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Commodity Zoning and Identification of Agricultural Practices Using an Agroecological Approach in Selur Village

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Abstract: Selur Village is an agrarian village where most residents rely on the agricultural sector as their primary source of livelihood. However, this sector faces challenges such as limited irrigation access, suboptimal land management, and the impacts of climate change. Agroecology offers an integrative solution combining ecological, social, and cultural aspects to enhance agricultural sustainability. This study aims to delineate superior commodity zoning through agroecological maps tailored to the biophysical potential of the area and to understand local farming practices based on agroecological principles. The research employs a mixed-method approach, with primary data obtained through interviews with 18 farmers, analyzed using Deductive Qualitative Analysis (DQA) to describe current farming practices, which were then interpreted about agroecological principles. Secondary data, including slope, elevation, air temperature, rainfall, and soil type, were spatially analyzed using QGIS to produce agroecological zone maps. Land suitability assessment was conducted using the matching method, aligning land characteristics with crop growth requirements. The results indicate that the majority of land in Selur village is suitable for perennial crops and forestry. Key commodities such as rice, maize, turmeric, and horticultural crops exhibit high compatibility with land conditions. The findings emphasize the application of agroecological principles, including crop diversification, soil conservation, and resource recycling, but highlight the need for further interventions. The study concludes by recommending strategies such as sustainable intensification, land rehabilitation, and enhanced market access to optimize agricultural productivity and resilience in Selur Village.

Keywords: Agriculture, Agroecology, Agroecological Zones

Introduction

This paper begins by outlining the methods employed to delineate agroecological zones and evaluate land suitability in Selur Village. The study utilizes spatial analysis through QGIS to integrate biophysical data, such as slope gradients, soil types, and climatic factors, with qualitative insights from farmer interviews. This is followed by an explanation of the results, highlighting the identification of seven agroecological zones and their compatibility with priority commodities like rice, maize, and turmeric. The discussion explores aligning current agricultural practices with agroecological principles, including resource recycling, crop diversification, and soil conservation. However, infrastructure limitations, market dependency, and knowledge gaps are also addressed. This paper concludes by proposing actionable strategies to enhance agricultural sustainability, including soil conservation in steep areas, intensification in fertile zones, and improving market connectivity to empower farmers and optimize land use.

The majority of Indonesia's population is in 73,007 villages, representing 87% of the total villages in the country, and they rely on the agricultural sector as their primary source of income (BPS, 2018). This condition underscores the strategic role of agriculture in reducing poverty in rural areas, as poverty is more prevalent in these regions (Sihombing, 2021). Consequently, the agricultural sector serves as the maizeerstone of rural economies and holds significant potential to drive sustainable development while improving the well-being of local communities (Corral et al., 2017). However, agriculture is highly vulnerable to climate change, which affects planting patterns, planting schedules, yields, and crop quality, with potential production declines ranging from 5–20% (Hidayati et al., 2015). Therefore, studying the agricultural sector in rural areas is critical to understanding its potential, challenges, and opportunities for development.

The agroecological approach offers an integrative solution combining ecological, social, and economic principles (Berkes et al., 2000; Pretty, 2003). This approach emphasizes sustainability, biodiversity, utilizing local resources, and indigenous knowledge in agricultural management. Agroecology has been proven effective in enhancing agricultural productivity, preserving environmental quality, and improving farmers' overall well-being (Giller et al., 2021). For planners, understanding agroecological zones serves as a fundamental basis for formulating development strategies tailored to the bio-physical characteristics of specific regions. This approach allows planners to optimize land allocation, identify suitable priority commodities, and promote agricultural practices aligned with local environmental conditions.

Selur Village, located in Ngrayun District, Ponorogo Regency, East Java Province, is an agrarian village in a highland area. The village relies heavily on agriculture as its primary source of livelihood, with 48.53% of its population engaged in the agricultural sector (*Pemerintah Desa Selur*, 2024b). Despite agriculture being the central economic pillar of the village, the Village Development Index (IDM) indicates that Selur's Economic Resilience Index remains low (0.63) compared to its Social Resilience Index (0.84) and Environmental Resilience Index (0.80) (*Pemerintah Desa Selur*, 2024a). This condition highlights the untapped potential of the agricultural sector. Preliminary interviews with local farmers, the Head of Krajan Hamlet, and the Selur Village Secretary revealed several key challenges, including limited irrigation access, suboptimal land management, and the impacts of climate change on productivity.

Given this background, Selur Village requires strategies for developing its agricultural sector. Thus, this study formulates research questions related to delineating agricultural commodity zones in Selur Village based on agroecological zoning, the current agricultural practices, and the extent to which these practices align with agroecological principles. This study aims to significantly contribute to the development of agriculture in Selur Village by integrating agricultural land use that holistically considers social, cultural, and ecological aspects. This approach is expected to enhance agricultural productivity, improve farmers' welfare, and preserve the local wisdom of the community.

Methods

This study adopts a mixed-method approach, combining qualitative and quantitative methodologies. The research utilizes secondary data to delineate agroecological zones and identify potential priority commodities, including slope gradient, elevation, air temperature, rainfall, and soil type. The analysis is conducted using spatial analysis using QGIS software. The analytical process involves several stages: 1.) Classification of slope gradients to determine the primary zones; 2.) Soil and drainage analysis to assess land capability; 3.) Grouping based on elevation to identify climatic variations; 4.) Analysis of moisture regimes using rainfall data.

