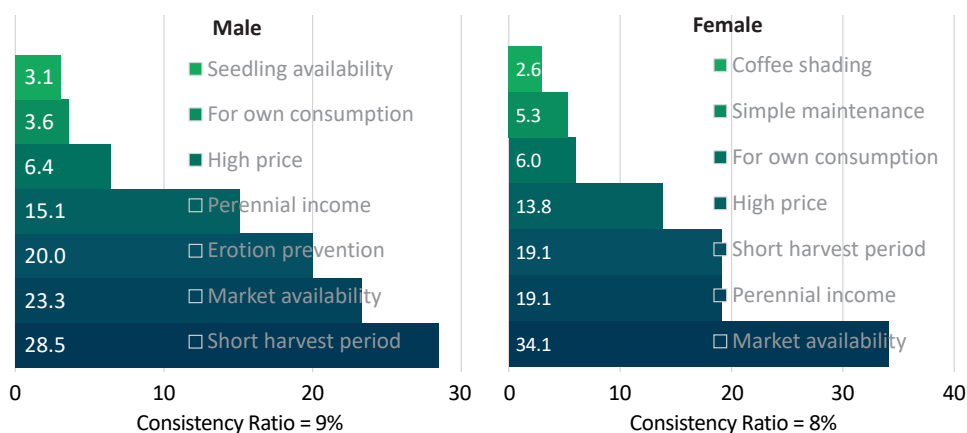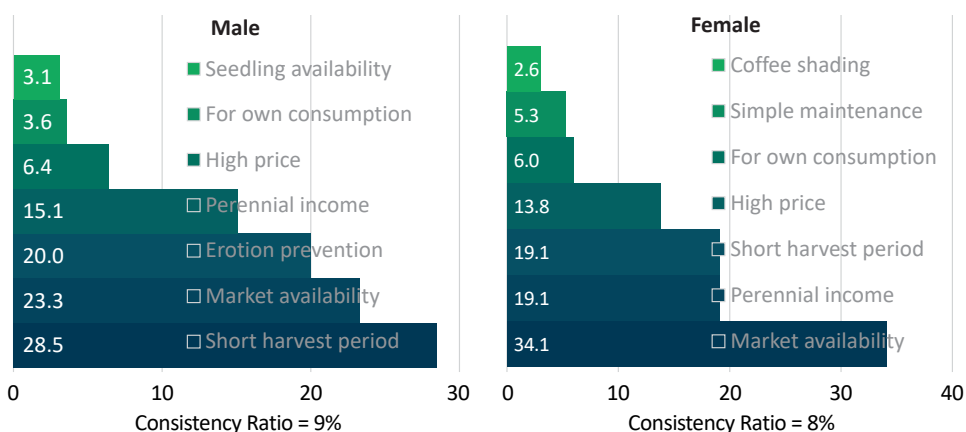

Figure 11. Smallholders' commodity selection criteria scores in Tanjung Keling
Note: Higher score percentage indicates higher priority relative to other criteria

According to the female group in Tanjung Keling, 'seedling availability', and 'land climate suitability' were the most important criteria for selecting a commodity. These criteria were related to the condition of the landscape and the location of Tanjung Keling Village. Smallholders in the village tended to be more dependent on themselves in their farming practices. The other major criterion was 'short harvest period', which reflected the importance of vegetable crops for females as a source of livelihoods. The fourth and fifth criteria, 'high price' and 'perennial income', also related to the commodity market. The other criteria mentioned — 'low cost' and 'simple maintenance' — were deemed less important.

Both male and female groups in ND2 preferred coffee and vegetable crops as their prioritised commodities. Coffee has always been the primary crop in Pagar Alam, including in this cluster. The recent development of seasonal crops has brought opportunities to combine their perennial incomes with short-term incomes from the vegetable crops. All groups in ND2 included commodities that will be supported through the Social Forestry scheme, such as jackfruit, avocado, clove, durian, orange, and pepper (Figure 12).
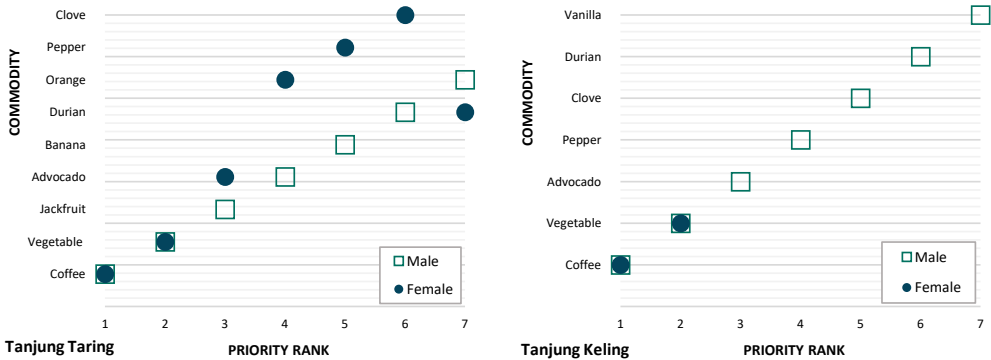
Figure 12. Smallholders' commodity priority ranking in Cluster ND2
Rank 1 = Highest priority; Rank 7 = Lowest priority

CHAPTER 6
CLUSTER CENTRAL DEMPO 1: SEMIDANG ALAS AND RIMBA CANDI

Cluster Central Dempo 1 (CD1) comprises Semidang Alas Village in Jokoh Municipality and Rimba Candi Village in Candi Jaya Municipality, both of which fall under Central Dempo Sub-District. The cluster area used to be forest; it was opened in 1970 due to spontaneous migration (Semidang Alas) and the transmigration programme (Rimba Candi).

The spontaneous migrants in Semidang Alas came from the neighbouring province of Bengkulu, which is located close to Pagar Alam. The migrants from Rimba Candi initially came from Central Java through the Government's transmigration programme. This cluster is dominated by the second and third generations of migrants. The population of Semidang Alas was about 100 persons and Rimba Candi about 258.

The smallholders grew coffee and seasonal crops albeit with many limitations due to the steep land. The cluster was dominated by sloping land that has more than 30% slopes. The water supply for agriculture in this cluster is limited.

The farm area represented a transition between forest–agroforest–intensive-agriculture areas. Settlements in CD1 are located next to the forest and many agricultural plots are located inside the designated forest area. Due to this situation, Semidang Alas and Rimba Candi are two of the targeted villages for the Social Forestry programme in Pagar Alam.

Cluster CD1 is located 1.5–2 hours' drive to Pagar Alam City. The cluster had poor proximity to markets and other required agro-infrastructure. The cellular data coverage was limited and the village road was unsealed (non-asphalt). The farmers' group members in this cluster were less active and more dependent on a few local elites.

6.1. Historical land-use and land-cover changes

According to the smallholders, coffee had been cultivated as the major crop in Semidang Alas even before Independence, mixed with seasonal crops for subsistence. In the 1940s to 1960s, the area was dominated by coffee agroforestry in the forest, with smallholders establishing temporary huts from which to manage their farms. Most of the early smallholders in Semidang Alas were local migrants from Bengkulu, a province nearby Pagar Alam. In this period, Rimba Candi was still a pristine forest area (Table 19).

In the early 1970s in Semidang Alas, Javanese teachers came to Pagar Alam with their families from Java to work as coffee sharecroppers for the local communities. Many of these teachers' relatives worked for smallholders in Semidang Alas. More people opened and cultivated within the forest area in Semidang Alas, both from Pagar Alam and Bengkulu. However, the area was still dominated by forest and coffee farms with temporary huts.

