TRADITIONAL ECOLOGICAL KNOWLEDGE AND VERTICAL FARMING PRACTICES IN SUSTAINABLE HIGHLAND AGRICULTURE: A CASE STUDY OF THE TENGGER COMMUNITY IN TOSARI VILLAGE, EAST JAVA

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Abstract Agriculture is an attempt to establish an artificial ecosystem in charge of providing food for humans. The location of this research was conducted in Tosari Village, Tosari District, Pasuruan Regency. Tosari District is one of the areas located on the slopes of Mount Bromo. This research was conducted for 2 days, starting from October 29 to October 30, 2022. The data used in this study were primary and secondary data. The Tengger indigenous people who live in Tosari Village almost 90% depend on agricultural land for their lives. The geographical condition of the Tengger Tribe which is located in a mountainous area forces them to still be able to utilize the land into agricultural land using a profitable vertical cropping pattern (Larian). Potato is one of the main commodities produced by the local community. In addition, leeks, cabbage, carrots, corn and wheat are also plants that are often planted by the community.

Keywords: Land Use Vertical (larian) Pattern, Tengger Tribe, Tosari Village, Agriculture

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1. INTRODUCTION

Indonesia is an archipelagic country located along the Ring of Fire, which results in a diverse topography or variety of landforms. The territory of Indonesia consists of marine areas, valleys, lowlands, highlands, and steep mountainous regions. These conditions provide blessings for Indonesia in the form of rich biodiversity of flora and fauna, as well as abundant natural resources.

Agriculture is an activity carried out to create an artificial ecosystem that can later be used to provide food for humans. Agriculture, in a narrow definition, can be interpreted as the activity of "cultivating crops." Meanwhile, in a broader sense, agriculture can be defined as other activities such as crop farming, plantations, fisheries, livestock, and forestry. The characteristics of agricultural activities are as follows:

1. During the production process, it must be able to form organic materials with the assistance of inorganic and organic substances.
2. There must be human efforts to renew all production processes that are "reproductive" and "cultivative" in nature [1].

Tosari District is one of the districts located on the slopes of Mount Bromo and is part of Pasuruan Regency. To this day, Tosari Village still strongly upholds the customs and

culture of the Tengger Tribe, even though the majority of its population is now Muslim. Tosari District consists of eight villages, namely Wonokitri Village, Ngadiwono, Tosari, Baledono, Kandangan, Mororejo, Sedaeng, and Podokoyo, with communities adhering to Mahayana Hinduism as well as various other religions such as Islam and Christianity [2]. Tosari Village is located in a highland area at an altitude of 1,800 meters above sea level, with a longitude coordinate of 112.891949 and a latitude coordinate of -7.893205, covering an area of 550.93 hectares, with the following boundaries:

1. Northern boundary: Baledono Village, Tosari District
2. Eastern boundary: Wonokitri Village, Tosari District
3. Southern boundary: Podokoyo Village, Tosari District
4. Western boundary: Ngadiwono Village, Tosari District

Nearly 90% of the Tengger indigenous community in Tosari Village depend on agricultural land for their livelihood. The geographical condition of the Tengger Tribe, which is mountainous, forces them to utilize the available land so that it can become profitable agricultural land. During the land cultivation process, there are unique practices that differ from commonly used techniques, making it one of the distinctive characteristics of local agricultural patterns. The Tengger indigenous people believe that cultivating land using vertical (larian) farming techniques on mountainous agricultural land will result in more optimal yields. Vertical (larian) farming is an agricultural technique carried out by creating straight vertical plots from top to bottom following the mountainous topography of the land. By applying this different and unique land formation, the land to be planted can become more extensive because it is not significantly divided by boundary partitions [3].

Such agricultural techniques are inseparable from the social and cultural influences of the Tengger indigenous community itself. With the majority of the population working as farmers and living in mountainous geographical conditions, the community is compelled to cultivate the land despite existing limitations. The lack of community knowledge regarding proper utilization of mountainous land is one of the factors contributing to the use of vertical (larian) farming techniques. The habits inherited from ancestors and passed down from generation to generation are considered correct and have therefore become a culture that is difficult to change by modern developments and scientific knowledge in a short period of time.

