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ECO-INNOVATION IN LANDUSE BY NGABLAK VILLAGE COMMUNITY USING GROUNDED THEORY STUDY IN MOUNT MERAPI NATIONAL PARK, INDONESIA (MMNP)

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Abstract

This research is about the portrait of landuse for salak fruit (salak) cultivation in Mount Merapi National Park (MMNP) conservation area by the local people of Ngablak Village, Srumbung District. Starting from literature studies that are not treated strictly about eco-innovation originating from local community knowledge in managing natural resources in MMNP. Then it was confirmed to the community in a grounded manner through in-depth interviews with 34 participants using snowball sampling techniques to produce original empirical data. The findings showed that the grounded theory coding process produced 17 concepts, nine main categories from 52 cases, and five core categories. This research tries to find out and explain the forms or expressions of eco-innovation carried out by the community in managing land in the Mount Merapi National Park (MMNP) conservation area. The conclusion obtained is that the eco-innovation of the people of Ngablak Village is reflected in their attitudes and approaches to wisely managing land on Verdict Land. The combination of salak-fruit planting provides space for various other types of plants to play their ecological roles, supported by community participation through various activities with Mount Merapi National Park (MMNP) managers. The eco-innovation of the Ngablak Village community forms a strong cohesion between the social welfare of the community and the welfare of the forest, where Calliandra becomes a bridge for providing forage for livestock as well as restoring forest formation on land designated as a Mount Merapi National Park (MMNP) traditional use zone.

Keywords: Eco-inovation, grounded theory, Mount Merapi National Park (MMNP).

INTRODUCTION

Humans and forests have an integral relationship that cannot be separated. Ellis et al., (2023) stated that humans have shaped the terrestrial nature since 12,000 years ago, this is characterized by simple human knowledge about forests, which was ancient human's efforts to survive by looking for resources from the forest to sustain their lives. Putri (2018) stated that this is due to the existence of a wise fundamental local knowledge in preserving forests through expressions filled with strong nuances of locality, both in the form of traditional ceremonies and forest management practices which are the main foundations for the realization of living in harmony with the forest. This is still well preserved today, especially by local communities around forests in Indonesia (Setiawan et al., 2021)

Chao (2012) estimates that more than 300 million people live in forest ecosystems globally. Local communities who live in forest buffer areas have a close dialectical attachment to forest resources. Besides functioning as sources of life sustenance, forests even also have social, cultural and religious functions to form a socio-ecological system of community culture that is integrated with the forest ecosystem (Dutta et al., 2014;

Kelbessa, 2010; Noon, 1981). High homogeneity is a specific characteristic of local communities living around forests, this is usually expressed in the social organization system, adopted religion, culture, local language used including livelihoods (Framujiastri et al., 2020).

Merapi Volcano as a unitary tropical rain forest ecosystem has an essential protective function for biological life, namely a habitat for biodiversity, as a bank of germplasm and also as social as well as religious functions (BTNGM, 2021). Apart from that, the Merapi Volcano area is a water reservoir area in the Central Java Province and Yogyakarta Special Region (Subagyono Kasdi et al., 2013). The long-term and very vital benefit is the ecological role of mountains in maintaining the continuity of human life over a wide range. According to Badan Pusat Statistik (BPS, 2021), there are residential areas around the slopes of Mount Merapi, even up to a height of 1,400 meters above sea level (a distance of ± 4 km from the peak). One of the settlements located in the Kawasan Rawan Bencana (KRB) level III by Badan Nasional Penanggulangan Bencana (BNPB, 2021) as well as in the buffer area of Mount Merapi National Park (MMNP) is Ngablak Village, which is located in Srumbung District, Magelang Regency. A total of 107 people in the community are farmers who work on land within the MMNP area (Wianti, 2020). The main commodities of Ngablak Village farmers are *salak* fruit and vegetables such as tomatoes, lettuce, beans and long beans (Subagyono Kasdi et al., 2013).

The existence of the Ngablak Village community in the Merapi forest area has been subsisting for a long time by managing the land since before the area was designated as a national park. The community occupies an area called "verdict land", which is an area within the Mount Merapi National Park (MMNP) (Traditional Zone - currently included in the Srumbung Resort area) which is adjacent to the residential area of the Ngablak Village community. Wijayati & Rijanta (2020) stated that the history of verdict land began when the community returned to managing agricultural land that had been abandoned after the eruption of Mount Merapi in 1930 and 1968. Currently, the actual area of land cultivated by the community is 37 hectares (Atmojo et al., 2018).

