



Ethno-Sciences and the Transformation of Traditional Agricultural Systems in Teluk Bintuni: Between Preservation and Modernization

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Abstract

Traditional farming systems are a form of long-term interaction between humans and their environment that manifests ecological and cultural adaptation. This study aims to explore the dynamics between the preservation of local knowledge and the pressures of modernization in the transformation of traditional farming systems of indigenous peoples in Teluk Bintuni, West Papua. Using an ethno-science approach with qualitative-descriptive methods through participatory observation, in-depth interviews, FGDs, and documentation studies in the Moskona, Wamesa, and Sumuri indigenous communities. The results of the study indicate that traditional farming systems are still maintained with high dependence on sago (85%), sweet potatoes (72%), taro (66%), and bananas (54%) as sources of food and cultural identity. The transformation of the farming system does not follow a linear pattern from traditional to modern, but rather creates a hybrid system that selectively combines traditional elements with modern technology. Indigenous peoples are not passive in facing change, but actively negotiate and adapt based on their ecological and cultural interests. The ethno-science approach offers a framework for integrating local knowledge into development planning, without ignoring the ecological and spiritual dimensions of indigenous peoples. Dialogue between local knowledge systems and modern science can produce more adaptive and inclusive agricultural policies, especially in indigenous areas such as Teluk Bintuni that face pressure from natural resource exploitation.

Keywords: Ethno-science, traditional farming systems, indigenous Papuans, local knowledge, agricultural transformation

1. Introduction

Traditional agricultural systems are the result of long-term interactions between humans and their environment, which are passed down from generation to generation as a form of ecological and cultural adaptation. This system not only provides a source of food but also represents local knowledge that is integrated with the cosmological and social values of the community (Agnoletti and Santoro, 2022). In various regions of Indonesia, especially in eastern regions such as Papua, traditional agricultural practices reflect a form of sustainability that has stood the test of time (Sopaheluwakan et al., 2023). In Teluk Bintuni, West Papua, indigenous communities such as the Moskona, Wamesa, and Sumuri tribes practice subsistence farming with a shifting cultivation system, the use of local plants, and a planting system that follows the traditional calendar. Data from field observations and reports from various local institutions show that most people in the interior of Teluk Bintuni still rely on traditional agricultural systems as their main source of livelihood (Wahyudi et al., 2024; Murdiyarso et al., 2021). The main commodities cultivated include sago, cassava, taro, and banana, which not only function as staple foods but also have symbolic value in local culture. A study by Okoronkwo, (2024) indicated that dependence on traditional agriculture in this area reaches more than 60%, especially in districts that are geographically remote and have limited access to markets and modern agricultural technology.

Another study by Thakur et al. (2022) revealed that indigenous people in the Teluk Bintuni area have strong knowledge regarding crop rotation, natural soil fertility, and organic-based pest control. However, this knowledge is still not widely documented in the scientific literature, and is often considered "unscientific" in the more technocratic paradigm of modern agricultural development.

On the other hand, the flow of modernization brings new challenges and opportunities. Local governments and the private sector have introduced various agricultural intensification programs with a green revolution approach, the use of chemical fertilizers, superior seeds, and uniform planting systems. Although it provides short-term production increases, it also triggers the degradation of local knowledge and changes in the pattern of people's relationships with

their land (Cotroneo et al., 2021). This is where the Ethno-Sciences approach becomes relevant. Ethno-Sciences positions local knowledge as a legitimate epistemological system, which can contribute to the development of contemporary science. This approach not only examines traditional practices, but also the social and cultural dynamics that shape them (Soldati and Almada, 2021).

The Ethno-Sciences approach also allows for dialogue between the two traditional and modern knowledge systems without negating each other. As explained by Dawson et al. (2021), the integration of local knowledge into resource management systems can improve ecological sustainability and strengthen the social cohesion of indigenous communities. This is very important, especially in the context of Papuan development which often conflicts with local cultural identity.