The results of these analyses are integrated through an overlay process to produce a map of the agroecological zones in Selur Village. Subsequently, land suitability assessments are performed using the matching method, which compares the land characteristics of each agroecological zone with the growth requirements of various crops, as outlined in the Technical Guidelines for Land Evaluation for Agricultural Commodities (Djaenudin et al., 2011). This analysis aims to identify priority commodities that align with the potential of each agro-ecological zone in Selur Village.

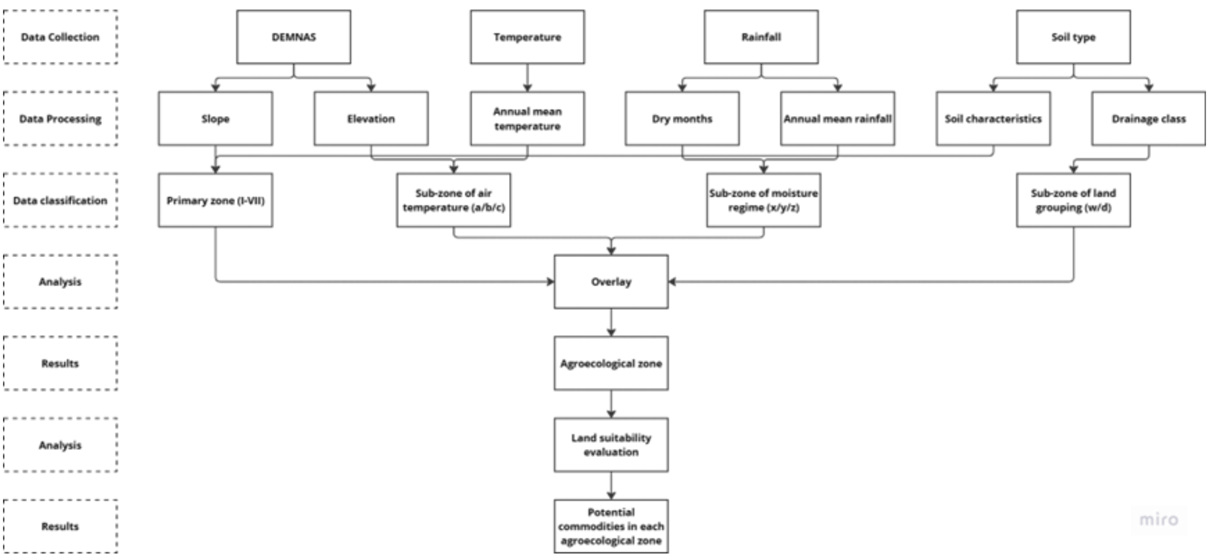

Figure 1. Scheme of the process for analyzing the zoning of potential commodities using the ZAE approach

The research population consists of residents of Selur Village who work as farmers or cultivators, with a sample size of 18 respondents. The sample includes 15 men and three women, aged between 26 and 88 years, reflecting the village's diversity of life experiences and farming practices. Interview data were analyzed using the Deductive Qualitative Analysis (DQA) approach (Fife et al., 2024) to describe the actual conditions of agricultural practices implemented in Selur Village.

The analysis began with data reduction, where transcribed interview data were selected and simplified to focus on relevant information, facilitating the analytical process. The data were then analyzed using deductive coding, where sections of the data were assigned codes based on predefined agricultural practice variables. This was followed by thematic analysis to identify patterns and relationships between agricultural practices and agroecological principles, allowing the researcher to understand how these principles are applied in Selur Village.

The final step involved theorization, connecting the findings with the theory of agroecological principles to produce an in-depth interpretation. These findings were then used to conclude the application of agroecological principles and the challenges faced by farmers in the village.

To ensure the validity of the findings, this study employs triangulation by integrating multiple data sources and methods. Spatial analysis results were validated through farmer interviews, identifying agroecological zones and suitable commodities like maize, *porang*, and rhizomes (e.g., turmeric). Respondents confirmed cultivating these crops, indicating alignment between analytical results and actual practices. Additionally, data from secondary sources, such as soil classifications indicating well-drained and dry land, were corroborated by farmers' statements that the soil in Selur Village is generally dry and rarely experiences waterlogging. Field observations further verified the presence of priority commodities in specific zones, cropping patterns, and land conditions, enhancing the credibility of the spatial and qualitative analyses. This integrative approach ensures that the research findings holistically reflect the actual conditions in Selur Village.

Result and Discussion

A. Result

1. Agroecological Zones in Selur Village

The primary zones were determined based on land resource characteristics: slope gradient and soil type. These zones were further divided into sub-zones by considering several factors. First, sub-zoning was conducted based on drainage class, distinguishing between wet and dry lands. Second, sub-zones were classified according to air temperature regimes, which depend on elevation above sea level. Third, moisture sub-zones were identified based on total annual rainfall and dry months in a year (Pusat Penelitian Tanah dan Agroklimat, 1999; Siagian, 2021; Wati et al., 2016). This classification aims to reflect the variations in land characteristics within Selur Village and provide a more detailed basis for assessing land suitability for priority agricultural commodities.

During 2018–2022, the average annual temperature in Selur Village was recorded at 27.4°C, indicating stable conditions within the tropical climate category. The average minimum temperature was 24.2°C, while the maximum reached 31.8°C, reflecting relatively consistent conditions without extreme fluctuations.