In the same period, the first wave of Central Java transmigrants came to Rimba Candi facilitated by the central Government. The previous forest area was cleared by the army for the transmigrants. These transmigrants were provided with initial capital and seedlings, such as coffee, clove, and seasonal crops, to initiate their livelihoods. As the initial capital was limited to supporting their livelihoods, the transmigrants at that time also worked as farm labourers in Semidang Alas. At the end of the 1970s, Rimba Candi officially became a village.

In the 1980s, permanent settlements replaced the huts in Semidang Alas and the area officially became a village. In this period, the local community was also asked to replace their coffee with clove and eucalyptus. Several farmers also joined the local migration programme to other villages in Pagar Alam. Within this time, the first forest tenurial conflict between smallholders and the authorities occurred in Rimba Candi. The conflict was problematic, as the transmigrants were previously received the agricultural land from the Central Government that designed the programme in the first place.

In the 1990s, the out-migrants from Semidang Alas returned to the village due to limited livelihoods' options in their new place. The return of these out-migrants was perceived to contribute to the expansion of the forest area. Around the mid-1990s, the clove price fell and many smallholders in both villages cleared the cloves from the land.

In the early 2000s, the Government provided cacao and vanilla seedlings that were soon abandoned due to the lack of markets for both crops. Forest encroachment intensified but the smallholders from Rimba Candi stated that they never expanded into the forest due to their bad experience with the army in the 1980s. However, a few from Rimba Candi gradually bought cultivated forest areas from the 'natives' of Pagar Alam who had opened the forest during this period.

Around the mid-2000s, Sundanese sharecropper gradually moved to the area from another part of Pagar Alam, possibly attracted by the road improvement to Semidang Alas that created better access for transporting vegetable crops. Since 2017, one of the Rimba Candi residents has operated a lemongrass (*sereh*) processing business that requires continuous supply. Seizing this opportunity, the smallholders in Rimba Candi cultivated lemongrass that could be sold at a relatively high price to the processor.

The villagers in CD1 stated that they had abandoned the practice of expansion of agricultural land into the forest since 2010 and, afterwards, they received inclusion in the Social Forestry programme, in 2018. However, forest encroachment in CD1 still occurs by outsiders from neighbouring districts.

Table 19. Land-use history and major events in Cluster CD1

Period	Event	
	Semidang Alas	**Rimba Candi**
1940s	Coffee has been cultivated as the major farming system since before Independence. Seasonal crops were cultivated in between coffee trees for subsistence.	Forest
1950s	Only huts for temporary occupation; the majority were local migrants from Bengkulu (a province next to South Sumatra).	
1960s		
1970s	Javanese migrants came from Java as teachers; more Javanese came to be coffee sharecroppers. More people opened the forest area for cultivation.	First transmigrants cultivated allocated shrub (non-forest) land. Pagar Alam was a part of Lahat District. Coffee, clove, and crop seedlings were provided as initial capital. Transmigrants worked on local people's land as labourers and acquired additional coffee seedlings from the locals. Officially became a village (Suka Karya).
1980s	Huts gradually replaced with permanent settlements. The community was asked to replant their farms with eucalyptus and clove; some moved to other areas (local transmigration programme).	Lemongrass (*sereh*) was cultivated for a while, without economic use. The village name changed from Suka Karya ('likes to work') to Rimba Candi ('forest temple'). Forest border conflict due to the designated transmigration area overlapping with the forest border. Crops and maize were cultivated for domestic use (subsistence). Pests became the major problem that continues until the present.
1990s	Former community members returned to Semidang Alas due to limited livelihoods' options. Forest encroachment became more frequent.	Clove price dropped; clove trees were removed from coffee agroforestry land.
2000s	The Government provided vanilla and cacao seedlings. Lack of knowledge and experience made the community abandon both commodities. The smallholders initiated growing seasonal crops intensively for commercial purposes. Better road access created more opportunities for seasonal crops. Sundanese sharecroppers gradually came to the area from other parts of Pagar Alam.	During and after the Reformation period, encroachment of the protected forest intensified. Transmigrants bought protected forest land from local people and opened the forest. Pagar Alam was enacted as a city; Rimba Candi was still a village.
2010–present	Smallholders stopped encroaching the forest in 2013. Encroachment, however, continues by outsiders perceived to come from the neighbouring Lahat District.	Lemongrass was re-introduced. Social Forestry programme started, including in the cultivated forest area.

6.2. Farming systems

Female and male smallholders in CD1 perceived that coffee farming still contributed most of their income. However, the smallholders in Rimba Candi also highlighted the potential market for lemongrass, which gradually attracted more smallholders to their village. There was a local trader and processor who bought lemongrass at a good price in Rimba Candi, which encouraged the smallholders to grow lemongrass (Figure 13). During the discussion, the smallholders revealed that the local government of Pagar Alam also planned to support lemongrass development with Rimba Candi as one of the pilot development areas.

The smallholders grew various vegetable crops, such as bean, chili, tomato, cabbage, potato, spring onion, carrot, mustard greens, chicory, red onion, eggplant, aubergine, broccoli, and chayote. Most of the harvests were sold to the markets in the cluster. In the coffee agroforestry system, the smallholders also cultivated jackfruit, avocado, 'mindi' wood (*Melia azedarach*), mahogany, 'albasia' (*Albizia* sp), 'sengon' (*Albizia chinensis*), and chili. CD1 smallholders mostly sold the harvests from their coffee plots, keeping but a small portion of coffee, fruit, and firewood for their household's consumption. In 2018, the smallholders in Rimba Candi started to cultivate lemongrass on private land that could be sold to the local processor at a relatively good price (Table 20)

The types of agricultural land management in Rimba Candi and Semidang Alas were similar but land mortgaging was only practised in Semidang Alas. In both villages, most of the farm households managed their own coffee farms or other people's through profit-sharing schemes. For seasonal crops, smallholders in Semidang Alas managed their land or other people's through profit-sharing. In Rimba Candi, smallholders practised various types of land management for vegetable farms, such as profit-sharing, rent, mortgage, and borrowing the land (Table 21).
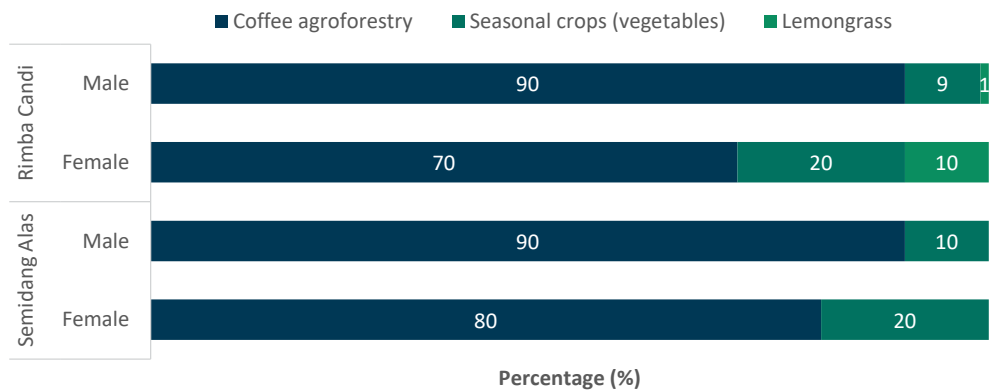

Figure 13. Perceived contributions of farming systems to local incomes in Cluster CD1

Table 20. Farming systems in Cluster CD1

Farming system	Commodities	
	For sale	**For own consumption**
Coffee agroforestry	Coffee, avocado, jackfruit, 'albasia' (*Albizia* sp), cinnamon, 'sengon' (*Albizia chinensis*), cloves (*Syzygium aromaticum*), mahogany (*Swietenia mahagoni*), 'mindi' wood (*Melia azedarach*), other timber for coffee-shading.	Timber on private land for construction and other harvested commodities partially used for domestic consumption by the farm households.
Seasonal crops (vegetable)	Bean, cabbage, leek (*Allium porrum*), cabbage, 'sawi' (*Brassica* sp), 'taruk gumai' (*Solanum nigrum*), carrot, potato, tomato, cayenne (*Capsicum annuum*), red onion (*Allium cepa*), red chili, green chilli, tomato, eggplant.	Small amounts of the harvested commodities used by the farm households.
Lemongrass ('sereh')	Lemongrass (*Cymbopogon citratus*)	-
Forest land	Coffee agroforestry	Small amounts of the harvested commodities used by the farm households.

