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PRESERVING THE SUSTAINABILITY OF NATURAL RESOURCES AND AGRO-ECOSYSTEMS IN TIDAL SWAMPLAND THROUGH LOCAL WISDOM IN INDONESIA

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Abstract: Tidal swamplands have an important role in supporting national food security. However, there are several obstacles in using tidal swamps for agricultural business, such as high acidity and water fluctuations. To overcome these problems, there are specific agricultural technologies based on local wisdom that can raise their image from marginal land to productive land. That local wisdom is an agriculture system used in tidal swamplands. This research aims to analyse the processing of agricultural land on tidal swamplands, and to analyse the value of local wisdom in the tidal swampland management process for land sustainability. This research used a qualitative method with an ethnographic approach. The sources of the data were primary and secondary data analysed using the triangulation technique (data reduction, data display, and data verification). The results showed that Banjarese rice farmers applied local wisdom for their rice fields. Cutting, rolling, flipping and spreading the grass is a form of local wisdom from South Kalimantan, which represent the principles of conservation so that swampland can be planted continuously. The government, as the stakeholders, can use the results of this study as a reference for applying the Banjarese local wisdom for agriculture.

Keywords: Local wisdom, tidal swampland, agriculture, sustainability, agro-ecosystem.

Introduction

The Indonesian population in the next 40 years will continue to grow with a growth rate of about 1.5% annually, and as a result, the need for food will also continue to increase. It is estimated that by 2025, Indonesia will import about 11.4 million tonnes of rice if wetland conversion still occurs at a rate of 190,000 ha per year and new paddy fields conversions are only 100,000 ha per year (Mulyani *et al.,* 2016). The rate of conversion of paddy fields in Indonesia has reached 100 thousand hectares per year (Hidayat *et al.,* 2018; Mulyani *et al.,* 2016). The highest amount of land conversion occurs in Java, around 75% to 80% (Mulyani *et al.*, 2016). The increase in paddy field conversion will have an impact on the decreasing food availability (Hidayat *et al.,* 2018). This is a motivation in finding the solution to the problem of rice production. One of the ways is by expanding farming land to sub-optimal land (tidal swamplands).

Tidal swamplands are the solution to realise food security, independence and sovereignty, especially in terms of rice. The tidal swampland is one type of agroecology that has considerable potential for agricultural development, especially food crops (Islam *et al.,* 2019). Tidal swamplands have an important role in supporting the improvement of national food security and the development of agribusiness systems and businesses, given the wide area potential and existing management technologies (Burbridge, 2019; Cahyana *et al.,* 2019; Noor & Sosiawan, 2019). However, the development of tidal swamplands for agricultural business has several constraints. Biophysically, the main factors affecting the development of tidal swamplands for agriculture are puddles, low soil pH, the presence of toxic substances, low soil fertility with high diversity and the topographic conditions of the land (Sulaiman *et al.,* 2019). The absorption of nutrients by plants will be hampered if the soil acidity level is high (Nurzakiah *et al.,* 2021).

Soil and water management technologies are the main key to successful agricultural activities in tidal swamplands (Manale *et al.,* 2018). Thus, for the development of swamplands, it is necessary to conduct water management and soil fertility management. If the land is managed appropriately through research, it can be used as production land to support increased food production, diversification of production, as well as agro-industrial and agribusiness development and employment.

Wetlands have many problems in their processing, especially land degradation and land fires. Indonesia concentrates on reducing the impact of land degradation through an economic carbon approach (Rajiani & Pypłacz, 2018). Land resource management needs to be done to make wetlands productive. People who still practise burning are also part of the problem (Tata *et al.,* 2018). Widespread fires in wetlands in the South Kalimantan region, especially during the dry season due to land clearing need to be addressed (Arisanty *et al.,* 2019). One way to overcome this is through local wisdom without resorting to burning.

To overcome technical problems in tidal swamplands, there are specific local wisdom-based agricultural technologies that can change the image of tidal swamplands from marginal land to productive land. Banjarese farmers in South Kalimantan are equipped to manage the swamplands. The farming system applied by Banjarese farmers on tidal swamplands, in general, is a traditional system, from land management, planting, harvesting to post-harvest (Hastuti *et al.,* 2019b; Hastuti & Sumarmi, 2017). The swamp-processing technologies owned by Banjarese farmers are the *tabas* (cutting the grass), *puntal* (rolling the grass), *balik* (flipping the grass) and *ampar* (spreading grass) systems. Various local wisdoms passed down from generation to generation have become farmers' reference in processing tidal swamplands. The rice farming system in South Kalimantan is well known as *bahuma* (Banjarese term). Banjarese farmers have been farming in tidal swamplands for centuries, resulting in local knowledge that is aligned with the rules of balance and sustainability of nature (Hastuti *et al.,* 2019b; Hastuti & Sumarmi, 2017). They form a knowledge system through experiences and experiments; thus, local wisdom is created.