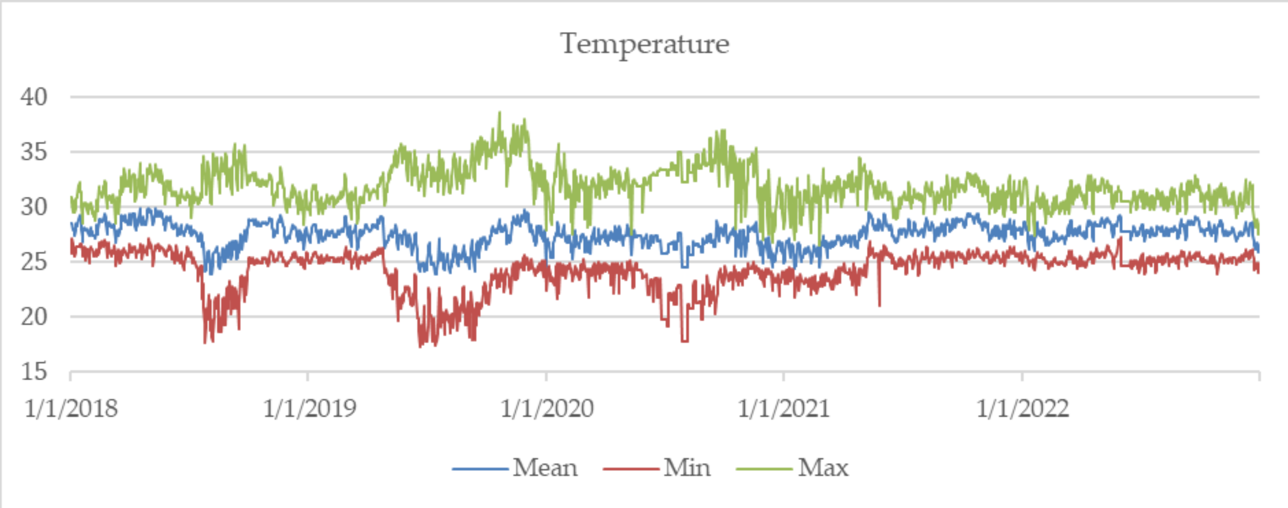

Figure 2. Air Temperature in Selur Village (2018–2022)

The Selur Village area is predominantly situated at an elevation of 700–2000 meters above sea level (m asl), with only a tiny portion lying below 700 m asl. This places Selur Village within the isohyperthermic subzone (<700 m asl) and isothermic subzone (700–2000 m asl) of the temperature regime. The village experiences a seasonal rainfall pattern, with peak rainfall occurring in February (465 mm) and a dry period from May to October. The average annual rainfall is 1,668 mm, ranging from 1,393 to 1,912 mm. The most rainy days are observed in January, while July is the fewest. With a dry season lasting six months (May–October), Selur Village falls under the ustic moisture regime, y subzone.

Figure 3. Soil in Selur Village

Data from the Public Works and Spatial Planning Agency (PUPR) of Ponorogo Regency indicates that the soil in Selur Village consists of Latosol Complex, characterized by acidic pH levels (4–5). This soil type has good drainage capabilities, absorbing water effectively without retaining it excessively. This conclusion is supported by statements from several farmers in the field, who noted that Selur Village rarely experiences waterlogging and is generally dry. This indicates that the area of Selur Village falls within the drainage subzone (d) and is categorized as dry land.

Dryland refers to land that never experiences flooding or only experiences flooding for a small portion of the year. In Indonesia, dry land use for agriculture is typically categorized into home yards, fields/gardens/plots, grasslands, plantations, woody plants, and uncultivated land (Aristin et al., 2023). Dry land is also a significant resource with substantial potential for agricultural development, including food crops, horticulture, plantations, and livestock. For dryland farming systems, it is recommended to develop food crop commodities that can be cultivated through intercropping and monoculture methods (Susanto et al., 2021).

Selur Village has significant topographical variation, with the southern region dominated by steep slopes exceeding 40%. This area's tightly spaced contour lines reflect sharp elevation changes and a high risk of landslides and soil erosion. In contrast, the central part of the village features gentler slopes, ranging from 8–15% to less than 8%, as indicated by light green areas on the map and widely spaced contour lines.

Based on the slope gradient classification for agroecological zones, most of Selur Village (approximately 70.17%, or 1,404.72 hectares) falls within the 16–40% slope category. Areas with slopes greater than 40% cover 181.66 hectares, while 8–15% cover 324.86 hectares. The flattest areas, with slopes less than 8%, account for the most minor portion, measuring 90.58 hectares.