Table 21. Types of agricultural land management in Cluster CD1

Land management	Rimba Candi		Semidang Alas	
	Coffee agroforestry	**Seasonal crops**	**Coffee agroforestry**	**Seasonal crops**
Self-managed	√	√	√	√
Profit-sharing	√	√	√	√
Rented	-	√	-	-
Mortgaged	-	√	√	-
Borrowed	-	√	-	-

"√" = Being practised, "-" = Not being practised

In CD1, coffee-farm households would involve non-family labourers in most farm activities, except in seedling preparation, postharvesting, and selling green beans. Most groups perceived that compared to the females, male farmers were usually more involved in the land-opening stage, spraying, and fertilising the plots. The female groups in both CD1 villages perceived that women were also highly involved in coffee land clearing.

In other coffee-farming activities, the work was mostly divided between female and male smallholders; female smallholders still actively participated in the farming activities. For example, male and female coffee smallholders in Rimba Candi and Semidang Alas would be equally active in postharvesting and marketing activities (Table 22 and 23).

Table 22. Perceived gender roles in coffee farming in Rimba Candi

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	1	√	3	1
Land clearing	√	3	1	√	3	3
Seedlings	-	-	-	-	3	3
Planting	√	3	2	-	3	3
Weeding	√	1	3	√	3	2
Spraying	√	3	1	-	3	1
Fertilising	√	3	1	-	3	2
Harvesting	√	2	3	√	2	3
Postharvesting	-	3	3	√	2	2
Marketing	-	3	3	-	3	3

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Table 23. Perceived gender roles in coffee farming in Semidang Alas

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	1	√	3	3
Land clearing	√	3	2	√	3	3
Seedlings	-	3	1	-	3	3
Planting	√	2	2	√	3	3
Weeding	√	2	2	-	3	3
Spraying	√	3	2	-	3	3
Fertilising	-	3	2	-	3	3
Harvesting	√	2	2	√	3	3
Postharvesting	-	3	2	-	3	3
Marketing	-	2	2	-	3	3

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Vegetable farm households in Rimba Candi and Semidang Alas were slightly different in involving non-family labourers. Rimba Candi smallholders stated that the involvement of non-family labourers was limited to the land-opening and clearing, planting, weeding, and harvesting stages while the smallholders in Semidang Alas stated that they would involve non-family labourers in all farming stages, except for spraying. Women's involvement in vegetable farming was relatively equal, except in the land opening, land clearing, spraying, and fertilising stages, which required more strength (Table 24).

Table 24. Perceived gender roles in seasonal crop farming in Rimba Candi

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	1	√	3	1
Land clearing	-	1	1	√	3	2
Seedlings	-	3	2	-	3	3
Planting	√	3	3	-	3	3
Weeding	-	1	1	√	2	3
Spraying	-	3	1	-	3	1
Fertilising	-	3	1	-	3	3
Harvesting	√	3	3	-	3	3
Marketing	-	3	1	-	3	3

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Table 25. Perceived gender roles in seasonal crop farming in Semidang Alas

Seasonal crop farming activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	1	√	3	1
Land clearing	√	3	1	√	3	1
Seedlings	√	2	3	√	3	3
Planting	√	2	2	√	1	3
Weeding	√	2	3	√	1	3
Spraying	-	3	1	-	3	1
Fertilising	√	3	2	-	3	3
Harvesting	√	2	3	√	3	3
Marketing	-	2	2	-	3	1

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

6.3. Forest contribution and extreme events

CD1 farmers cultivated their farms on private land as well as designated state forest land. Most of the farm areas for Semidang Alas and Rimba Candi communities were located far inside the forest. These farms could take hours or even a whole day to reach, only accessible by walking or using a motorcycle modified for the hilly trails. In general, the male and female groups agreed that forest land still provided a large contribution to livelihoods in CD1.
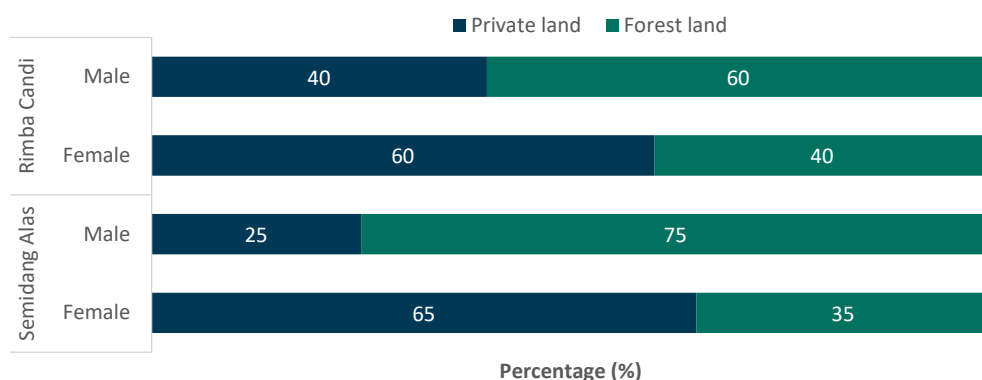
Figure 14. Perceived proportions of land contributions to local incomes in Cluster CD1

There was a significant difference between female and male perceptions in Semidang Alas: the male group perceived that forest land provided about 75% of their livelihoods compared to 35% contribution as perceived by the female group. However, both groups agreed that many coffee and vegetable farms were located within the forest area.

A similar perception was also found in Rimba Candi: the male group perceived that crops cultivated in the forest area provided a much higher contribution compared to those on private land. Rimba Candi's male group stated that forest land provided about 60% of their livelihoods compared to 40% as perceived by the female group (Figure 14).

All smallholders in CD1 perceived that price fluctuations had a negative impact on their livelihoods during the last 5–10 years (Table 26). However, the impact was perceived not as high as in the other cluster. Rimba Candi smallholders perceived that price falls occurred more frequently, both for coffee and vegetable crops, particularly during harvest seasons. Farmers in Semidang Alas perceived that coffee and vegetable price falls were relatively less frequent but the shocks brought similar impact as experienced by their neighbours in Rimba Candi.

Hailstorms were an extreme event that moderately affected farming activities and damaged crops in CD1, as stated by the female groups. However, both groups in Rimba Candi and Semidang Alas perceived that this particular shock was less frequent. The female groups in CD1 also stated that small landslides sometimes occurred in agricultural plots.

For the male groups in Cluster CD1, prolonged rain had become more frequent although the impact was still moderate. Both groups also indicated warmer temperatures compared to previous decades and mentioned that the climate pattern had become more difficult to predict.