The transformation of the agricultural system in Teluk Bintuni cannot be seen as a linear process from “traditional to modern”, but rather as a space for negotiation between preservation and adaptation. As in the study by Altieri and Koohafkan (2008) showed that several farmer groups began to integrate simple irrigation technology while maintaining traditional planting practices such as *menugal* and *mombon* (planting deliberation). This shows that the community is not passive towards change, but actively selects and sorts elements that are in accordance with their values.

The problem that then arises is how agricultural development policies and modernization programs can value and involve this local knowledge. The lack of participatory approaches in intervention programs often leads to alienation of communities from their own agricultural systems (Bourgeois et al., 2023). Therefore, understanding these changes from an Ethno-Sciences perspective is important for formulating contextual and equitable agricultural strategies. By exploring the dynamics between the preservation of local knowledge and the pressures of modernization, this article aims to build a scientific narrative on the transformation of traditional agricultural systems in Teluk Bintuni. This research is expected to provide conceptual contributions in the field of Ethno-Sciences as well as become a reference for policies that support the ecological and cultural sustainability of indigenous Papuan communities.

2. Literature Review

2.1. The concept of ethno-sciences in contemporary science

Ethno-Sciences is an approach that places local knowledge as a legitimate epistemological system, equal to modern science in understanding and managing natural resources (Soldati & Almada, 2021). In this perspective, local knowledge is not only practical but also reflects the social, spiritual, and ecological dimensions of indigenous communities. Dawson et al. (2021) explain that the integration of local knowledge into resource management systems can strengthen ecological sustainability and social cohesion, especially in indigenous areas that are under pressure from modernization.

2.2. Traditional farming systems and local wisdom

Traditional farming systems in various regions of the world have long been considered a form of sustainable ecological adaptation. Altieri and Koohafkan (2008) state that practices such as crop rotation, the use of natural fertilizers, and water and soil conservation techniques are the result of knowledge accumulated from generation to generation. In Indonesia, similar practices are found in Papua, Nusa Tenggara, and Maluku, where indigenous communities have developed agricultural methods that are integrated with natural cycles and cultural values (Sopaheluwakan et al., 2023).

2.3. Transformation of agricultural systems in the modernization era

Agricultural modernization is often identified with production intensification through the adoption of technology, superior seeds, and chemical inputs. Although aimed at increasing yields, this process often ignores the local context and erodes traditional cultural values (Cotroneo et al., 2021). In West Papua, agricultural intensification programs have begun to be implemented in recent years, but face challenges in terms of community acceptance and incompatibility with local ecological conditions (Wahyudi et al., 2024).

2.4. Resilience and adaptation of indigenous communities

Research shows that indigenous communities are not passive in facing change. They actually have a high capacity for adaptation through the selection of locally-based technologies and innovations. For example, communities in Teluk Bintuni modified traditional planting systems such as *menugal* and *mombon* by incorporating simple irrigation techniques (Altieri & Koohafkan, 2008). This confirms that agricultural transformation is not simply a shift from “traditional to modern”, but a process of dialogue and negotiation of values.

2.5. Documentation and validation of local knowledge

One of the main challenges in the Ethno-Sciences approach is the lack of systematic documentation of local knowledge. Thakur et al. (2022) emphasize that traditional farmer knowledge is often unrecorded, making it difficult for scientists and policymakers to access. In fact, if scientifically validated, this knowledge can be an important basis for community-based innovation and sustainable agricultural policies (Okoronkwo, 2024).

2.6. Related studies in the Papua region

Several studies have highlighted the dynamics of indigenous people's agriculture in Papua. For example, Murdiyarso et al. (2021) mapped the practices of sago farming and food forests in West Papua that still persist despite being under pressure from land expansion and infrastructure projects. Meanwhile, Bourgeois et al. (2023) criticized the top-down approach in agricultural development programs in this region, which often failed to involve communities in a participatory manner.