This situation becomes a dilemma, on the one hand the area plays its role in serving the community's living needs by using the existing land as an area for cultivating *salak* plants, on the other hand the Merapi forest area functions as protection for the life support system and biodiversity and there is no land use that can change its ecological function. How to compromise these two interests is the question that this research wants to answer.

Starting from the literature study on Eco-Innovation, this research will start deductively but will not be treated strictly because the eco-innovation parameters will be confirmed in the field as empirical data. Rennings (2000) stated that eco-innovation is environmentally friendly innovation in the practice of utilizing natural resources and leads to mitigation aspects to preserve the environment. Eco-innovation is one element of ecopreneurship or business activities that consider aspects of ecological sustainability. Environmental burdens as an impact of natural resource utilization activities require solutional and innovative behavior (Kainrath, 2010). Eco-innovation in the context of land management on verdict land by the Ngablak Village community is interesting to be researched. This is because the location of the community's agricultural land is within KRB III and Mount Merapi National Park (MMNP), so the principle of land management must be based on conservation and emergency aspects of the potential disastrous eruption of Mount Merapi. This research starts from the big question of how are land use and local community knowledge framed by the concept of eco-innovation? which took place in Ngablak Village. It is aspired that this research will at least make a contribution in the context of communities working on land in conservation areas.

LITERATURE REVIEW

Eco-Innovation in Sustainable Natural Resource Management

Eco-innovation refers to the development and implementation of new practices, processes, or management approaches that reduce environmental impacts while supporting sustainable resource utilization. (Rennings, 2000) initially emphasized the environmental dimension of innovation, particularly its contribution to reducing ecological pressures. More recently, (El Ouardi & Boungab, 2025), through a systematic review of 85 studies, demonstrated that eco-innovation has evolved beyond technological improvements to encompass organizational capabilities, institutional arrangements, and broader sustainability transformations. This perspective indicates that eco-innovation can also emerge from community-based initiatives and locally developed resource management practices. In conservation landscapes, such innovations are particularly relevant because communities must balance livelihood requirements with ecological protection.

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Agroforestry and Biodiversity Conservation

Agroforestry represents an integrated land-use approach that combines agricultural crops with trees and other vegetation within the same management system. This practice contributes to biodiversity conservation, soil protection, carbon storage, and the provision of ecosystem services (McNeely & Schroth, 2006; Udawatta et al., 2019). Recent evidence from (Aaron et al., 2024) indicates that agroforestry can provide multiple ecological and socioeconomic benefits, although its performance depends on management practices, crop selection, and local conditions. Similarly, (Yang et al., 2024) highlight the important relationship between biodiversity and ecosystem services in agroforestry systems, particularly in supporting ecological restoration and environmental resilience. In this context, combining salak cultivation with forestry species and annual crops can be understood as a multifunctional land-use strategy that maintains agricultural productivity while supporting ecological functions in conservation areas.

Local Ecological Knowledge and Sustainable Land Management

Local ecological knowledge plays an important role in shaping community practices for managing natural resources. Such knowledge develops through continuous interactions between communities and their surrounding environments and is commonly reflected in traditional agricultural practices, seasonal observations, and natural resource management strategies. (Setiawan et al., 2021) demonstrate that local wisdom contributes to natural resource conservation among communities living in national park buffer zones in Indonesia. Similarly, (Fidiyani & Kamal, 2012) explain that pranata mangsa represents a Javanese traditional knowledge system used to interpret natural signs and determine seasonal patterns for agricultural activities. These practices illustrate how inherited knowledge can support adaptive land management. In Ngablak Village, the application of pranata mangsa, organic manure, vegetative soil conservation, and botanical pest management reflects the integration of local knowledge into environmentally oriented agricultural practices.

Community Participation in Conservation Management

Community participation is a fundamental component of sustainable conservation management, particularly in protected areas where local livelihoods are closely connected to natural resources. (Ostrom, 2009) emphasizes the importance of institutional arrangements and collective action in maintaining the sustainability of social-ecological systems. Furthermore, (Collins, 1991) and (Ebregt & Greve, 2000) identify buffer zones as important spaces for integrating ecological protection with community welfare and participatory management. (Triguero et al., 2013) also highlight the importance of organizational and institutional factors in encouraging environmentally oriented innovation. Therefore, collaboration between local communities and national park management can strengthen conservation awareness, improve resource management practices, and reduce potential conflicts over land utilization. Such participation is relevant to understanding the conservation activities undertaken by the Ngablak Village community in Mount Merapi National Park.