Table 26. Perceived shocks and stressors that affect livelihoods in Cluster CD1

Shocks and stressors		Rimba Candi				Semidang Alas			
		Male		Female		Male		Female	
		I	F	I	F	I	F	I	F
1	Hailstorms	-	-	3	1	-	-	3	1
2	Prolonged rain	3	3	-	-	3	2	-	-
3	Pests and diseases	-	-	2	1	-	-	-	-
4	Warmer temperatures	2	3	-	-	2	1	-	-
5	Landslides	-	-	2	1	-	-	2	1
6	Price fluctuations	3	3	4	3	3	1	4	1

Impact (I) score: 1= Very low impact, 5 = Very high impact
Frequency (F) score: 1= Infrequently, 3= Very frequently

6.4. Commodity criteria and rank (AHP)

The male group in Rimba Candi selected criteria related to economic value, vegetable crops, and markets as the major considerations for selecting the crops. 'High price', 'short harvest period', and 'market availability' were the three major considerations, representing 85% of the total relative importance score for the whole criteria list in the group. The other criteria mentioned by the male group in Rimba Candi were 'perennial income', 'land and climate suitability', 'seedling availability', and 'for own consumption', although these criteria were deemed as less important compared to the first three criteria (Figure 15).

According to the female group in Rimba Candi, practical and market considerations were the most important criteria in selecting which commodity to cultivate. The 'land suitability' and 'climate suitability' came out as the most considered criteria, with 57% of the total importance score. In the next criteria, 'market availability' and 'high price' were

also deemed important for females in Rimba Candi, which indicated that the smallholders would consider the market in selecting their crops. The other criteria that were mentioned by the group, albeit with less importance, were 'short harvest period', 'investment', and 'simple maintenance'. 'Investment' here refers to timber crops that would be harvested years after the planting period with relatively high prices, such as 'bambang lanang' and mahogany trees, as well as perennial crops that can be harvested annually for a long period.

The male group in Semidang Alas selected 'land and climate suitability' as the most important consideration for selecting crops. This criterion scored high relative to the other criteria, representing 40.4 % of total importance from the whole list of criteria. Semidang Alas has a sloping agricultural landscape that could be challenging to cultivate and thus the male group considered suitability as the major criterion. 'Short harvest period', 'market availability', and 'perennial income' were three other major considerations, representing 49% of total relative

Figure 15. Smallholders' commodity selection criteria scores in Rimba Candi

Note: Higher score percentage indicates higher priority

importance from the males' criteria list. The other criteria mentioned by the male group in Semidang Alas were 'high price, 'coffee shading', and 'for own consumption' although these criteria were deemed less important compared to the first four (Figure 16).

For the female group in Semidang Alas, 'market availability', and 'short harvest period' were considered important, with the two representing 55.5% of total

relative importance. The most important criteria for Semidang Alas' female group was 'market availability', representing 34.2% of total relative importance. Different from their male counterparts, 'land climate suitability' was considered a less important criterion. This was likely due to less involvement of females in the preparation stage of farming. The other criteria mentioned by the female group were 'high price', 'coffee shading', and 'simple maintenance'.
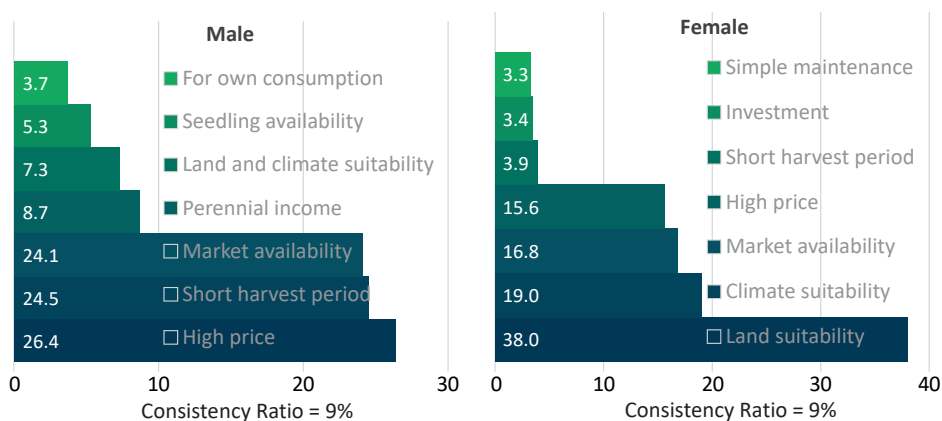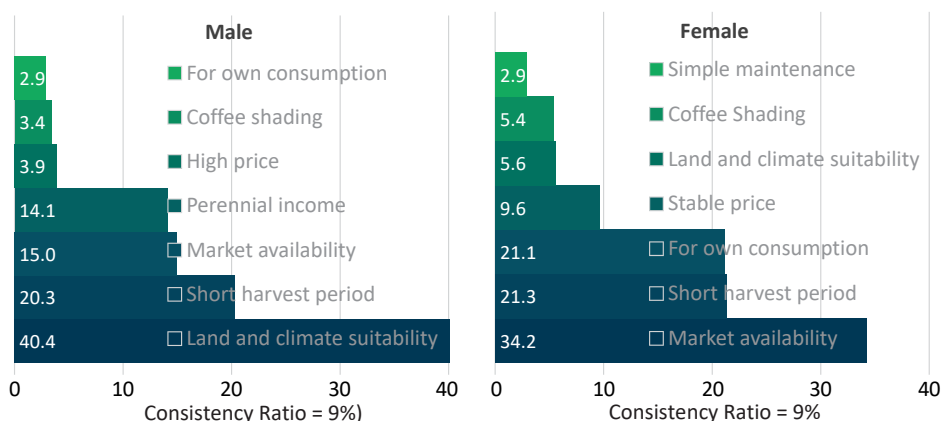

Figure 16. Smallholders' commodity selection criteria scores in Semidang Alas

Note: Higher score percentage indicates higher priority

All of the farmers' groups in Cluster CD1 selected coffee as their priority commodity. Vegetable crops were included in the preference list because they provided daily incomes for female groups, who worked as day labourers, and seasonal income for vegetable farm households, in both villages. The female group in Semidang Alas considered that rice was the second-most important commodity due to the upcoming irrigation reservoir construction in their cluster.

Considering market availability in the village, female and male farmers in Rimba Candi placed lemongrass on the commodity priority list. Male farmers from both villages included timber and fruit trees, such as avocado, jackfruit, durian, and orange, as priority commodities as they considered it likely that those commodities would be cultivated in the Social Forestry area with support from the Government (Figure 17).
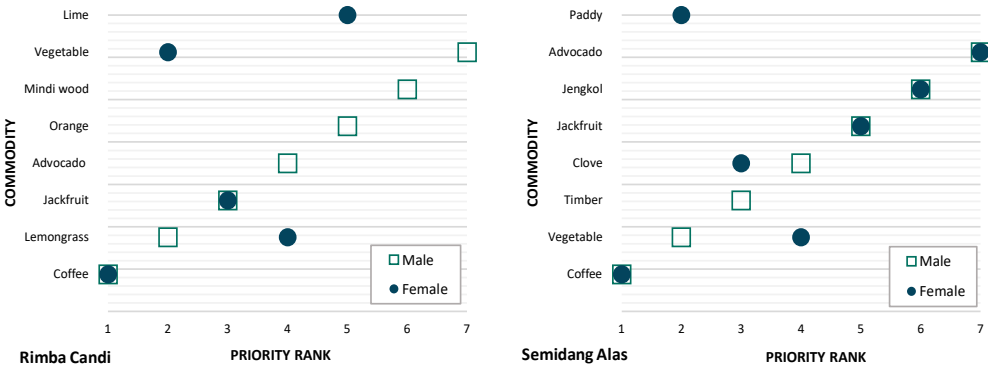
Figure 17. Smallholders' commodity priority ranking in Cluster CD1

Rank 1 = Highest priority; Rank 7 = Lowest priority

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CHAPTER 7
CLUSTER CENTRAL DEMPO 2: JOKOH AND GENTING JAYA

Cluster Central Dempo 2 consists of Jokoh and Genting Jaya villages, located in Jokoh Municipality of Central Dempo Sub-district. Jokoh is dominated by the 'native' people of Pagar Alam while Genting Jaya mostly consists of spontaneous migrants from Central Java and local migrants from nearby villages. Jokoh's population was 260 persons while Genting Jaya was about 325.