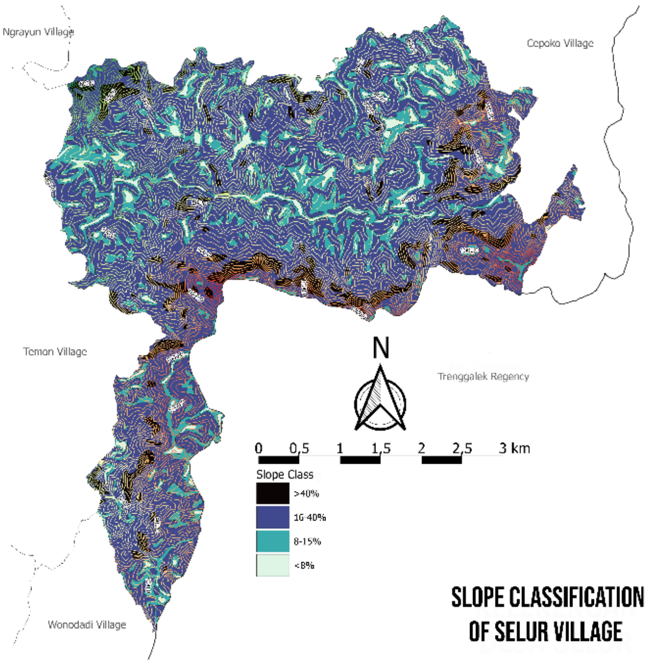

Figure 4. Slope Classification of Selur Village Based on Agroecological Zones

Based on slope gradient classification, Selur Village is divided into four primary zones: Zone I (>40%), Zone II (16–40%), Zone III (8–15%), and Zone VII (<8%). These zones integrate slope gradients with other physical and environmental factors, such as air temperature, moisture regime, and drainage class. This integration aims to create more detailed agroecological zones, comprehensively representing the land's biophysical conditions.

After combining all variables, spatial analysis was conducted using QGIS software to map the agroecological zones in Selur Village. This analysis delineated agroecological zones that reflect land suitability for various priority agricultural commodities in the region. The integration of these factors identified seven agroecological zone combinations in Selur Village, as shown in Table 1. Each zone represents differences in land suitability for various agricultural commodities, considering each area's potential and biophysical conditions.

Table 1. The land distribution in Selur Village is categorized based on a combination of agroecological zones (slope gradient, air temperature, elevation, rainfall, dry months, and soil type)

Primary Zone	Subzone			Area	
	Drainage Class	Air Temperature Regime	Moisture Regime	ha	%
I	d	a	y	9.21	0.46
I	d	b	y	172.20	8.60
II	d	a	y	21.57	1.08
II	d	b	y	1,379.61	68.92
III	d	a	y	1.55	0.08
III	d	b	y	321.03	16.04
VII	d	b	y	87.93	4.39
Water Body				8.73	0.44
Total				**2,001.82**	**100**

The agroecological zone classification in Table 1 identifies four primary slope gradient categories as the main zones (Zone I, II, III, and VII), two air temperature regimes (isohyperthermic (a) and isothermic (b)), one moisture regime (ustic (y)), and one drainage class (dry (d)).

Table 1 reveals that the most extensive and dominant agroecological zone in Selur Village is Agroecological Zone II-dby. This zone features slopes ranging from 16–40%, dry drainage class, isothermic air temperature regime, and ustic moisture regime, covering a total area of 1,379.61 hectares (68.92%) of the entire Selur Village.

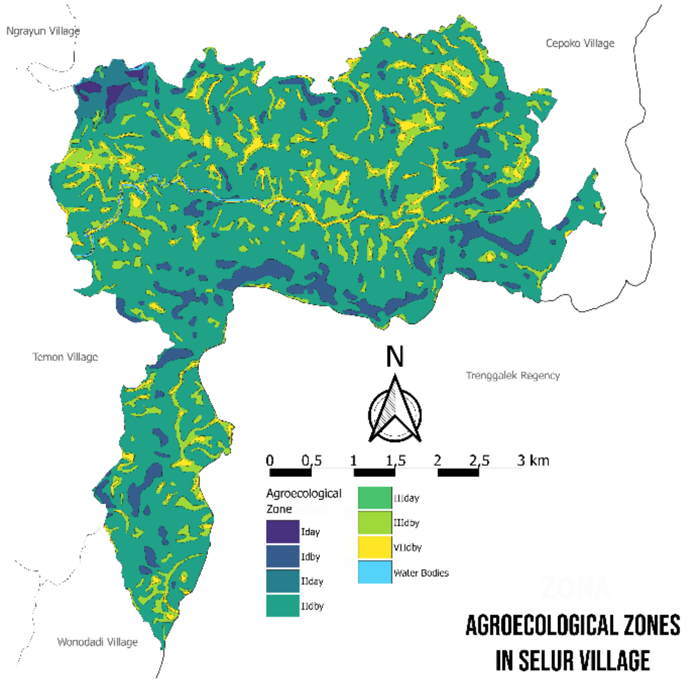

Figure 5. Agroecological Zones in Selur Village

2. Agricultural Commodity Zoning

The zoning of priority agricultural commodities in Selur Village, Ngrayun District, Ponorogo Regency, was conducted through land suitability evaluation and identifying priority commodities in the area. Based on the classification of agricultural land, the area is divided into two main categories: wetland (W) and dryland (D) (Susanto et al., 2021).

Land suitability evaluation in Selur Village identified several priority commodities aligned with the village's physical and environmental conditions. The low soil acidity (pH 4–5) is suitable for crops such as turmeric, aromatic ginger (*kencur*), and cardamom, while other crops may require soil pH adjustment for optimal growth. With a six-month dry season, the area is more appropriate for drought-resistant crops such as secondary crops (*palawija*). In terms of topography, Selur Village's varying slope gradients increase the erosion risk, necessitating appropriate soil conservation measures. The area's good drainage supports the development of horticultural crops that require optimal water management.

The land evaluation in Selur Village reveals diverse agricultural potential based on agroecological zone divisions. According to the analysis of agroecological farming practices, local farmers have already cultivated several crops. Food crops such as rice, maize, and *porang* (*Amorphophallus muelleri*) demonstrate high suitability for the land, with *porang* gaining popularity due to its high market value. Horticultural crops, such as fruit trees, although not the primary focus, are also widely planted, offering opportunities for product diversification to increase farmers' income. Rhizome crops, such as turmeric and galangal, are also widely cultivated, reflecting the suitability of Selur Village's soil conditions. Additionally, forage crops for livestock feed, including elephant grass, legumes, and setaria, are used as intercropping or fencing plants, supporting efficient land use. This aligns with the characteristics of Selur Village farmers, many of whom raise livestock.