Livelihood Diversification and Ecological Restoration

Sustainable land management also requires consideration of the economic conditions and livelihood security of communities surrounding protected areas. Dependence on a single natural resource may increase pressure on forest ecosystems, making livelihood diversification an important component of conservation-oriented development. Agroforestry systems can support this process by providing multiple products, including food, fodder, timber, and additional household income. (Aaron et al., 2024) emphasize that agroforestry offers interconnected ecological and socioeconomic benefits, while research by (Yang et al., 2024) demonstrates its potential contribution to biodiversity-related ecosystem services. In this context, the development of Sapera dairy goat farming in Ngablak Village represents an alternative livelihood strategy that complements existing agricultural activities. The utilization of Calliandra calothyrsus as livestock forage also creates an ecological connection between livestock production and vegetation restoration. Thus, integrating livestock activities with diversified planting systems may provide opportunities to strengthen community welfare while supporting the recovery of forest vegetation.

Research Gap and Conceptual Positioning

Previous studies have extensively discussed eco-innovation, agroforestry, local ecological knowledge, and community participation as separate components of sustainable natural resource management. However, the integration of these dimensions into a community-based land-use framework within a national park conservation area requires further investigation. In particular, limited attention has been given to how traditional agricultural

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knowledge, mixed planting systems, vegetative conservation practices, community participation, and alternative livestock-based livelihoods interact to produce locally developed forms of eco-innovation. Therefore, this study addresses this gap by examining the land-use practices of the Ngablak Village community through a grounded theory approach. Rather than imposing predetermined indicators, the study explores how eco-innovation emerges from community experiences and interactions with the Mount Merapi National Park ecosystem.

METHOD

Research site

This research was conducted in Ngablak Village, Srumbung District, Magelang Regency, Central Java, Indonesia (Mount Merapi National Park/ MMNP).



Image 1. Map of research area

Data Collection

Through systematic data collection and analysis, the grounded theory method investigates and builds the theory behind the phenomenon (Bungin, 2023; Strauss and Corbin, 2003). This research was designed to determine the community's expression of eco-innovation in the use of natural resources in Mount Merapi National Park (MMNP). Grounded theory is a good approach to building theory and is considered the most scientific method in qualitative research (Creswell & Creswell, 2017).

Data was collected through live-in observations to portray the activities and interactions of residents of the Ngablak Village community in the Mount Merapi National Park (MMNP) area. The observation results are empirical data obtained through semi-structured, in-depth interviews using open-ended questions asked of the informants. Moreover, all interview results were recorded with a digital recorder with permission from the participants and transcribed verbally. Information on community interactions within the Mount Merapi National Park (MMNP) area was collected from key participants based on their character and experience interacting with or managing land within the Mount Merapi National Park (MMNP) area. Key participants were obtained using the snowball method, which is a sampling method obtained through a rolling process from one informant to another. Usually, this method is used to explain social or communication (*sociometric*) patterns in a particular community (Neuman, 2003; Nurdiani, 2014). The number of informants interviewed was 34.

Analysis

Empirical data obtained through in-depth interviews was then transcribed word for word. Grounded Theory uses detailed data analysis procedures consisting of three coding phases (*coding analysis*), open coding, axial coding, and selective coding, as developed by (Corbin, 2003) . Grounded theory has clear stages for developing information categories (*open coding*), then connecting categories (*axial coding*), and finally finding a series of discontinuous theoretical propositions (*selective coding*). Charmaz Kathy (2016) elaborated that the empirical data are interpreted and translated by researchers and participants. Thus, the findings, both in the form of identification and theory, are built by researchers in the field, not by other researchers' theories. The researcher's findings are uniquely local and original, as well as typical of the research location.

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RESULTS AND DISCUSSION

Open Coding

One part of the analysis, open coding, is the labelling and categorizing stage of long-transcribed data. Open coding can also be done by marking words or phrases that are considered to represent an important concept in the data cluster. The labelling of data transcriptions, original statements, or prime statements is labelled "c", then gives rise to the concept of "cc" which is obtained through label classification and label abstraction. Then, category "C" is obtained through classification and concept abstraction. In total, there are 17 concepts and nine initial categories in 52 original cases or statements. Table 1 shows an example of open coding.