3. Methods

3.1. Research approach

This research uses a qualitative-descriptive approach with ethnographic methods. This approach was chosen to understand the practices, values, and transformation of traditional agricultural systems of indigenous peoples in Teluk Bintuni in depth through the lens of Ethno-Sciences. Ethnographic research allows researchers to engage directly with local communities to record traditional knowledge, social structures, and responses to modernization interventions.

3.2. Research locations and subjects

This research was conducted in several villages in the Teluk Bintuni area, West Papua, which are home to indigenous peoples such as the Moskona, Wamesa, and Sumuri tribes. The locations were chosen purposively because the communities in this area still maintain traditional agricultural practices and, at the same time, are the targets of various agricultural modernization programs. The research subjects included traditional leaders, senior farmers, female farmers who have knowledge of the planting cycle, village officials, local agricultural extension workers, and representatives of NGOs or civil society organizations that assist empowerment programs in the agricultural sector.

3.3. Data collection techniques

Data collection was carried out through participatory observation, in-depth interviews, focus group discussions (FGDs), and documentation studies. In participatory observation, researchers are directly involved in community agricultural activities such as land clearing, hoeing, and harvesting, and record the accompanying socio-cultural activities. In-depth interviews are conducted semi-structured with key informants to obtain rich narratives about changes in agricultural systems and their experiences. FGDs are used to capture group dynamics and formulate collective perceptions about agriculture and modernization. Documentation studies focus on local agency reports, data from the Department of Agriculture, village archives, and previous research as complementary sources.

3.4. Research instruments

The main instruments in this study are interview guides and observation sheets designed based on the Ethno-Sciences approach. The instruments focus on exploring local knowledge about planting patterns, seasons, types of commodities, and the symbolic and spiritual meanings of agricultural practices carried out. In addition, the instruments also include social aspects such as the mutual cooperation system, division of labor in farming households, and decision-making processes based on customary deliberation. The entire data collection process is carried out by respecting the principle of free, prior and informed consent (FPIC), namely ensuring that participation is carried out voluntarily and informatively.

3.5. Data analysis

Data were analyzed using thematic analysis methods. The first stage was carried out by transcribing the results of observations and interviews, followed by open coding to identify key themes such as changes in cropping patterns, adoption of technology, and the loss of local varieties. Furthermore, axial coding was applied to connect these themes with concepts in Ethno-Sciences such as ecological adaptation, spiritual-ecological knowledge, and community survival strategies. This analysis aims to build a complete ethnographic narrative, describing changes in the agricultural system in the cultural and ecological context of the Teluk Bintuni community.

3.6. Research ethics

This research was conducted by upholding the principles of social research ethics. The researcher first requested official permission from traditional leaders and the village government, and explained the purpose of the research openly to the community. Information provided by informants was treated confidentially, especially data that was personal or sensitive. To ensure data accuracy, the researcher conducted a member check with the main informant. As a form of return, the research results were compiled in the form of a popular summary and returned to the community in a village forum, as a collaborative effort in local knowledge-based development.

4. Results and Discussion

4.1. Characteristics of traditional farming systems in Teluk Bintuni

The results of field observations and interviews show that indigenous peoples in Teluk Bintuni, such as the Moskona, Wamesa, and Sumuri tribes, still maintain a subsistence farming pattern based on a shifting cultivation system. This practice is characterized by the use of local seeds, the mangal method, crop rotation, and sensing planting times based on natural phenomena (bird movements, air temperature, moon position).

This system is not only ecologically functional, but also full of cultural and spiritual meaning. For example, sago planting is often accompanied by the "mombon" ritual, as a form of respect for the ancestral spirits who guard the forest. The existence of these values reflects that agriculture is not only seen as an economic activity, but also as a socio-cosmological practice. Observation results also show that the people of Teluk Bintuni are still very dependent on four main commodities, namely sago, sweet potatoes, taro and bananas as a source of food and culture. This can be seen in Table 1.