2. MATERIAL AND METHOD

The research location was in the Tosari area, more specifically in Kecamatan Tosari, Kabupaten Pasuruan. The location was selected purposively with clear considerations, namely Desa Tosari, which is an area inhabited by the Tengger Tribe and is located on the slopes of Mount Bromo. This research was conducted for 2 days, from October 29 to October 30, 2022 [4].

The data sources obtained in this research consisted of primary and secondary data. Primary data were collected through direct interviews based on questions arranged in the form of questionnaires distributed to local residents whose occupation is farming, as well as from several sources of information obtained from the local community. In addition, direct observations were conducted in the research area. Secondary data were obtained from relevant literature, previous studies, and one related institution involved in this research, namely the Kantor Kecamatan Tosari, Kabupaten Pasuruan, as well as through the website of BPS Kabupaten Pasuruan. The samples obtained in this research were farmers at the time the study was conducted. The sampling technique used in this research was the multi-stage cluster sampling technique, which is a sampling process carried out in two or more stages.

3. RESULTS AND DISCUSSION

The Tengger tribal community in Desa Tosari is one of the community groups that has distinctive characteristics, namely consistently upholding their customs and traditions that have been preserved for hundreds of years by their ancestors, reflecting a strong image of traditional life. These customs are believed in and practiced within social bonds that promote a prosperous, simple, honest, and safe way of life. Although they adhere to different religions, their lives are characterized by strong unity. In their daily lives, most of the community members work as farmers on steep hilly fields, with their main agricultural products being leeks, cabbage, and potatoes. Due to the generally steep land conditions, most of the people in Desa Tosari utilize the available land by applying a vertical (larian) planting pattern in their daily agricultural activities [2].

3.1 Application of the Vertical (Larian) Planting Pattern by the Tengger Indigenous Community in Desa Tosari

The Tengger Mountains are an agrarian region; therefore, it is not surprising that the Tengger community spends more time engaging in farming activities or working as vegetable farmers rather than staying indoors. Due to land conditions that are mostly in the form of steep slopes, the local community is encouraged to utilize land using a vertical (larian) pattern. Vertical (larian) farming is an agricultural system that produces food crops in vertically stacked layers (upward) [5]. However, this system often creates problems in the farming process of the Tengger community, as farmers prefer to use the vertical (larian) farming pattern, which differs from agricultural systems in other mountainous areas of Java Island that generally use horizontal terracing systems (sengkedan) [5,6].

The negative impacts of this agricultural system can lead to soil erosion, landslides, and even cause unwanted accidents during work. The reasons why the Tengger indigenous community uses the larian farming technique include reducing their workload on steep land conditions, protecting seedlings from being stepped on during planting, and the belief that this technique can accelerate water absorption into the soil [5].

By using this pattern, Tengger vegetable farmers do not suffer significant losses due to reduced agricultural land. Although the vertical (larian) farming pattern contradicts conservation principles according to bureaucratic officials from the Dinas Kehutanan Balai Besar Taman Nasional Bromo Tengger Semeru (BBTN-BTS) and academic opinions, its application causes environmental damage due to continuous soil erosion and land degradation, resulting in decreased land productivity [6].

3.2 Application of the Terracing System in Desa Sukasari Kaler, Majalengka, Which Has Similar Geographical Conditions to the Tengger Region

Desa Sukasari Kaler is one of the villages that applies a terraced farming system and is located in Kabupaten Majalengka, more precisely in the southeastern part bordering directly with Kabupaten Kuningan. This area lies at the foothills of Gunung Ciremai and consists of several hilly areas. Due to these topographical conditions, especially in Kecamatan Argapura, the area has developed into agricultural and plantation land. Most of the area in Kecamatan Argapura consists of steep hilly terrain with slope gradients ranging from 15% to 50% (Profil Kec. Argapura, 2015). With such slope conditions, several plots of land in the village can be arranged into terraces, thereby creating terraced agricultural land [7].

These terraced agricultural lands are utilized by the community for horticultural crops such as leeks, shallots, tomatoes, cabbage, potatoes, red chili, mustard greens, and carrots. The terraced land is located on part of Bukit Panyaweuyan in Desa Sukasari Kaler and is therefore better known as the Panyaweuyan Argapura terraces. These geographical conditions are considered to be almost the same as those of the Tengger community in Desa Tosari, Kecamatan Tosari, Kabupaten Pasuruan [8,9].