Table 1. Open Coding Example

Primitive statement	Initial Concept	Initial Category
c1. long beans; c6. chili peppers are planted, if they are not planted; c8. chilli sometimes comes out sometimes not; c9. vegetables such as lettuce, cabbage, chili, eggplant and tomato	cc1. cultivation of annual crops/vegetables on verdict land	C1. Type/commodity in verdict land
c2. mostly salak; c11. dominant salak; c20. mostly salak; c21. Salak is easier to care for than chili; c22. it used to be a rice field but now it's all salak; c25. It's all salak, the temperature here is suitable for salak	cc2. *Salak* is the main agricultural commodity in the verdict land	
c3. Calliandra; c4. sengon; c17. wuni and coconut	cc3. forestry plants such as Calliandra, *wuni*, coconut and *sengon* on verdict land	
	…	
c21. Chilies are planted at the beginning of the rainy season; c22. tomatoes are not suitable to be planted in the rainy season; c23. Salak is good in the rainy season, less so in the dry season	cc4. Calculating the planting time for annual plants or *pranata mangsa**	C2. The influence of seasons on snake plant plants and agriculture in verdict land
c39. drought means snake fruit rarely bears fruit; c67. dry season and wind constraints; c42. water shortages in the dry season	cc5. Season is an obstacle to *salak* productivity	
	…	
c33. Weeding/watering and fertilizing; c34. flowering; c36. pruning/pruning; c37. watering/irrigation; c38. make guludan	cc6. watering, fertilizing, flowering, pruning/pruning leaves, watering/irrigation; making *guludan* (soil mound)	C3. Natural maintenance of *salak* plants
	…	
c47. Most dominant manure; c51. Goat manure and goat urine; c53. chicken manure	cc7. Fertilization by using goat and chicken manure	C4. Types of manure used by the community
	…	
c65. There are 2 models of irrigation, natural and artificial. Natural, namely land with a height below the flow of water so that water can flow naturally. artificial, meaning assisted with pipes/paralon for land that has a different height/higher than the flow of water/rivers; c67. manual irrigation with buckets during the dry season	cc8. Watering/irrigation	C5. Soil conservation in verdict lands
c68. Taking sand from the verdict land aims to normalize the land so that the land can be managed	cc9. The purpose of taking sand is for maintaining *salak* gardens	

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Primitive statement	Initial Concept	Initial Category
c57. The purpose of the bunds is to prevent landslides during the rainy season and to hold fertilizer so that it does not get lost in the flow of water. Apart from that, it makes it easier to irrigate; c59. various types of bunds: stone, coconut fiber and earth; c60. guludan/galengan as boundaries between plots; c61. Mitigation against wind for salak plants that are more than 20 years old is made of guludan/galengan of earth, so that when strong winds can support the branches. Apart from that, the mound of soil can also be used to channel nutrients considering that the roots that grow through the stem cannot reach the ground anymore when the plant is old.	cc10. Traditionally making *guludak* to prevent landslides/soil erosion	
	…	
c.77. kenikir planted on the edges of the *bedengan* (beds); c78 kenikir can repel plant pests	cc11. *kenikir* plants to repel plant pests	C6 Natural pest control
	…	
c79. Young people planting trees at water sources; c86. data collection on woody plants on verdict land with the community; c88. planting native species and fruit plants	cc12. tree planting activities	C7. Community participation in conservation at MMNP
c80. fire control in 2018; c82. participatory mapping of areas (judgment lands)	cc13. extinguishing forest fires and mapping verdict lands	
	…	
c90. Formerly a sand miner since 2006, now working full time on a sapera goat farm; c93. being a farmer is more enjoyable and relaxing than mining	cc14. Shifting livelihoods from mining communities to *sapera* goat** breeders	C8. Cultivating *sapera* goats benefits the community
c94. year 1-2 profits may be the same, but after entering year 3 there are more profits; c96. Sapera's positive impact is community welfare; c99. sapera advantages: milk, meat, manure; c100. sapera can give daily, monthly results, while salak is not certain	cc15. impact of *sapera* goats on community welfare	
	…	
c112. the need for Calliandra for goats is increasing because the number of breeders is increasing; c105. Calliandra always grows every 5 months after pruning so it is suitable for food; c118. Calliandra leaves are only taken and not cut	cc16. Calliandra as main diet for *sapera* goats	C9. Switching from diet of grass to Calliandra
c102. Sapera feed is divided into 2, dry and fresh. dry consisting of dried water spinach, green beans, concentrate and nutrients as well as forage namely Calliandra; c109. Calliandra is good for goats because it makes more milk	cc17. importance of Calliandra for *sapera* goats	

*Pranata mangsa is cultural scientific knowledge and guidelines for the Javanese people regarding the periodization of time for one year, which is divided into 12 seasons (*seasons*) based on the circulation of the sun. The prey system requires local wisdom in reading natural signs, such as the position of the sun, wind direction, weather, and the behavior of animals and plants that connect Javanese people with their environment. For Javanese people, natural phenomena reflect the trajectory of time (Handayani et al, 2023).