All forms of local wisdom are lived, practised, taught and passed down from generation to generation while, at the same time, forming patterns of human behaviour towards fellow human beings (Figure 1).

The study aims to analyse the processing of agricultural land in tidal swamplands and to analyse the value of local wisdom in the

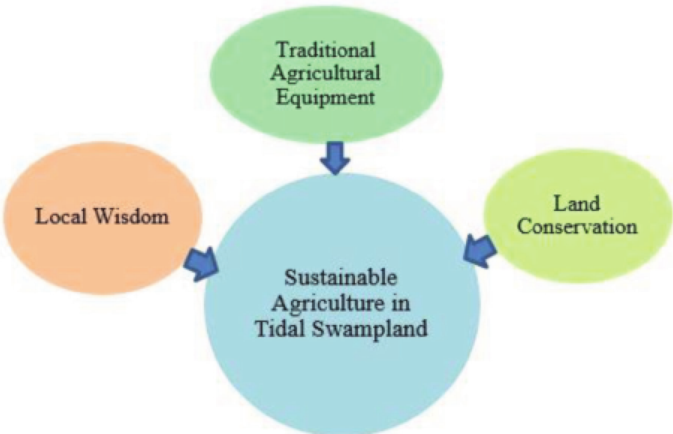

Figure 1: Conceptual framework of sustainable agriculture in tidal swamplands

tidal swampland management process for land sustainability. Scientific understanding in the context of local cultural wisdom is also expected to broaden the insights of stakeholders in consideration inof utilising swamplands properly and sustainably.

Local Wisdom

Local wisdom is the heritage of ancestors in the repertoire of the values of life that provides unity in the form of beliefs, culture and customs. In its development, society adapts to the environment by developing wisdom in the form of knowledge or ideas, equipment and activities to manage the environment without destroying nature (Kupika *et al.,* 2019; Sumarmi *et al.,* 2020). This means that local wisdom is the result of knowledge, experience and practices passed down from one generation to the next, which is used to solve various problems in the living environment (Prayoga *et al.,* 2020).

Various studies on local wisdom have been conducted, including in the agricultural field. A study by Musta'id (2019) focuses on local wisdom called *pranotomongso* by the Javanese, which has the concept of environmental management to maintain the function of the environment to be sustainable. *Pranotomongso* involves calculations through the Javanese calendar that determines planting time based on natural signs. The results of the study on a farmer community in Ogan Komering Ilir swampland, South Sumatra, showed that with local knowledge called *Lebak Lebung* management, farmers have succeeded in developing swamplands into fertile and environmentally friendly agricultural land (Yunita, 2012).

Local wisdom can change the long-term behaviours of farming communities in managing agricultural land to increase the production of environmental-based agricultural entrepreneurs (Mokoginta & Indrianti, 2020). The success of farmers in the management of swamplands based on local wisdom is also proven by Wahyu and Nasrullah (2012), who studied in a community of the Dayak Bakumpai tribe. Dayak Bakumpai farmers have local wisdom consisting of a planting phase called *malacak* (divide the rice seed), *manatak* (clean up the fields) and *maimbul* (planting paddy). The activities carried out by the Dayak Bakumpai farmers are traditional practices based on local knowledge of conservation rules.

Furthermore, indigenous floating agriculture holds enough potential to help farming communities in the flood-prone regions of Bangladesh to sustain lives and livelihoods during floods and long-term waterlogged conditions (Chowdhury & Moore, 2017). The purpose of applying this planting phase is to keep the farming system in swamplands sustainable (Bari, 2019; Fagorite *et al.,* 2019; Sulaiman *et al.,* 2019). Several studies have been conducted in various regions on the contribution of local knowledge to the sustainability of agriculture. For example, the forest gardens owned by the Dayak tribe in East Kalimantan have implications for the continuous management of natural resources (Mulyoutami *et al.,* 2009). Furthermore, indigenous people in Nuevo San Juan Mexico have traditional farming systems that contribute to sustainable agricultural development (Pulido & Bocco, 2003).

One of the slogans of the Sustainable Development Goals (SDGs) is "no one is left behind", which is a spirit of togetherness where no party should be left behind. The SDGs have four main pillars, namely social development, economic development, environmental development, and law and governance development (Miola & Schiltz, 2019). Local wisdom can be integrated with the SDG movement because there are similarities in the goals and values. This is in line with the goals of SDG 2030, namely maintaining sustainable improvement in the economic welfare of the community, maintaining the sustainability of the community's social life, maintaining environmental quality and inclusive development and implementing governance that is able to maintain the improvement of the quality of life from one generation to the next (Infid, 2021). Local wisdom has a significant impact on the environment that creates harmony with nature, which is one of the SDGs.