3.3 Agricultural Commodities

Based on data from the Village Monograph, the economic potential of Desa Tosari is largely derived from agriculture, livestock, and tourism services. Agriculture is one of the dominant economic sectors in the research area, with its main commodity being potatoes [4].

Desa Tosari also produces leeks as the second-largest commodity after potatoes. The production of leeks in Desa Tosari also experiences fluctuations similar to potatoes [9]. Leek production increases significantly in August and declines in March. In addition to the two main commodities, potatoes and leeks, cabbage and carrots are also leading commodities in Desa Tosari. However, the production of cabbage and carrots also fluctuates significantly each month and these crops are considered secondary or non-priority crops for farmers [5].

The seasonal fluctuation of horticultural commodities reflects a strong dependence on climatic conditions, particularly rainfall patterns and temperature variations typical of mountainous regions. Vertical farming systems, which allow for controlled microclimates, could reduce production volatility by enabling year-round cultivation of leafy vegetables such as leeks, cabbage, and carrots [5,6]. This approach may reposition secondary commodities into more stable income sources, especially when integrated with simple, low-energy vertical structures adapted to highland conditions [5].

There are also corn and wheat commodities. These commodities are planted every month by farmers. Corn production is not sold to the market but is consumed by the farmers themselves and the community of Desa Tosari, as corn is a staple food for the Tengger community in Desa Tosari. The continuous cultivation of corn as a subsistence crop highlights the importance of food security and cultural values in the Tengger community. Vertical farming initiatives in this context should therefore not be oriented solely toward commercialization, but also toward supporting household-level food availability. Small-scale vertical farming units could complement traditional fields by supplying vegetables for daily consumption, reducing pressure on land while respecting local food traditions [5,6,10].

During the dry season, farmers switch from planting potatoes to wheat, as wheat does not require much water and is therefore suitable for cultivation during the dry season. Wheat seeds are obtained by farmers from the local Dinas Pertanian. Wheat is planted when farmers' land does not have adequate irrigation [7,9]. Conversely, if farmers' land has good irrigation or water sources, they will continue planting potatoes [9,10]. This adaptive cropping strategy demonstrates farmers' responsiveness to water availability, yet it also underscores the vulnerability of conventional agriculture to seasonal water scarcity [10]. Vertical farming systems, particularly those using recirculating water or hydroponic methods, have the potential to significantly reduce water consumption. In the Tengger highlands, such systems could function as a buffer during dry seasons, enabling farmers to maintain productivity even when irrigation is limited

Corn production is not sold by farmers because corn crops are only consumed by the farmers and the community of Desa Tosari. Historically, the residents of Desa Tosari have consumed corn as their main staple food. The corn seeds used are of relatively good quality. The type of corn planted by farmers in Desa Tosari is white corn, which has a sweet taste. Farmers in Desa Tosari have cultivated corn for generations, passed down through families or relatives with experience. The main issue with corn as a commodity is that it is planted only to meet the needs of family members or relatives and cannot be used as an additional source of farmers' income [2,6].

The generational continuity of corn cultivation reflects strong local knowledge and cultural attachment to traditional crops [4,6,7]. While vertical farming may not replace staple corn cultivation due to crop characteristics and cultural considerations, it can serve as a complementary system that diversifies farmers' income through high-value vegetables and herbs. By integrating vertical farming with existing agricultural practices, Desa Tosari could enhance economic resilience while preserving the cultural identity of the Tengger community

3.4 SWOT Analysis

3.4.1 STRENGTH

The advantages that can be obtained by farmers when utilizing agricultural land with the vertical planting pattern (larian) include reducing their workload on land with steep slopes, protecting planted seedlings from being stepped on during planting, and the belief that this technique can accelerate water absorption into the soil.

3.4.2 WEAKNESS

The use of agricultural land with the vertical planting pattern (larian) also has various weaknesses and disadvantages, such as accelerating soil erosion, causing landslides, and increasing the risk of accidents due to the generally steep land slope.

3.4.3 OPPORTUNITIES

The opportunity of utilizing agricultural land with the vertical planting pattern (larian) is that it can also be developed as an agricultural educational tourism site because it differs from conventional agricultural land. In addition, the use of sloping land is relatively rare in several regions in Indonesia, so areas with highland agriculture can utilize their agricultural activities as family-oriented educational tourism destinations.