The smallholders mainly grew coffee and seasonal crops, with a few in Jokoh cultivating rainfed rice. The water supply for agriculture in this cluster is limited. The farm area was mostly located on sloping land with 15–30% slopes.

The farm area represented a transition between forest–agroforest–intensive-agriculture areas. The settlement of Genting Jaya was next to the forest and many agricultural plots were located inside the designated forest area. Due to this situation, Genting Jaya was targeted for the Social Forestry programme. Jokoh was separated from the forest area by Genting Jaya and Semidang Alas from Cluster CD1.

Cluster CD2 is located 1–1.5 hours' drive from Pagar Alam City. The cluster had poor proximity to markets and other required agro-infrastructure. The cellular data coverage was limited and the village

road was unsealed (non-asphalt). The farmers' group members in this cluster were less active and more dependent on a few local elites.

7.1. Historical land-use and land-cover changes

In Cluster CD2, Jokoh was one of the 'old' villages in Pagar Alam, established as a settlement area in 1900. Until the 1950s, the communities in Jokoh practised subsistence farming, with rainfed and dry-land rice, simple vegetable crops, as well as hunting and gathering. In the 1960s, the local communities in Jokoh started to practise coffee farming, intercropped with cloves. Population growth drove the expansion of farms and settlements into the forest area. Genting Jaya cultivated coffee by utilising seeds acquired from the Dutch. Coffee was mixed with other crops and trees for subsistence. At that time, rainfed rice was also practised in Genting Jaya in the land-opening phase of coffee farming (Table 27).

In the 1970s, Genting Jaya was part of Jokoh Village. During that period, the Genting Jaya area was a farm area located in the forest, in which only very few migrants from Java stayed in temporary huts. These in-migrants worked as sharecroppers for local landowners. In this

period, farmers mixed clove with coffee. New farms were opened in the forest area in Genting Jaya and Semidang Alas of Cluster CD1.

During the 1980s, clove was abandoned because it became unproductive. A forest restoration program was initiated and many smallholders were forced to leave their farms in the Government-designated forest area.

In the 1990s, about 30 households lived in Genting Jaya and the area was acknowledged as a 'talang' (temporary hut) area. The second and third generation of migrants from Java started to buy farms from the original landowners, mostly from Jokoh Village. Only a very limited number of migrant descendants dared to open farms in the forest.

There was a big male out-migration in 1991 due to a significant drop in coffee prices that caused most of the male villagers to leave the village to find work. In the mid-1990s, smallholders started to mixed coffee with pepper. In the early 2000s, cacao was introduced by the Government but soon was abandoned due to pests and diseases while pepper was abandoned by the communities due to a significant price fall. Seasonal crops were introduced by sharecroppers in Jokoh Village, Sundanese migrants who were brought to the area by local landowners. In this period, smallholders in CD2 started to experiment with grafting to improve coffee productivity.

In the mid-2010s, clove prices were considered to have recovered and a few smallholders started to replant clove in their coffee agroforestry plots. Several households experimented with planting rubber (monocultural and in coffee plots). In this period, the Government provided cassava seedlings that soon were abandoned due to the absence of local cassava markets. Intensive vegetable farming was introduced to the smallholders in Genting Jaya. Many females in Genting Jaya worked as day labourers on vegetable farms as their source of income.

Table 27. Land-use history and major events in Cluster CD2

Period	Event	
	Jokoh	**Genting Jaya**
1890	Settlement already established.	Forest area.
1950s	Practised rainfed and dry rice, hunting and gathering, and subsistence vegetable crops.	The village was shrubs and agricultural land with 'native' smallholders' huts. Simple coffee agroforestry was already cultivated, using seedlings from the Dutch.
1960s	Coffee cultivation started with seedlings from other areas in Pagar Alam. The upper part (Semidang Alas, Genting, and Rimba Candi) had not been established.	Coffee trees were intercropped with shade trees and subsistence crops. Rainfed rice was cultivated for subsistence needs in the early phase of land opening.

Period	Event	
	Jokoh	**Genting Jaya**
1970s	Clove was planted in between coffee trees Farms were opened from the forest area.	Spontaneous migrants from Central Java came to the area.
1980s	Jokoh was already a village under Lahat, which included Genting, Semidang Alas, and Candi Jaya. Cloves died due to lack of maintenance and were abandoned. Forest rehabilitation programmes (eucalyptus and 'sengon') started and smallholders were banned from the forest area.	
1990s	Big out-migration due to coffee price drops: most males left the village to find jobs. Pepper was introduced for mixed cropping in coffee agroforestry.	The village started as huts with only about 30 households, mostly from Java. The last rain-fed rice cultivation occurred in the early 1990s. Irrigated rice was initiated: only 7 hectares (5 households) are cultivated due to the land suitability. Smallholders realised that most of the coffee plots were too crowded with shade trees and started to reduce their number to improve coffee productivity. 1st and 2nd generation migrants from Java started to acquire plots that were mostly bought from locals from Jokoh; only a small number of migrants opened new land in the forest area.
2000s	Cacao was introduced by the Government and local initiatives, however, the majority was abandoned due to pests and diseases. Pepper was abandoned by the communities due to significant price falls. Seasonal crops were introduced by migrant Sundanese sharecroppers brought in by local landlords.	Genting and Selebang were part of different villages in Pagar Alam. Grafting was introduced in 2008–2010; coffee smallholders became more enthusiastic in maintaining their coffee trees.
2010s–present	Clove price recovered; smallholders started to re-plant clove in their coffee plots. Several households experimented with growing rubber (monocultural and in coffee plots). Cassava seedlings were distributed as part of a Government programme but was abandoned due to the absence of markets.	Intensive seasonal crops introduced by migrants from West Java. The community in Genting Jaya preferred to be sharecroppers.

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7.2. Farming systems

Smallholders in CD2 perceived that coffee was still the dominant contributor to their livelihoods. However, vegetable crops' contribution to local incomes was perceived to increase, stated at around 10–15 % in Jokoh and Genting Jaya villages (Figure 18). Only a small number of smallholders (less than 10 persons) owned rice fields in the cluster because there was limited area suitable. The smallholders perceived that income from rice had been relatively stable during the last decade.