Table 2. Guidelines for Agricultural Commodity Zoning in Selur Village

Zone	Farming System	Commodity Guidelines	Area ha	%
I-day	Forestry/Natural Vegetation	Forest trees/natural vegetation	9.21	0.46
I-dby	Forestry/Natural Vegetation	Forest trees/natural vegetation	172.2	8.6
II-day	Perennial Crops/Forestry	Rambutan, durian, langsat, soursop, breadfruit, sugar apple, sapodilla, longan, banana, avocado, jackfruit, snake fruit, mangosteen, pineapple, *petai*, turmeric, aromatic ginger, cardamom, cinnamon, tobacco, kapok, galangal, Napier (elephant) grass, legumes, Setaria, hardwood trees	21.57	1.08
II-dby	Perennial Crops/Forestry	Rambutan, durian, langsat, soursop, breadfruit, sugar apple, sapodilla, longan, banana, avocado, jackfruit, snake fruit, mangosteen, pineapple, *petai*, turmeric, aromatic ginger, cardamom, cinnamon, tobacco, kapok, galangal, Napier (elephant) grass, legumes, Setaria, hardwood trees	1,379.61	68.92
III-day	Seasonal/ Perennial Crops	Rice, maize, *porang*, *rambutan*, durian, langsat, soursop, breadfruit, sugar apple, sapodilla, longan, banana, avocado, jackfruit, snake fruit, mangosteen, pineapple, *petai*, spinach, mustard greens, Napier (elephant) grass, legumes, Setaria, hardwood trees	1.55	0.08
III-dby	Seasonal/ Perennial Crops	Rice, maize, *porang*, rambutan, durian, langsat, soursop, breadfruit, sugar apple, sapodilla, longan, banana, avocado, jackfruit, snake fruit, mangosteen, pineapple, *petai*, spinach, mustard	321.03	16.04

Zone	Farming System	Commodity Guidelines	Area ha	%
		greens, Napier (elephant) grass, legumes, Setaria, hardwood trees		
VII-dby	Seasonal Crops	Rice, maize, *porang*, spinach, mustard greens	87.93	4.39
Water Body			8.73	0.44
Total			**2,001.82**	**100**

Zone I-day and I-dby. These zones share characteristics of steep slopes (>40%) and dryland farming systems. Given these conditions, suitable agricultural systems include forest conservation or cultivating perennial crops, such as forest trees or plantation crops, to reduce erosion risk. These areas are ideal for forestry conservation to maintain ecosystem stability. Recommended farming systems involve forestry or natural vegetation, with commodities tailored to environmental conditions. This practice aligns with the current state of Selur Village, where pine trees are widely planted. Pine trees effectively prevent erosion and sedimentation, especially in sloped areas prone to erosion during the rainy season (Kesuma, 2024). Additionally, the community benefits economically from pine resin, which can be harvested and sold to *Perhutani*.

Zone II-day and II-dby. These zones have slopes of 16–40% and are classified as dryland farming areas. Suitable farming systems for these zones include the development of plantations consisting of perennial crops, permanent crops, woody plants, and agroforestry systems. These systems may include fruit trees, forage crops, and long-lived plants that stabilize soil conditions. Recommended farming systems involve forestry or perennial crops, with commodities such as *rambutan*, durian, langsat, soursop, breadfruit, sugar apple, sapodilla, longan, banana, avocado, jackfruit, snake fruit, mangosteen, pineapple, *petai*, turmeric, aromatic ginger, cardamom, cinnamon, tobacco, kapok, galangal, elephant grass, legumes, setaria, and hardwood trees. These crops can provide additional income for farmers, either as protective plants in fields or as yard crops. This aligns with the social conditions of Selur Village, where farmers grow various crops to increase their income, both for high-market-value products and daily needs.

Zones III-day and III-dby are characterized by 8–15% slopes and classified as dryland farming areas. A suitable farming system for these zones would combine seasonal and perennial crops. This approach includes food crops, plantation crops, secondary crops (*palawija*), and forage crops to enhance land productivity while maintaining ecosystem stability. Recommended commodities include rice, maize, *porang*, and fruits such as rambutan, durian, langsat, soursop, breadfruit, and bananas. Vegetables such as spinach and mustard greens are also suitable. Forage crops like elephant grass, legumes, and setaria, alongside hardwood trees, are recommended to support environmental sustainability and diversify agricultural outputs.

Zone VII-dby features less than 8% slopes and is also classified as a dryland farming area. The recommended farming system for this zone focuses on seasonal crops, including food crops and horticulture. Suitable commodities include rice, maize, *porang*, spinach, and mustard greens, which align with the physical land conditions and offer the potential for high yields in a dryland system. Intensification of agriculture can be applied in this zone, supported by natural irrigation from year-round river flows. However, management practices must prioritize environmental sustainability to prevent soil resource exploitation.

3. Agricultural Practices in Selur Village

Agricultural activities in Selur Village are diverse, encompassing forestry, food crops, horticulture, plantations, and paddy fields. Most of the village's land is utilized for agricultural purposes, with only 4.59% (approximately 91.84 hectares) allocated to built-up areas. The most extensive land use is dominated by fields or dryland farms (*tegalan*) and mixed gardens, covering 844.28 hectares and 895.26 hectares, respectively. There are also paddy fields, although their extent is more minor than dryland farms and mixed gardens.