** Sapera goats are a type of small ruminant that can produce milk. The Sapera type is the result of a cross between *Sanen* goats and *Etawah* crossbreeds (Christi et al., 2021).

There are 17 initial concepts grouped into nine initial categories: types/commodities in verdict land, seasonal calculations (pranata mangsa) for salak planting and agriculture, salak natural maintenance, types of manure (natural) used by the community, soil and water conservation in verdict land, natural pest control, community involvement in management activities at Mount Merapi National Park (MMNP), profitable sapera goat farming, and switching from grass grazing to Calliandra.

Axial Coding

Axial coding is a coding stage that involves connecting codes through inductive and deductive approaches. Relationships between categories are then abstracted from the initial categories into main categories.

Table 2. Main Categories formed by axial coding

Initial Category	Main Category
Cultivation of annual plants/vegetables on verdict land; *salak* as the main agricultural commodity in the verdict land; forestry plants such as Calliandra, *wuni,* coconut, and sengon on the verdict land	Types/commodities of plants on the verdict land
Calculation/planting time for annual plants or *pranata mangsa*; Season is a constraint on *salak* production	Calculation of seasons for *salak* plants and annuals
Watering, fertilizing, flowering, pruning/pruning leaves, watering/irrigation; making bunds;	Natural maintenance of *salak* plants
Fertilizing using goat and chicken manure	Types of (natural) manure used by the community
Watering/irrigation; the purpose of taking sand for soil maintenance in *salak* gardens; making traditional mounds to prevent landslides/soil erosion	Soil conservation in verdict lands
Kenikir plants to repel plant pests	Biotic pest control
Tree planting activities; extinguishing forest fires and participatory land mapping	Community participation in conservation at Mount Merapi National Park (MMNP)
Shifting the livelihoods of mining communities to *sapera* goat breeders; impact of *sapera* goats on community welfare	Farming *sapera* goats benefits the community
Calliandra for forage for *sapera* goats; Calliandra needs for forage for *sapera* goats	Switching from diet of leaf to Calliandra

Table 2 shows that the main categories of crop commodities on verdict land are formed through three initial categories: the cultivation of annual crops and vegetables on verdict land; salak as the main agricultural commodity in the verdict land; and forestry plants such as Calliandra, wuni, coconut, and sengon on the verdict land. The main category of seasonal calculations for salak and annual plants consists of two initial categories, namely calculations/planting times for annual plants, or pranata mangsa; Seasons are a constraint on salak production. The main categories of natural salak plant maintenance consist of two initial categories: watering, fertilizing, flowering, leaf pruning, watering/irrigation; and making bunds. The main category of manure used by the community consists of one initial category, fertilization using goat and chicken manure.

The main category of soil conservation is formed by three initial categories, irrigation; the purpose of taking sand for soil maintenance in salak gardens; and making traditional mounds to prevent landslides and soil erosion. The main category of biotic pest control is formed by one initial category, such as kenikir plants to repel plant pests. Initial categories of community participation in conservation in MMNP are formed by two initial categories, tree planting activities, extinguishing forest fires and participatory land mapping.

The main category of sapera goat cultivation that benefits the community consists of two initial categories, the transition of livelihoods from miner communities to sapera goat breeders: and sapera goat impact on the welfare of society. The main category of switching from a grass diet to Calliandra diet consists of two initial categories: Calliandra needs forage for sapera goats; Calliandra needs forage for sapera goats.

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Selective Coding

By exploring the inherent relationships between major categories, selective coding systematically selects categories to discover core categories. Table 3 describes the relationship between each series using selective coding steps, describing the expression of eco-innovation of the Ngbalak Village community in managing land in MMNP. Table 3 shows the main categories formed by selective coding.

Table 3. Core categories formed by selective coding

Main Category	Core Category
Type/commodity in verdict land	Combination of *salak* planting with forestry plants and annual plants
Calculating seasons (*pranata mangsa*) for *salak* planting and agriculture	Manage verdict lands based on local knowledge
Natural maintenance of *salak* plants	
Types of manure (natural) used by the community	
Soil conservation in verdict lands	
Natural pest control in verdict land	
Community involvement in management activities at Mount Merapi National Park (MMNP)	Community participation in conservation activities at Mount Merapi National Park (MMNP)
Cultivating *sapera* goats benefits the community	Alternative community livelihoods
Switching from grazing to Calliandra	Restoring forests through Calliandra