The smallholders grew various vegetable crops, such as bean, chili, tomato, cabbage, potato, red onion, mustard greens, eggplant, 'leunca', long bean, broccoli, and chayote. Most of the harvests were sold to local traders in the cluster. In their rice fields, smallholders also planted
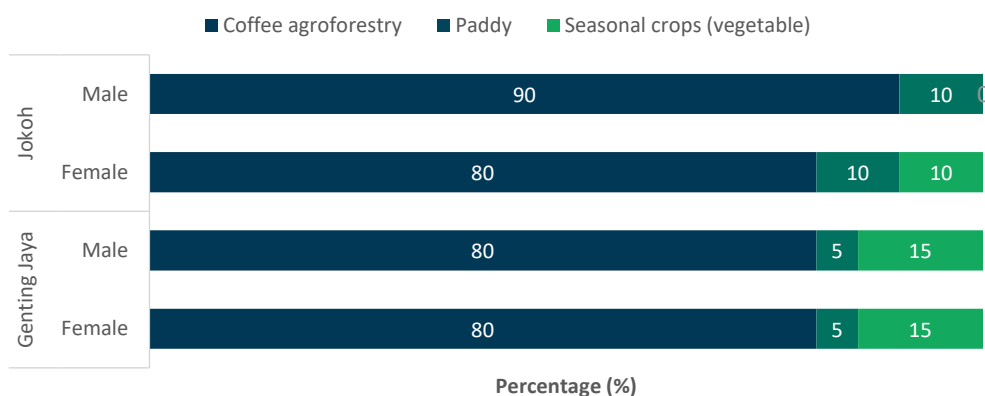

Figure 18. Perceived contributions of farming systems to local incomes in Cluster CD2

Table 28. Farming systems in Cluster CD2

Farming systems	Commodities	
	For sale	**For own consumption**
Rice field	Rice (*Oryza sativa*)	Households usually kept a small portion of the rice harvest for their own use.
Coffee agroforestry	Coffee, clove, chili, cinnamon, avocado, guava (*Psidium guajava*), jackfruit, 'jengkol' (*Archidendron pauciflorum*), durian (*Durio zibethinus*), cayenne, pepper, ginger (*Zingiber officinale*), 'bambang lanang', 'albasia', mahogany, 'petai' (*Parkia speciosa*).	Albasia and other timber on private land used for house construction and firewood. Part of the cash crops are for own consumption,
Seasonal crop (vegetables)	Tomato, cabbage, potato, chili, celery, onion, mustard greens, chili, red onion, potato, eggplant, 'taruk gumai'/'leunca', bean, long bean, chayote.	Households usually keep some portion of the harvested products for their own use.
Forest land	Coffee agroforestry	Households usually keep some portion of the harvested products for their own use.

vegetables, such as chilli, cabbage, and tomato. In the coffee agroforestry plots, the smallholders also cultivated chili, avocado, guava, jackfruit, jengkol, petai, durian, ginger, and banana, Just like the other clusters, smallholders in CD2 mostly sold their harvests from coffee plots while keeping small portions of coffee, fruit, and firewood from their farms for household consumption (Table 28).

Farm management in CD2 was similar with the other clusters. Coffee farmers in Jokoh and Genting Jaya villages implemented profit-sharing and mortgages for the coffee plots. For the vegetable crops, CD2 smallholders managed their own farms, implemented profit-sharing agreements or rented land from a landowner. In addition, vegetable growers in Jokoh could also borrow land from the owner, particularly, from relatives (Table 29).

Compared to the perceptions of the female groups, male coffee farmers in CD2 stated that they involved more non-family labourers in most of the farming activities. Usually non-family labourers were involved in land opening, land clearing, weeding, spraying, fertilising, and harvesting stages. Most groups perceived that compared to the females, male farmers were usually more involved in the preparation phases, such as land opening and clearing, and in spraying and fertilising the plots. The female groups in both CD2 villages stated that women were also highly involved in harvesting, postharvesting, and selling the green beans. In coffee farming, male farmers were slightly more involved across all stages, particularly, in the activities that required more physical strength, such as land opening, spraying, and fertilising (Table 30).

Table 29. Types of agricultural land management in Cluster CD2

Land management	Jokoh		Genting Jaya	
	Coffee agroforestry	Seasonal crops	Coffee agroforestry	Seasonal crops
Self-managed	√	√	√	√
Profit-sharing	√	√	√	√
Rented	-	√	-	√
Mortgaged	√	-	√	-
Borrowed	-	√	-	-

"√" = Being practised, "–" = Not being practised

Table 30. Perceived gender roles in coffee farming in Genting Jaya

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	1	√	3	2
Land clearing	√	3	1	-	3	3
Seedlings	-	3	2	-	3	1
Planting	-	3	2	-	3	2
Weeding	√	3	2	-	3	3
Spraying	√	3	1	-	3	3
Fertilising	√	3	2	-	3	1
Harvesting	√	2	2	√	3	3
Postharvesting	-	2	2	-	2	3
Marketing	-	2	2	-	3	3

√ = Using non-family labour; "–" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Table 31. Perceived gender roles in coffee farming in Jokoh

Activity	Male perception			Female perception		
	Non-family labor	Level of involvement		Non-family labor	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	1	√	3	1
Land clearing	√	3	2	√	3	3
Seedlings	-	3	2	-	3	3
Planting	√	3	3	-	3	3
Weeding	√	3	3	√	3	2
Spraying	√	3	1	-	3	1
Fertilising	√	3	2	-	3	2
Harvesting	√	3	3	√	2	3
Postharvesting	-	3	2	√	2	2
Marketing	-	3	2	-	3	3

√ = Using non-family labour; "–" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Vegetable farming in Genting Jaya mostly involved non-family labourers although, according to the female groups, spraying usually did not involve external labourers. In Jokoh, seedlings, spraying, and fertilising were usually done by family members and did not involve external labourers.

Female and male vegetable growers in CD1 had balanced roles, except in land opening, land clearing, and spraying, in which male farmers usually had more involvement. The discussion groups in Genting Jaya and Jokoh indicated that women played more roles in planting and weeding compared to the male farmers. In Semidang Alas, males sold crops to the market, while in Jokoh, females usually also were involved in marketing (Table 32).

Table 32. Perceived gender roles in seasonal crop farming in Genting Jaya

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	1	√	3	3
Land clearing	√	3	1	√	3	2
Seedlings	√	2	2	√	2	3
Planting	√	2	2	√	2	3
Weeding	√	2	2	√	2	3
Spraying	√	3	1	-	3	1
Fertilising	√	2	2	√	2	3
Harvesting	√	2	2	√	2	3
Marketing	-	3	2	-	-	-

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

Table 33. Perceived gender roles in seasonal crop farming in Jokoh

Activity	Male perception			Female perception		
	Non-family labour	Level of involvement		Non-family labour	Level of involvement	
		Male	Female		Male	Female
Land opening	√	3	1	√	3	1
Land clearing	√	3	1	√	3	1
Seedlings	-	3	1	-	3	1
Planting	√	1	3	√	2	3
Weeding	√	1	3	√	2	3
Spraying	-	3	1	-	3	1
Fertilising	-	3	3	√	2	3
Harvesting	√	3	3	√	2	3
Marketing	-	1	3	-	3	2

√ = Using non-family labour; "-" = Not using non-family labour
1 = No involvement; 2 = Limited involvement; 3 = High involvement

7.3. Forest contribution and extreme events

Female and male smallholders in Jokoh Village stated that all of their farm plots were located on private land because their village was located further from the forest. Thus, all farm livelihoods in Jokoh were contributed from private land. The male smallholders in Genting Jaya perceived that the contribution of forest was less significant and most of the farms were located on private land, while their female counterparts perceived that forest still provided a significant contribution — as much as half — of their livelihoods (Figure 19).