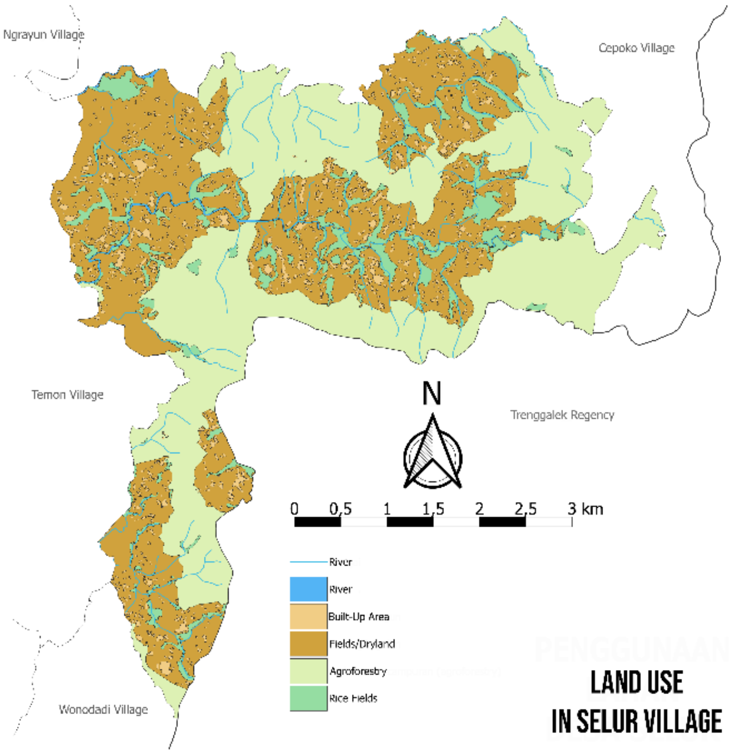

Figure 6. Land Use in Selur Village

Most respondents cultivate food crops, with *porang*, maize, cassava, and rice as the primary commodities. Rhizome crops, such as ginger, turmeric, Java ginger (*temulawak*), and galangal, are also widely grown. Additionally, some respondents grow vegetables like mustard greens, cabbage, and chili peppers. Minority crops, such as dragon fruit, legumes, coffee, vanilla, onions, and cloves, are cultivated by some farmers. Farmers also use their land from seasonal crops to grow fruit trees, pine, albizia (*sengon laut*), mahogany, acacia, and *wali tanah*.

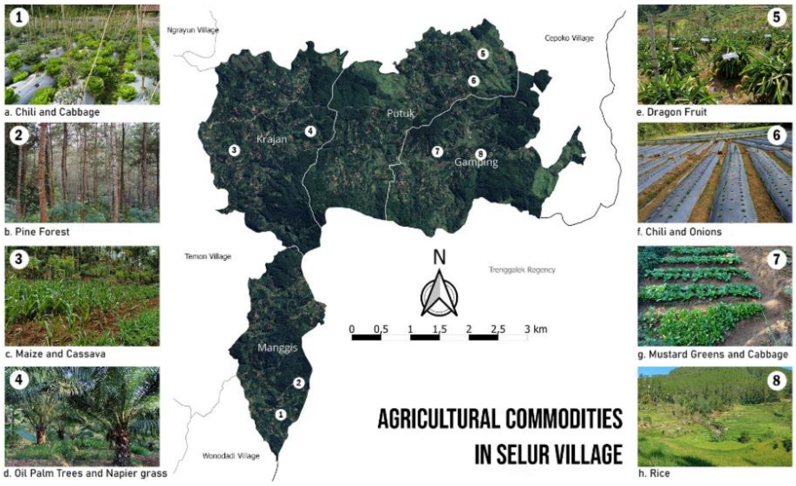

Figure 7. Types of Agricultural Commodities Cultivated by Farmers in Selur Village

Agricultural practices in Selur Village reflect the application of agroecological principles that support ecosystem sustainability. Farmers implement crop diversification, rotation, polyculture, and agroforestry systems while integrating crops with livestock. Using natural materials for fertilizers and pesticides has started to reduce dependence on chemical inputs. Some farmers also conduct independent seed production, tailoring seeds to local environmental conditions and reducing reliance on external suppliers.

From a social perspective, strong solidarity among farmers is evident through knowledge-sharing and innovation. Farmer groups serve as platforms for mutual support in agricultural practices. However, implementing agroecology in Selur Village faces challenges such as limited technical assistance, inadequate knowledge, and fluctuating commodity prices. Dependence on middlemen (*tengkulak*) also influences the choice of crops cultivated.

The evaluation results indicate significant potential for developing commodities aligned with agroecological conditions, including rice, maize, vegetables, fruit trees, plantation crops, and forage crops. Some crops, such as rainfed rice, *porang*, turmeric, and galangal, and forest crops like pine, align well with the land characteristics and contribute to environmental conservation efforts to mitigate landslides and erosion.

4. Alignment with Agroecological Principles

This section discusses the alignment between agricultural practices in Selur Village and the 13 principles of agroecology, encompassing environmental, social, economic, and resource governance dimensions. These principles include recycling, input reduction, soil health, animal health, biodiversity, synergy, economic diversification, co-creation of knowledge, social values and diets, fairness, connectivity, land and natural resource governance, and participation (Sinclair et al., 2019).