Table 1: Main commodities and percentage of user households in Teluk Bintuni

No	Commodities	Plant Type	Percentage of Households (%)	Additional Information
1	Sago	Local	85%	Main staple food, high symbolic value
2	Sweet Potato	Local	72%	Daily consumption and for barter
3	Taro	Local	66%	Used during rituals and lean seasons
4	Banana	Local	54%	Alternative source of nutrition
5	Dryland Rice	Local/Introduction	25%	Used by peri-urban communities
6	Mixed Vegetables	Modern	18%	Result of integrated farming program

Table 1 shows the distribution of the use of main commodities in the Teluk Bintuni community based on the percentage of households that rely on each commodity. Based on these data, it can be seen that sago dominates as the main commodity with 85% of households using it, followed by sweet potatoes (72%), taro (66%), and bananas (54%). In addition, other commodities such as paddy rice (25%) and mixed vegetables from the integrated farming program (18%) were also recorded although in smaller percentages. The visualization of this data can be seen in the pie chart in Figure 1, which clearly illustrates the proportion of each main commodity used by households in Teluk Bintuni. This image provides a more easily understood picture of the community's dependence on these commodities.

Household Commodity Commodity Based on Agricultural Commodities in Bintuni Bay

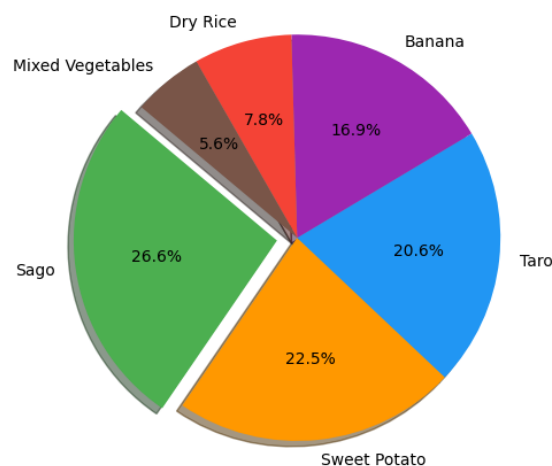


Figure 1: Pie chart visualization

4.2. System transformation and modernization challenges

Although traditional practices are still strong, some areas closer to sub-district centers or industrial exploration sites have begun to experience a transformation of the agricultural system. The introduction of modern agricultural programs such as extension of chemical fertilizer use, superior seeds, and monoculture planting systems has brought mixed results.

Some farmers have begun to abandon crop rotation and choose commodities that are considered more economically profitable, such as fast-growing vegetables for the local market. However, on the other hand, communities also reported an increase in dependence on external inputs, as well as a decrease in soil fertility due to the uncontrolled use of chemicals. The transformation of the agricultural system that occurred did not completely replace local values, but created a hybrid model that combines traditional and modern elements. A comparison of key aspects can be seen in Table 2.

Table 2: Comparison of traditional farming systems and partial modernization

Aspects	Traditional	Partial Modernization
Input	Local seeds, organic fertilizer	High-quality seeds, chemical fertilizers
Crop patterns	Based on customary seasons	Based on national calendar
Techniques	Menugal, mombon	Hoes, manual tools
Market dependency	Very low	Moderate
Food sovereignty	High	Decreasing in the long term
Cultural values	Very attached	Tends to fade

Table 2 shows a comparison between traditional and partially modernized farming systems that have occurred in the Teluk Bintuni community. It can be seen that despite the application of modern elements such as the use of superior seeds and chemical fertilizers, many traditional aspects are still maintained, such as the selection of local seeds and the use of organic fertilizers. The changes that have occurred are more partial, with some farmers switching to more economically profitable crops, but still maintaining most of the techniques and planting patterns based on customary seasons.

The decrease in dependence on local inputs, as well as the reduction in long-term food security, reflect the impact of this modernization. This finding is in line with a study by Cotroneo et al. (2021) which states that modernization that does not consider local values can lead to cultural and ecological alienation, which can ultimately damage sustainable farming systems that are in accordance with the cultural context of the community.