All smallholders in CD2 perceived that price fluctuations and hailstorms had negative impacts on their livelihoods in the last 5–10 years (Table 34). Smallholders in Genting Jaya perceived that vegetable crop price falls were more frequent, particularly, during harvest seasons. Farmers in Jokoh perceived that coffee price falls were relatively less frequent but had a huge impact on their livelihoods

■ Private land ■ Forest land
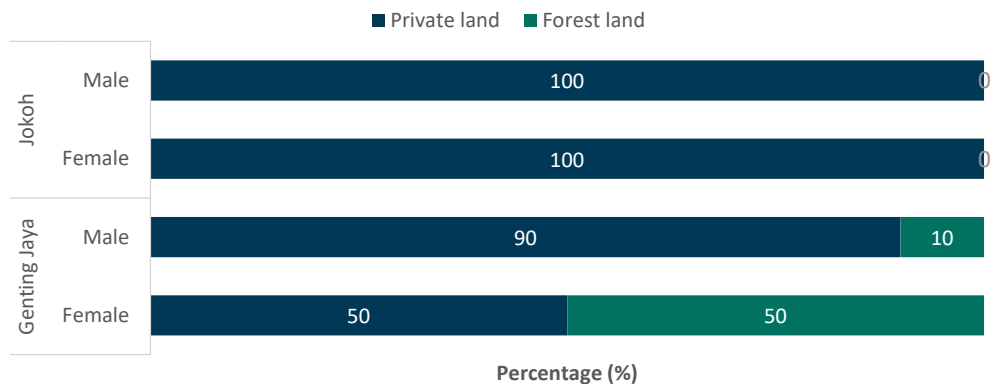
Figure 19. Perceived proportions of land contributions to local livelihoods in Cluster CD2

Table 34. Perceived shocks and stressors in Cluster CD2

Shocks and stressors		Jokoh				Genting Jaya			
		Male		Female		Male		Female	
		I	F	I	F	I	F	I	F
1	Prolonged droughts	-	-	2	1	-	-	4	1
2	Hailstorms	4	1	5	3	5	1	3	1
3	Prolonged rain	-	-	-	-	-	-	5	2
4	Decreased water supply	1	2	4	3	-	-	-	-
5	Pests and diseases	-	-	-	-	5	1	-	-
6	Warmer temperatures	-	-	4	2	2	3	-	-
7	Price fluctuations	4	1	5	1	5	3	5	3

Impact (I) score: 1= Very low impact, 5 = Very high impact
Frequency (F) score: 1= Infrequently, 3= Very frequently

because most farmers in Jokoh were dependent on coffee farming for their main income.

Hailstorms were also perceived as extreme events that could affect farming in CD2 because of damage to crops. However, most groups perceived that this shock was less frequent while only the female group in Jokoh perceived hailstorms as becoming more frequent.

As the downstream village, Jokoh frequently experienced decreased water supply while Genting Jaya had never experienced a significant decrease in water supply. Female smallholders in both villages perceived that droughts had a negative impact on their agricultural activities even though droughts occurred infrequently. The female group in Genting Jaya also perceived that prolonged rainy seasons had become more frequent in their village, with a negative impact on their livelihoods' activities.

7.4. Commodity criteria and rank (AHP)

In Jokoh, the male group considered 'market availability' the most important criterion when selecting a commodity. The other criteria that were considered as important by this group were 'perennial income', 'coffee shading', and 'short harvest period'. Together, these four criteria represented 82.8% of total relative importance of the whole commodity selection criteria in Jokoh. The 'perennial income' indicated coffee as the primary crop while 'short harvest period' applied to the growing interest in cultivating rice and vegetable crops. The other criteria were 'for own consumption', 'high price', and 'investment' albeit with less importance compared to the first four criteria (Figure 20). 'Investment' here refers to perennial crops that can be harvested annually for a long period, such as coffee and clove.
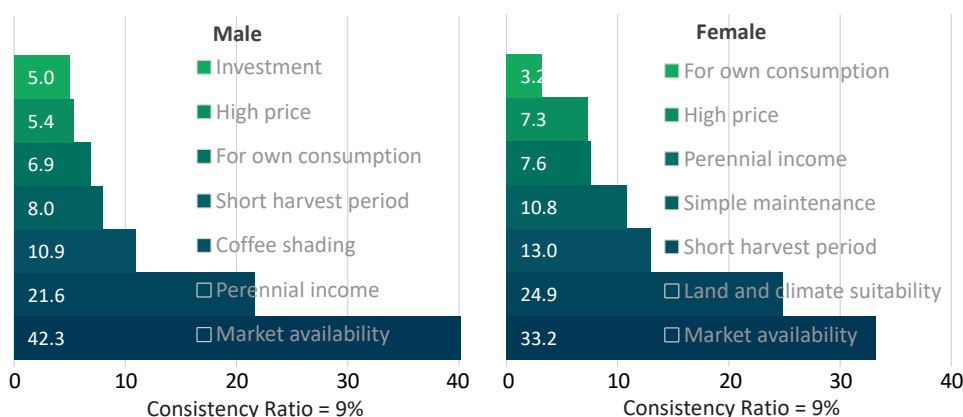

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Figure 20. Smallholders' commodity selection criteria scores in Jokoh

Note: Higher score percentage indicates higher priority

For the female group, 'market availability' was also the most important criterion, representing 33.2% of the total relative importance score. Similar with their male counterparts, Jokoh female smallholders also considered 'land and climate suitability' a major consideration when selecting crops. The other criteria deemed as important were 'short harvest period' and 'simple maintenance', indicating the vegetable crops and less intensive management preferred by

the group. The other criteria with less relative importance scores were 'perennial income', 'stable price', and 'for own consumption'.

Both male and female groups in Genting Jaya selected 'market availability' as the major consideration when selecting crops. This was likely due to the greater remoteness of farms in Genting Jaya, which could limit access to markets compared to Jokoh and other villages in Central Dempo (Figure 21).
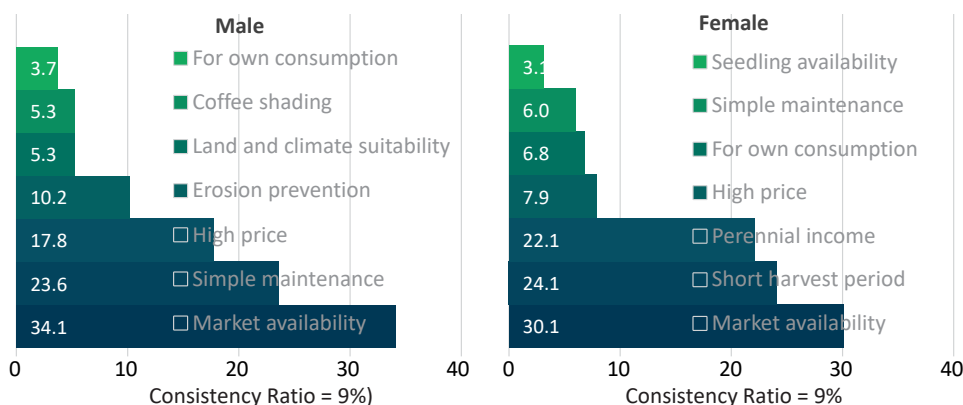

Figure 21. Smallholders' commodity selection criteria scores in Genting Jaya

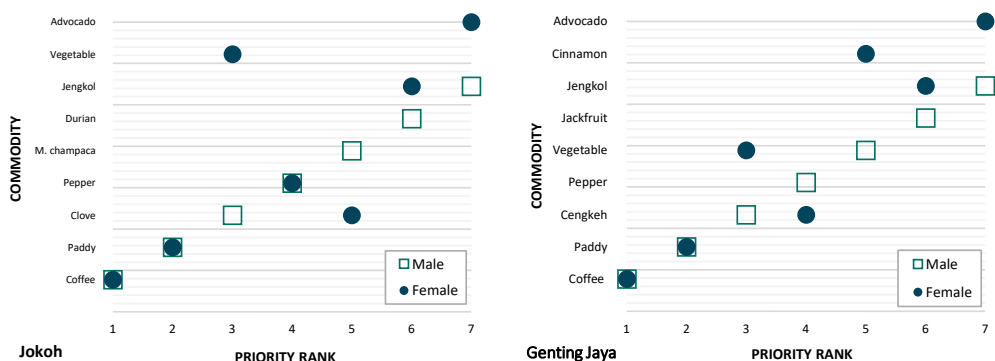Note: Higher score percentage indicates higher priority

Figure 22. Smallholders' commodity priority ranking in Cluster CD2

Rank 1 = Highest priority; Rank 7 = Lowest priority

For the male smallholders, the second-most important criterion was 'simple farming', which was related to practicality. 'High price' and 'erosion prevention' were the other important criteria, representing the smallholders' focus on markets and on slope topography. The male smallholders' other considerations when selecting crops were 'land and climate suitability', 'coffee shading', and 'for own consumption' although these criteria had lesser importance compared to the previous four criteria.