Table 3 shows that the core category of combination of salak planting with forestry crops and annual crops covers one main category of agricultural types/commodities on verdict land. The core category of Managing Verdict land based on local knowledge includes five main categories, namely pranata mangsa (*calculating season*) for planting salak and agriculture, natural maintenance of salak plants, types of (natural) manure used by the community, soil conservation on verdict land, and pest control on a regular basis, natural in the land of verdict. The core category of community participation in conservation activities in MMNP comes from the main category of community involvement in management activities in MMNP. The core category of Community livelihood alternatives comes from the main category. Farming sapera goats benefits the community and the core category of restoring forests through Calliandra includes the main category of switching from grazing to Calliandra.

Combination of planting salak with forestry plants and annual plants

Agroforestry is a planting pattern that combines annual crops with other commodity crops which are planted together or alternately (Bardhan et al., 2012; Rendón-Sandoval et al., 2020; Shin et al., 2020). The land within the MMNP area covers an area of 37 hectares which has been referred to as verdict land by the local community, since the year 1912 it has been managed by the community with the main commodity being *salak* plants and combined with several types of annual and seasonal plants, this pattern is usually known as mixed gardens.

The *salak* plant is a hereditary plant that is passed down to children and grandchildren. The type of snake fruit that is cultivated is the pondoh type, this type has the requirement to grow at an altitude of 300-700 m above sea level with flat to hilly topography. *Salak* grows well at temperatures of 20-30^{o}C, so it is very suitable to be developed in areas around MMNP. Apart from *salak*, people also grow various types of vegetables such as tomatoes, eggplant, lettuce, cabbage and chilies. In between the snake fruit plants, the community also planted forest plants, namely *Wuni* (*Antidesma bunius*), Coconut *(Cocos nucifera*), *Sengon* (*Paracerienthes falcataria*), *Kaliandra* (*Calliandra calothyrsus*), and candlenut (*Aleurites moluccana*). Calliandra is a type that is currently popular with the public because it functions as excellent forage for goats.

Mixed planting are usually more intensively managed because the plants are usually used for fruit and wood (Nerlich et al., 2012). In terms of ecological value, this planting pattern is able to reduce the rate of surface runoff due to plant density (McNeely & Schroth, 2006; Singh et al., 2021; Udawatta et al., 2019). From an economic perspective, it can increase added value for society (Kamaluddin et al., 2020; Sudaryanto & Variasa, 2018).

Manage verdict land based on local knowledge

Calculations of seasons (pranata mangsa) for salak planting and agriculture

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In Ngablak Village, people also develop local knowledge that supports the implementation of vegetative conservation on verdict land, namely *pranata mangsa*. Fidiyani & Kamal (2012) stated that the *pranata mangsa* is the local wisdom of the Javanese people in reading natural signs to determine the seasons that will be used as benchmarks in the fields of agriculture and fisheries. The *pranata mangsa* is used to mark the *salak* harvest period, namely *Mangsa kanem - kapitu*, a term in *pranata mangsa* system, namely November-January as the main harvest period. *Mangsa Kanem,* meaning sixth season, is characterized by the rainy season, accompanied by winds blowing from West to East with frightening rumble. *Mangsa Kanem* has the characteristic "*Nikmating rasa mulyo"* (*blossoming heart of abundance*) meaning the fruit trees are starting to ripen and the farmer is happy with that situation.

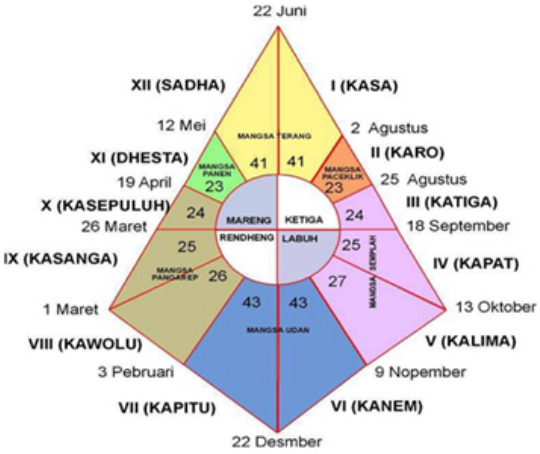


Image 2. Pranata Mangsa Calendar

Use of Manure

Most of the people or farmers of Ngablak Village use manure as additional nutritional intake for *salak* and annual plants. Almost every farmer has livestock so their manure can be brought to the garden as organic fertilizer. Another factor to consider is the relatively expensive price of chemical fertilizers. Approaching the main harvest (November - February) the intensity of fertilizer application increased to get optimal results when harvest arrives. Accroding to Adijaya and Yasa (2015) stated that the response of *salak* plants fertilized with manure was clearly visible, a significant increase in yield. Manure is a source of macro nutrients such as N, P, K and other micro-nutrients that have positive influences on plants even though its release is slow (Nurrohman et al., 2015).