Sustainable Agriculture

Sustainable agriculture is an implementation of the concept of sustainable development in the agricultural sector. The term “sustainable agriculture” has been recognised globally, where harvest crops are grown without harming the environment (Fawzi & Qurani, 2020). Basically, a sustainable agriculture system is returning to nature, which is non-destructive, unchanging, harmonious and balanced with a compliant environment or agriculture, and follows the natural rules. Sustainable agriculture seeks to make the best use of nature’s goods and services, and technologies and practices must be locally adapted and fitted to the place (Doering, 2018; Jaramillo *et al.,* 2019). According to the farming context, sustainability is the successful management of resources for agricultural enterprises to assist the change of human needs and to maintain or to improve the quality of the environment and conserving natural resources. That high system in sustainability, which can be taken as the aim to make the best use of environmental goods and services while not damaging these assets (Flora, 2018; Rees *et al.,* 2018). The concept of sustainable agriculture is based on three pillars, which are economic, social, and ecology (Flora, 2018; Sarkar *et al.,* 2018). The concept of sustainable development is oriented towards three dimensions of sustainability, namely: (1) ecologically sound, which means the agricultural cultivation system should not wander from the existing ecological system, in which stability is an indicator of the harmonisation of ecological systems whose mechanisms are controlled by natural laws, (2) economically valuable, which means that the agricultural cultivation system should refer to profit and loss considerations, both for ourselves and others, for the short term and the long term, as well as for organisms in the ecological system, as well as outside the ecological system and (3) socially just, where agricultural systems must be aligned with social and cultural norms embraced and cherished by the people.

Having analysed previous studies on local wisdom in the field of agriculture, it can be concluded that there is not much discussion on the processing of land, particularly in tidal swamplands. The practice of cultivation by Banjarese farmers in South Kalimantan is an interesting topic to investigate since it has its own uniqueness that cannot be found in other areas. This cultivation process unique to Banjarese people is the activity of cutting, rolling, flipping and spreading the grass. Banjarese farmers use this system because they are aware that tidal swamplands have specific characteristics. The Banjarese farmers use traditional tools, such as trowels, to cultivate the land while cutting, rolling, flipping and spreading the grass. Trowels prevent the exposure of pyrite layers, which can increase soil acidity. With the implementation of this system, soil in tidal swamplands can be used for sustainable rice farming.

Material and Methods

Research Location

The research was conducted in Mekarsari Village, Barito Kuala District, South Kalimantan Province. The astronomical location of Mekarsari Village is 2^{0}43’36’’S-2^{0}56’5”S and 141^{0}31’28’’E-141^{0}45’38”E (Figure 2). The selection of the research sites was based on the following considerations: (a) most of the land area are tidal swamplands (96.07%), which are the main suppliers of rice in South Kalimantan Province and (b) the research area is realised as the agricultural central for the area, supporting the national food security programme (Central Bureau of Statistics [BPS], 2016).

The slope of the land in Mekarsari Village is almost non-existent at less than 2%. The thickness of the peat in the village is quite deep, between 0.5 m and 2 m. It is located in a tidal swamp area with high soil acidity (pH of 3.5 to 5.5). With the physical condition of the area dominated by swamplands, most of the people in Mekarsari Village work in agriculture, especially planting rice. The types of rice planted by the community are local rice varieties that are generally resistant to the physical conditions of swamplands (BPS, 2016).