In Selur Village, farmers have implemented various sustainable agricultural practices that align with ecological principles, mainly focusing on resource recycling and reducing external inputs. These farmers use organic materials such as animal manure and crop residues to enhance soil fertility, demonstrating their commitment to recycling local resources and decreasing dependence on external inputs. While many still rely on chemical fertilizers and synthetic pesticides, some have adopted organic fertilizers and natural pesticides derived from plants. A few farmers have even ceased using pesticides altogether, showing their effort to reduce external chemical inputs.

Conservation practices are also evident in the community, with farmers employing techniques such as terracing, planting woody trees, and using organic fertilizers to maintain soil health. These practices ensure the long-term sustainability and fertility of the land, enhancing soil biota and supporting better plant growth. Many farmers in the region also raise livestock, including chickens, goats, and cattle. This integration of agriculture and livestock farming contributes to a symbiotic system where animal manure is used as fertilizer, further promoting sustainability and animal welfare.

Diversity in agricultural practices is another hallmark of the region. Farmers grow various crops, including rice, maize, horticultural plants, and other commercial crops. The presence of wild animals around farming areas also contributes to the area's biodiversity. This variety of cultivated crops and species supports agroecosystem resilience and biodiversity while offering opportunities for improved biodiversity management.

Moreover, economic diversification is a key aspect of the agricultural system in Selur Village. Farmers cultivate various crops and engage in livestock farming and small-scale services, creating multiple income streams. This diversification reduces financial risks and enhances the resilience of farming households. Some farmers have also started processing their produce, although this is not widespread. Processing provides additional value to their products and allows them to respond better to market demands, which could enhance financial independence.

Collaborative knowledge creation among farmers is another strength of Selur Village's agricultural system. Farmers share traditional knowledge and innovative techniques through informal networks, facilitating local-level agricultural innovations. Farmers also cultivate various crops for personal and commercial purposes, fostering a sustainable food system that reflects local culture, identity, and traditions.

However, the principle of equity remains a challenge. The limited availability of facilities and the reliance on intermediaries to market agricultural products do not fully support fair livelihoods for all involved. There is potential to strengthen equity by promoting fair trade, eliminating intermediaries, and providing better market access.

Connectivity in Selur Village is another area needing improvement. Farmers face challenges accessing their land and markets, emphasizing the need for enhanced infrastructure, particularly roads, to facilitate efficient agricultural distribution. Government intervention promoting fair and short distribution channels could help address these challenges and improve farmers' welfare.

Land and natural resource governance are well-established, as farmers in Selur Village are entrusted with managing their land. This recognizes smallholder farmers as sustainable land stewards. Finally, participation is another key principle embraced by the farmers, evidenced by their active involvement in social organizations such as farmer groups and farmer cooperatives. Their participation strengthens decentralized decision-making, ensuring local agricultural and food systems are managed according to community needs and traditions.

These practices reflect a growing commitment to sustainability, although further efforts are needed to address equity, connectivity, and market access.

B. Discussion

This study aims to identify potential agricultural zones and analyze the gap between optimal potential and actual conditions in the field. By understanding this gap or alignment between optimal land conditions and existing farming practices, strategies for agricultural sector development can be explored. Based on this analysis, strategic recommendations can be formulated to support spatial planning policies to optimize land management and utilization sustainably while enhancing the resilience of the village's agricultural sector in climate change.

The zoning of agricultural commodities also shows that farmers cultivate crops that broadly align with the physical characteristics of the land and its environment. These include rainfed paddy rice, maize, *porang*, horticultural crops, rhizomes such as turmeric and galangal, and forage crops for livestock feed. Forest crops, particularly pine trees, dominate much of the village area, reflecting their suitability to the land and their role in soil conservation to mitigate erosion and landslides.

The agroecological zones identified in Selur Village offer distinct ecological and economic opportunities that inform sustainable agricultural practices and economic development strategies. Zone I, characterized by steep slopes exceeding 40%, is vital for slope stability. Maintaining this zone as forested land with pine trees ensures ecological benefits like carbon sequestration and biodiversity support while providing economic value through resin extraction. Zone II, with 16-40% slopes, provides an ideal balance between productive agricultural land and ecological conservation. This zone supports agroforestry systems with fruit trees like durian, enhancing biodiversity and soil stability. This zone's economic potential lies in cultivating high-value perennial crops alongside agroforestry. Commodities like *porang*, cinnamon, and cardamom align with market demands and can provide sustainable incomes. Integrating livestock with crop farming adds economic resilience by diversifying income sources.

Zones III and VII further highlight opportunities for sustainable intensification and high-yield farming. Zone III, with moderate slopes of 8-15%, allows diverse cropping systems, integrating seasonal and perennial crops such as rice, maize, and horticultural products. Sustainable practices like intercropping and crop rotation improve soil health and boost productivity. Meanwhile, Zone VII, the flattest and most arable area, benefits from proximity to rivers, enabling irrigated farming for water-intensive crops like rice and vegetables. However, ensuring sustainable practices, such as regulated irrigation and soil management, is essential to avoid nutrient depletion. Investments in market access, cooperative-based marketing, and infrastructure for post-harvest processing could enhance profitability and reduce post-harvest losses across these zones.

Several commodities, such as aromatic ginger (*kencur*), cardamom, cinnamon, and various horticultural crops, hold significant potential for development in Selur Village but remain underutilized by farmers. The development of these commodities is hindered, in part, by the current agricultural practices that heavily rely on intermediaries as the primary intermediaries in the distribution of produce.