4.3. Integration of local values in hybrid farming systems

Some communities have begun to demonstrate adaptive strategies by creating hybrid farming systems, namely selectively combining elements of modern technology with traditional principles. An example is the use of simple bamboo-based irrigation for sweet potato fields, but still following the planting schedule based on the traditional calendar. This pattern shows that local communities are not passive recipients of modernization, but active agents who negotiate changes based on their ecological and cultural interests. The following is a concept map of the integration model of traditional and modern systems, which can be seen in Figure 2.

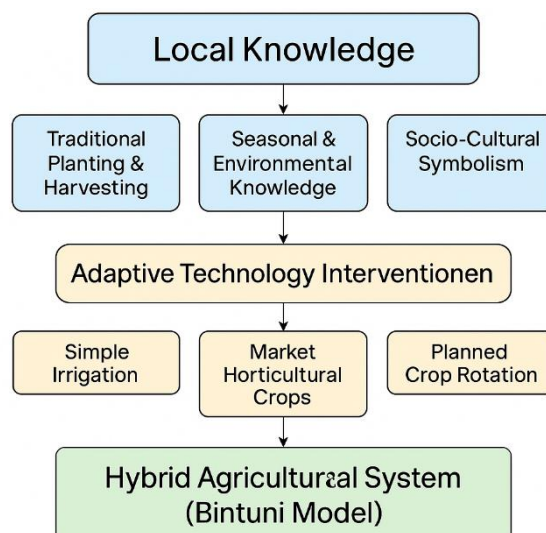


Figure 2: concept map of the integration model of traditional and modern systems in the perspective of ethno-sciences

4.4. The role of ethno-sciences in formulating contextual agricultural policies

The Ethno-Sciences approach offers a framework for assessing and integrating local knowledge into development planning, without neglecting the ecological and spiritual dimensions of indigenous communities. Understanding these values is essential for designing programs that are not only technically effective, but also socially and culturally sustainable.

As Dawson et al. (2021) emphasize, dialogue between local knowledge systems and modern science can produce more adaptive and inclusive agricultural policies, especially in indigenous areas such as Teluk Bintuni which face pressures from natural resource exploitation.

5. Conclusion

This study reveals that the traditional agricultural system in Teluk Bintuni, West Papua still has a vital role for the indigenous people of Moskona, Wamesa, and Sumuri. Through an ethno-science approach, it was identified that local agricultural practices not only function as economic activities, but also represent a knowledge system integrated with the spiritual and socio-cultural values of the community. The transformation of the agricultural system that occurred did not follow a linear pattern from "traditional to modern", but rather created a hybrid system that selectively combines traditional elements with modern technology.

The indigenous people in Teluk Bintuni were shown to have a high dependence on four main commodities, namely sago (85%), sweet potatoes (72%), taro (66%), and bananas (54%) as a source of food and cultural identity. Although agricultural modernization programs have been introduced, including the use of chemical fertilizers and superior seeds, many traditional practices are still maintained such as the "mombon" ritual in planting sago and the shifting cultivation system that adapts to local ecological conditions.

Other key findings show that indigenous people are not passive about change, but are actively negotiating and adapting based on their ecological and cultural interests. An example is the use of simple bamboo-based irrigation for sweet potato fields that still follow the planting schedule based on the traditional calendar.

The ethno-scientific approach offers a framework for integrating local knowledge into contextual agricultural development planning. Dialogue between local knowledge systems and modern science can produce more adaptive and inclusive agricultural policies, especially in indigenous areas such as Teluk Bintuni that face pressure from natural resource exploitation.

This research contributes to the understanding that agricultural development in Papuan indigenous areas requires an approach that not only focuses on increasing productivity, but also respects and involves the ecological, spiritual, and socio-cultural dimensions of indigenous communities. Thus, the ethno-scientific approach can be an important bridge in creating a sustainable and equitable agricultural development model for Papuan indigenous communities.

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