Genting Jaya female smallholders stated 'market availability', 'short harvest period', and 'perennial income' as important considerations when selecting crops. These three criteria constituted 76.3% of the total relative importance from the criteria list. This result indicates that having marketable commodities — such as short-term vegetable crops and coffee that provides perennial income — was very important for female smallholders in Genting Jaya. The female group also mentioned other criteria, namely 'high price', 'for own consumption', 'simple maintenance', and 'seedling availability' albeit with relatively lower importance scores.

Both male and female groups in Jokoh and Genting Jaya preferred coffee and rice as their most prioritised commodities. Coffee had always been the primary crop in CD2 while the new irrigation development in the area was expected to bring opportunities to intensify irrigated-rice farming. All groups in CD2 noted clove in the most prioritised commodity list, with male smallholders in both villages placing clove in third place. Female groups in CD2 considered vegetable crops as the priority commodity because they provided income opportunities from day labour. Only male smallholders in Genting Jaya included vegetable crops in the list of commodity priority (Figure 22).

CHAPTER 8
KEY FINDINGS AND RESEARCH RECOMMENDATIONS

This book compiles the results of land-cover-change analysis and focus-group discussions with female and male smallholder groups in Pagar Alam, an upland area in South Sumatra Province, Indonesia. The focus groups were conducted in four village clusters located in the buffer zone of state forestland and were targeted as participants in the social forestry and irrigation reservoir programmes. The focus groups in the four forest-border clusters indicated that smallholders had limited information on designated land use by the government. Much of the agricultural land was located within the forest administrative boundaries due to various reasons. This situation influenced the national Government to target the four clusters for the Social Forestry programme (*Hutan Kemasyarakatan*).

Farmers considered coffee as their primary crop and an important part of their culture, but they also seized the opportunity of complementing perennial income from coffee with annual income from vegetable farming. Farmers considered that market availability and the complementary aspects of short-term and perennial incomes were the most important considerations in deciding which crops to cultivate.

Farming activities in Pagar Alam involved both genders. The perceived gender roles were adjusted based on mutual understanding: men were highly involved in farming activities that required specific physical strength, such as in the land-opening and spraying stages, while women would be highly involved in other activities, such as weeding, planting, and harvesting. Many farming activities involved men and women simultaneously, both in coffee and vegetable farming. The FGDs also revealed the influence of migrants and infrastructure development in introducing new knowledge and technologies in farming practices, such as new market opportunities and innovations in managing vegetable farming in the upland landscape of Pagar Alam. From the results, a pattern was seen in which migrants moved to the upland clusters when road improvements were completed, helping to improve market access. The presence of migrants in the clusters intensified the vegetable farming that was previously only practised for subsistence needs.

These findings from land-cover-change analysis and focus-group discussions describe the issues and opportunities in this forested upland landscape. Policymakers and development agencies

at both national and local levels could reflect on this information to formulate context-based agricultural and environmental policies for Pagar Alam.

Based on the findings, we provide several key findings and research recommendations.

1 Coffee agroforestry is a multifunctional farming system that has capacity to maintain watershed functions (Verbist, 2008; Pasha and Leimona, 2011; Amaruzaman et al., 2017), and provide continuous and stable income of famers. However, this system is experiencing conversion to other more intensive systems, such as vegetable farming in the upland of Pagar Alam. Researches on these topics must focus on understanding ecological and economic trade-offs – locally and globally – between the two competing systems. Further, it is essential to understand how to maintain and improve coffee agroforestry in the uplands to respond to the expansion of vegetable farming. Thus, these research results can provide inputs to multiple policy instruments, such as land-use planning and zoning, incentives, technical support, and better market access. Research questions include:

i. What are the economic and environmental trade-offs between coffee agroforestry and vegetable farming? What is the profitability of each farming system? What is the impact of the conversion of coffee agroforestry to intensive vegetable farming?

ii. What are the opportunities for a better profitability of coffee agroforestry through improving on-farm management, *such as intercropping with high-value commodities and improved productivity*, and off-farm management, *such as facilitation of market access and other value-added activities*?

iii. What are the social, economic, and environmental values of the landscape for the local communities?

iv. How to sustainably manage the landscape in the agriculture–forest transition area of the forest border?

v. What are the ideal land-use criteria and zonation for vegetable crops in Pagar Alam?

2 Smallholders in Pagar Alam mostly do not have safeguards in facing commodity price fluctuations and no power in directing the commodity markets. Thus, they are vulnerable to changes in the commodity market and price, which typically pushing these farmers to non-strategically change crops and causing financially worse-off conditions. Research questions to provide recommendations for improvement in each agricultural commodity supply chain cover:

i. What are the existing supply chains for coffee, vegetables, and other prominent commodities?

ii. What are the problems and root causes in the supply chains?

iii. What is the situation of smallholders' livelihood capitals and how to use and improve those capitals to address the problems and root causes in the commodities' supply chains?

iv. What should be done by smallholders to solve the problems and address the root causes of problems in the supply chains?

v. What is the external support required by smallholders to enable them to efficiently access markets?

vi. What are the existing planting patterns and the ideal scheduled cropping patterns for vegetable farming in Pagar Alam?

3 Shocks and stressors as the results of natural disasters and climate change are perceived of causing economic and social hardships, and particularly for the farmers, they impact negatively to their farming activities. Research questions surround comprehending further on climate patterns and impacts to the landscape, local community, and smallholders, and more importantly finding solutions on how to mitigate and adapt such climate change crisis.

i. What are the changing climate patterns and their impacts on farming practices in the various upland landscapes of Pagar Alam?

ii. What are the on-farm and off-farm activities required to mitigate or adapt to the negative impacts of the climate crisis?

iii. What is the support required by smallholders to mitigate or adapt to the negative impact of the changing climate on their farms?

4 Vegetable farming is a promising option for farmers to increase their incomes. Positioned in a volcanic agriculture area with a suitable climate, the four clusters are ideal for cultivating cash crops. In addition to that, vegetable markets are widely opened with opportunities from getting contract tradings with large companies. However, annual crops, especially when cultivated in sloppy lands and without environmentally benign practices, can threaten the ecosystem service provided by the upstream watershed. Research questions comprise understanding aspects of climate-smart vegetable farmings and identifying how farmers can sustainably adopt such practices.

a. What are the barriers for farmers to practice conservation and climate-smart vegetable farming?

b. What support needed by farmers to remove the barrier?

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Profile of the production landscape of Pagar Alam: towards sustainable upland agriculture is the first book of two book series that aimed to understand the characteristics of land use and farming practices in four upland clusters located on the forest border of Pagar Alam, West Sumatra Indonesia. This book presents descriptive results of land-cover-change analysis and focus-group discussions with farmers in Pagar Alam, Indonesia.

The other book in this series is: *Production-landscape characteristics and vision through the lens of upland smallholders in Pagar Alam, Indonesia*. The second book contains information derived from a series of household surveys on farm households' characteristics, the farming practices, and the smallholders' perspectives of the upland landscapes that they occupy in three agri-upland sub-districts of Pagar Alam: Central, North, and South Dempo.

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