1. Vegetative Soil Conservation

Basically, vegetative soil conservation is any form of use of plants or plant remains to reduce erosion. Plants or plant remains function to protect the soil from the impact force of rainwater and the carrying capacity due to surface flow (run-off) and increase water infiltration into the soil (Machado et al., 2022; Sriwongsitanon & Taesombat, 2011).

The vegetative soil conservation technique used by Merapi farmers in Ngablak Village is *guludan* (mounds). Bunches are piles of soil that are made to extend along contour lines or cut across slopes (Arsyad, 2010). There are 3 types of bunds that are practiced locally, namely earth mounds, stone mounds, and coconut fiber bunds. Apart from that, there is a mound of soil around the *salak* plant which functions to maintain the distribution of nutrients. If farmers build a mound, the roots could still absorb water and nutrients from the soil. This technique is usually carried out when the *salak* plant reaches 10 years of age, which causes productivity to begin to decline. This is because the older the *salak* is, the taller the stem is (the local term is "*glugu*"), thus triggering the growth of roots at the top of the stem. Society says:

> *Jawa: "Kui ben nek keno angin ora ambruk mbak ben ora gampang ambruk, nek ono impunane kan oyot tunggang iki iso ketutup dadi ora gampang ngungkang. Ki yo galengan mbarang gawe ngampangke nek misale mh ngelep ben ora gampang ilang nek nekani banyu. Nek ra ono galengane kan banyune blabas ilang".*
> *Translation: This is done so that when there is strong wind, the salak stems do not fall over easily. If there is an "impunane" mound, the roots can be covered and will not easily collapse if there is wind. Guludans are also made to make it easier to irrigate salak gardens.*
> **Impunane: a form of soil mound around salak plant to cover its stem as a foundation.*

2. Natural Pesticides

Currently, chemical pesticides are still used to control plant pests, but the use of chemical pesticides makes pests resistant. Therefore, integrated pest control is carried out by the community using natural pesticides (Utami & Damanhuri, 2020). Natural pesticides are used for controling pests and diseases in cultivated plants. The people of Ngablak Village used the Kenikir plant (*Cosmos caudatus*) as a natural pesticide in areas of annual crops and *salak* cultivation. In accordance with the results of Rahayu et al., (2012), pointed that botany pesticide treatment derived from kenikir leaves can control leaf roller caterpillar pests (*L. indica*) because *kenikir* plants contain chemical flavonoids, alkaloids and essential oils so they are effective in repelling insects (Budiyanto, 2018).



Image 3. Photo of Kenikir as a natural Plant Pesticide

C. caudatus leaves have active secondary metabolites such as flavonoids, non-flavonoids, and essential oils. This active compound can be used as an insecticide or pesticide compound (Ramadan, 2020). *C. caudatus* have equally strong biological activity against natural enemies such as insects or pests (Mawli & Putri, 2023). The community stated that *kenikir* planting was chosen because it is safe for the environment. This is in accordance with what was stated by Astuti, et al (2013) that the use of pesticides can have a negative impact on the environment such as killing organisms that are beneficial to the soil and plants, resistance and emergence of pests, poisoning of workers in the field and pollution of soil, water, air and the products produced. Apart from that, it also results in lost opportunities for farmers to capture opportunities for higher economic rewards.

Community Participation in Conservation Activities at MMNP

Communities living around conservation areas are a challenge for operator (Ostrom, 2009). The Ngablak Village community lives in the MMNP buffer area, utilizing Merapi forest resources to meet their daily needs, with forms of utilization including: land for planting grass, looking for animal feed from leaves, looking for firewood, clean water for daily living needs and sand mining. Utiliza tion of forest resources as a form of interaction between local communities and forests in the MMNP area (BTNGM, 2021).

Buffer zones can provide ecological, social, economic and institutional benefits. The ecological benefits of buffer zones include protecting the area from illegal activities, invasion of flora and fauna, and acting as an extension of the habitat for animals living in conservation areas. Meanwhile, the social benefit of the buffer zone is a flexible conflict resolution mechanism space. Buffer zones also provide economic benefits, including providing opportunities for local communities to utilize forest resources and ecosystem services both directly and indirectly (Collins et al., 1991). In the institutional aspect, buffer areas can be a forum and medium for introducing participatory planning methods, as well as increasing awareness of the importance of natural areas for direct and indirect use (Ebregt and Greve, 2000).