3.4.4 THREATS

The constraints in utilizing agricultural land with the vertical planting pattern (larian) occur especially during the harvest season, as the steep (vertical) land can hinder farmers due to limited vehicle access and several other factors that complicate the harvesting process. In addition, the use of sloping land as agricultural land poses a risk of farmers slipping due to the steep terrain.

4. CONCLUSION

Indonesia is an archipelagic country located along the ring of fire, resulting in diverse topography or landforms.

Agriculture is an activity carried out to create an artificial ecosystem that can later be used to provide food for humans. In a narrow definition, agriculture can be interpreted as the activity of “cultivating crops.” Meanwhile, in a broader sense, agriculture can be defined as other activities such as crop farming, plantations, fisheries, livestock, and forestry. Desa Tosari, located in Kabupaten Pasuruan, still strongly upholds the customs and culture of the Tengger Tribe, even though the majority of its population is Muslim. The area of Desa Tosari is located in a highland region with an altitude of 1,800 meters above sea level, with a longitude coordinate of 112.891949 and a latitude coordinate of -7.893205, and covers an area of 550.93 hectares.

Nearly 90% of the Tengger indigenous community in Desa Tosari depend on agricultural land for their livelihood. The geographical condition of the Tengger Tribe, which is located in a mountainous region, forces them to utilize the land to become profitable agricultural land. In the land cultivation process, there are unique practices that differ from commonly used techniques. Vertical farming (larian) is an agricultural technique carried out by creating straight plots vertically from top to bottom following the mountainous topography of the land. By applying such land formation, the cultivable land becomes wider because it is not significantly divided by boundary partitions.

Such agricultural techniques cannot be separated from the social and cultural influences of the Tengger indigenous community itself. With the majority of the community working as farmers under mountainous geographical conditions, they are compelled to cultivate the land despite various limitations.

REFERENCES

[1] R. Safa'at, *et al*., "Rekonstruksi politik hukum ketahanan pangan berbasis sistem kearifan lokal guna mewujudkan kedaulatan pangan," *Jurnal Media Hukum*, vol. 16, no. 3, pp. 585–598, Dec. 2019.

[2] Y. Yuliati, *Perubahan Ekologis dan Strategi Adaptasi Masyarakat di Wilayah Pegunungan Tengger*. Malang, Indonesia: UB Press, 2011.

[3] Rahmaniah, *Etnografi Masyarakat Desa Ngadas Kecamatan Poncokusumo Kabupaten Malang*. Malang, Indonesia: LPPM UIN Maulana Malik Ibrahim Malang, 2015.

[4] Badan Pusat Statistik Kabupaten Pasuruan, Kabupaten Pasuruan dalam Angka. Pasuruan, Indonesia: BPS Kabupaten Pasuruan.

[5] M A Ambayoen, et al., "The Roots of Resilience: Strengthening Agricultural Sustainability in Tengger, Indonesia Through Scoial Capital", *Sustainability*, vol. 7, no 1., 2025

[6] M Ismanto et al., "Continuity and Change in the Midst of Ecological and Livelihood Transformation in Tengger East Java", ISCS 2020: Proceedings of the 1st International Seminar on Cultural Sciences, pp 42-50

[7] R. Risal, Darmawan, et al., "Efektivitas sistem pertanian terpadu hedgerows terhadap peningkatan produktivitas lahan kering," Jurnal Sains dan Teknologi, vol. 14, no. 3, pp. 220–230, Dec. 2014.

[8] O. H. Nurcahyono, "Social Capital of Indigenous Village Communities in Maintaining Social Harmony (Case Study of The Tenggerese Indigenous Community, Tosari, Pasuruan, East Java)", Proceedings of the International Conference on Rural Studies in Asia (ICoRSIA 2018), May. 2019

[9] D. A. Maretya, "Perilaku petani dalam mengelola lahan terasering di Desa Sukasari Kaler Kecamatan Argapura Kabupaten Majalengka," Jurnal Jurisprudence, vol. 3, no. 5, pp. 1–10, Feb. 2017.

[10] I Wahyuni, et.al. "Detemining Growing Season of Potatoes Based on Rainfall Prediction Result Using System Dynamic". Indonesian Journal of Electrical Engineering and Informatics, vol.6, no.2, pp 210-216, May.2019