Strategic interventions are needed to promote the development of priority commodities such as aromatic ginger, cardamom, cinnamon, and other horticultural crops to reduce farmers' dependence on intermediaries. Steps that could be taken include strengthening farmers' access to broader market information, providing technical and financial support, and establishing farmer cooperatives or groups to facilitate direct commodity marketing. These efforts are expected to enhance agricultural diversification, optimize land use potential, and sustainably increase farmers' incomes.

The agricultural system in Selur Village can further be developed by comparing current land-use patterns with the ideal agroecological model derived from agricultural commodity zoning. This step aims to redesign the agricultural system for more sustainable development. Spatial planning and land-use strategies based on the development of agricultural zoning would involve more profound structural changes in agricultural and natural resource management. This approach can be implemented by developing land use based on land capability and environmental carrying capacity, as outlined by *Pusat Penelitian Tanah dan Agroklimat* (1999) and Simon-Rojo (2023).

In high-potential zones (Zones III and VII), sustainable intensification should be prioritized, focusing on increasing productivity through post-harvest technology and agricultural commodity development while maintaining environmental sustainability. In vulnerable zones (Zone I), land rehabilitation through soil conservation techniques and sustainable natural resource management reflects efforts to improve ecosystems as part of the agricultural system redesign. Meanwhile, extensification in underutilized zones (Zone II) can be achieved by developing infrastructure to support spatial planning changes and agricultural management patterns.

These findings align with the research by Pandangwati et al. (2024), which emphasizes the importance of structural interventions managed by the state as a key element in transitioning to agroecology. While farmers have successfully developed agroecological innovations locally, state support is crucial to ensure the management and implementation of these practices on a broader scale.

Conclusion

Based on the agricultural zoning in Selur Village, there are four types of dryland farming systems:

Forestry/Natural Vegetation System in Zones I-day and I-dby (9.06%; 181.04 Ha), focused on forest trees and natural vegetation commodities.

Perennial Crop/Forestry System in Zones II-day and II-dby (70%; 1401.18 Ha), with commodities such as *rambutan*, durian, *duku*, soursop, breadfruit, sugar apple, sapodilla, longan, banana, avocado, jackfruit, snake fruit, mangosteen, pineapple, *petai*, turmeric, galangal, cardamom, cinnamon, tobacco, kapok, elephant grass, legumes, Setaria, and hardwood trees.

Annual Crop/Perennial Crop System in Zones III-day and III-dby (16.12%; 322.58 Ha), with commodities including rice, maize, iles-iles, rambutan, durian, *duku*, soursop, breadfruit, sugar apple, sapodilla, longan, banana, avocado, jackfruit, snake fruit, mangosteen, pineapple, *petai*, spinach, mustard greens, elephant grass, legumes, Setaria, and hardwood trees.

Annual Crop System in Zone VII-by (4.39%; 87.93 Ha) focused on commodities such as rice, maize, iles-iles, spinach, and mustard greens.

The results of this study indicate that the zoning of priority agricultural commodities in Selur Village can be optimized by delineating agroecological zones that consider slope gradient, air temperature, moisture regime, drainage, and soil type. Based on the zoning of agricultural commodities in Selur Village, there is significant potential for the development of crops such as rice, maize, *porang* (Amorphophallus muelleri), and horticultural plants. Rhizome crops, forage crops for livestock, and fruit trees are compatible with the village's biophysical conditions.

The agricultural practices implemented by farmers in Selur Village have generally adopted several agroecological principles, such as resource recycling, reduction of external inputs, soil conservation, economic diversification, and biodiversity. Farmers utilize local resources, such as organic fertilizers made from animal manure, integrate crop and livestock farming, and manage land using conservation techniques like terracing. Additionally, the diversity of crops grown supports agroecosystem resilience and the potential for economic diversification. However, several aspects have not yet fully aligned with agroecological principles, particularly equity and connectivity. The availability of agricultural facilities remains limited, and the dependency on middlemen (*tengkulak*) hinders the development of fair agricultural practices, especially for farmers. Infrastructure, including roads and access to land and markets, also requires improvement to facilitate more efficient distribution of agricultural products. Enhanced connectivity would enable better access to both markets and resources, which is essential for the equitable development of agriculture in the village.

The agroecological zoning approach developed for Selur Village offers valuable insights for the local government in managing and enhancing the agricultural sector while also considering the social and cultural context of the community. The study suggests three main strategies for agricultural development: sustainable intensification, land rehabilitation, and extensification. Sustainable intensification can be applied to high-potential zones such as zones III and VII, focusing on increasing productivity through technological improvements, better market access, and targeted training. Incentives like seed or fertilizer subsidies could further support high-potential commodities. Land rehabilitation should be applied to zones vulnerable to degradation, like zone I, using techniques such as terracing, drainage systems, and slope-stabilizing vegetation. This would ensure sustainable land management and protect against soil erosion. Extensification, aimed at expanding productive agricultural areas, is recommended for underutilized zones like Zone II. Developing supporting infrastructure, such as farm roads and appropriate mechanization, would help optimize these areas.

Future research should explore deeper spatial analyses of agroecological principles and identify gaps between current agricultural practices and optimal land management. Economic aspects such as commodity pricing, distribution, and market access should also be analyzed to support local agribusinesses. Lastly, aligning policies at various government levels is essential for more holistic and sustainable regional planning, fostering synergy between ecological, socio-cultural, and economic factors.

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