The harmonization of the Ngablak Village community with the Merapi forest is manifested in various forms of community involvement in preserving the area. In 2018, MMNP management carried out mapping activities of land boundaries in the verdict land or traditional use zone which was attended by a number of community leaders and produced a Tenurial Conflict Identification Result Map inside the MMNP region, showing the separate areas, each of which is arable land controlled by the community. Ideally, community involvement should be designed according to community needs, abilities, desires, and behavior. Therefore, the understanding and attitudes of local

communities towards protected forest conservation and sustainable natural resource management are very important (Triguero et al., 2013). Aside from that, a farmer group of 50 people was formed to coordinate various community activities in collaboration with MMNP management. MMNP also empowers women farmers through the Salak Culinary Gate (GKS) organisation by providing training in the production of candied salak.

Alternative Community Livelihoods

Most of the people of Ngablak Village are salak farmers on Mount Merapi. Farming is a hereditary livelihood inherited from ancestors. Salak farmers in Ngablak Village are farmers cultivating land in the MMNP area. Apart from salak farmers, some people work as sand miners in the rivers around Merapi, so the community's dependence on natural resources is high (Faida et al., 2021).

Since 2020, people have begun to learn about sapera dairy goats, which have the potential to be farmed on the slopes of Merapi. Dairy goats are a livestock commodity that is currently starting to be developed in Magelang Regency, Central Java Province (Ariyanto et al., 2021). This is supported by the physical condition of the slopes of Merapi, which is comfortable for dairy goat farming, especially the altitude factor. According to Ariyanto et al (2021), altitude affects the micro-temperature and humidity of the cage. In raising goats, the role of temperature and humidity is a very important indicator because they will affect the physiological condition of the livestock. The higher the location of the farm, the better the growth experienced by livestock (Batubara et al., 2016). Altitude will affect the availability of feeds such as legumes, which are the main feed for dairy goats. Calliandra grows a lot in the MMNP area, so people can use its leaves as forage for livestock.



Image 4. Female Sapera Goat



Image 5. Male Sapera



Image 6. Sapera Community Goat Farm

Most of the dairy goat breeders in Ngablak Village are the verdict generation of salak farmers with an age range of 20–45 years. According to the community, the interest in *sapera* dairy goats lies in their ability to produce optimal milk, relatively easy maintenance, and income that exceeds that of mining sand and *salak*. “luwih ayem ternak kambing mbak” (*Language: It is more peaceful to raise goats*). Sapera dairy goats provide an alternative livelihood option for the community, besides salak and sand miners.

Restoring forests through Calliandra

Sapera dairy goat feed comes from legumes. Leguminosae is a forage that can improve the quality of nutrition and protein for livestock (Abqoriyah et al., 2015). Calliandra is a legume plant with high protein content and productivity that can grow in the dry season (Nurjannah et al., 2022). It is estimated that Calliandra production planted in wet or dry tropical environments reaches 0.80-5.60 tonnes ha, o or the equivalent of 4.80-33.60 tonnes/hectare/year (Matimati et al., 2009). The need for green fodder in Ngablak District is increasing along with the number of sapera goat breeders. In the community, Calliandra (*Caliandra callothyrsus*) is planted on the edges of salak plants or as a hedge plant. Calliandra is a type of legume that grows quickly, is resistant to pruning, and can grow back quickly after pruning. Therefore, Calliandra is very popular with the people of Ngablak Village because this type is a potential type of forage for *sapera* goats.

Calliandra is a mixture of *salak* plants alongside other types such as *wuni*, coconut, jackfruit, and *sengon*, which are planted on the verdict land. It is hoped that the *salak* plantation will become a forest garden with high

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diversity so that this buffer area can carry out its ecological functions. Calliandra can be a bridging towards returning *salak* plantations to a more complex form of forest formation, the types of which make up the ecosystem.

CONCLUSION

The eco-innovation of the Ngablak Village community is reflected in their attitudes and ways of wisely managing land on the verdict land. The combination of salak planting provides space for various types of plants to play their ecological role, supported by community participation through various activities with Mount Merapi National Park (MMNP) managers. The eco-innovation of the Ngablak Village community forms a strong cohesion between the social welfare of the community and the welfare of the forest, where Calliandra becomes a bridge for providing forage for livestock as well as restoring forest formation on land sentenced to the MMNP traditional use zone.

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