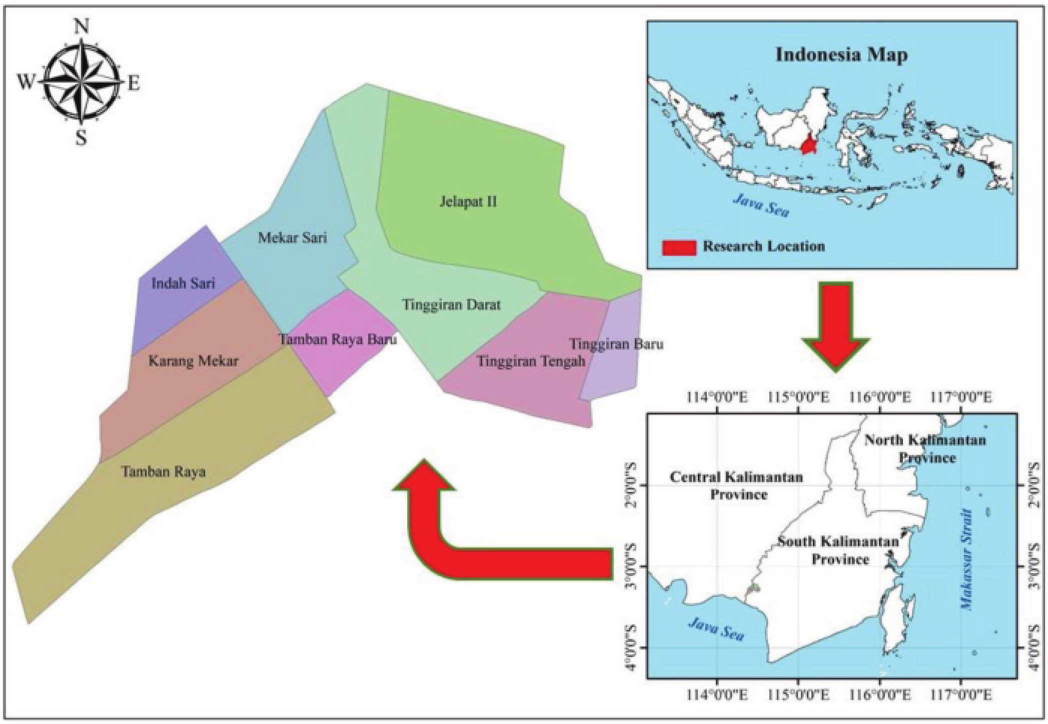

Figure 2: Research location

Research Assumption

Local wisdom is a form of knowledge, belief, understanding or insight, as well as customs or ethics that guide human behaviour in life in an ecological community. Local wisdom is the noble values that are applied in the life of the community to protect and manage the environment in a sustainable manner (Figure 3).

Data Collection

This research used a qualitative method with an ethnographic approach. The ethnographic approach aims to describe people's behaviour in an "ethnic" cultural environment based on the "natural" truth. The largest tidal swampland in South Kalimantan, and the majority of the population in this area are Banjarese working as rice farmers (BPS, 2016). The data in this study refer to the results of surveys conducted between December 2017 and February 2018. The data are in the form of the research site, interviews and documentation.

For the analysis of geographical conditions, demographic characteristics and agricultural conditions are compiled from various data sets. The data on geographical conditions and demographic characteristics were obtained from BPS of Barito Kuala Regency, and the data on agricultural conditions were obtained from the Agricultural Extension Centre, BPS of Mekarsari District and the Department of Agriculture, Food Crops and Horticulture of Barito Kuala District.

From December 2017 to February 2018, besides conducting observation and documentation, in-depth interviews with several informants were conducted. The data on local farmers' wisdom were compiled from interviews with selected people based on their background knowledge, namely Banjarese farmers, the head of farmers, and the field officers. Information on local farmers' wisdom in tidal swamplands to cultivate the land was excavated through a series of individual and group interviews with experienced farmers. From this process, a comprehensive description of the practices and actions in managing swamplands and conservation efforts was undertaken. There were 20 informants in total, 16 Banjarese farmers, two heads of farmers and two field officers. Interviews were conducted using the Indonesian and Banjarese languages and were recorded with a tape recorder. The interviews used open-ended questions, so that the informants can answer the questions freely (Table 1).

Data Analysis

To maintain the validity of the findings, cross-checks on the observations, interviews, and documentation were conducted. Data analysis was conducted using the triangulation technique (data reduction, data display, and data verification) (Miles *et al.,* 2014). Interview results were reduced by selecting the data relevant to the research focus. Then, the results of the interview that had been reduced would be presented in descriptive form. At the same time, a comparison between the data (data verification) and the secondary data (obtained from literature studies and information from relevant agencies) was conducted.

Verification of literature data in qualitative research is carried out together with verification of data findings in the field. According to Lincoln and Guba (2017), in qualitative research, there are four verification standards, namely credibility, transferability, confirmability and dependability. The institutions involved in the verification process are the Agricultural Extension Centre, BPS of Mekarsari District and the Department of Agriculture, Food Crops and Horticulture of Barito Kuala District, South Kalimantan.

Table 1: Question asked during the semi-structured interviews

Question	**Rationale**
Personal detail: Name, age, education background, gender, religion, member of the family	Socio-demographic
Are you still implementing traditional methods in the rice farming system on tidal swamplands?	Local wisdom
What is a method to process the tidal swampland?	Local wisdom
What are the tools to process the tidal swampland?	Local wisdom
Why do you use these traditional tools?	Local wisdom
What is the purpose of this system of treating the soil in tidal swamplands?	Local wisdom
Why should the grass be cut in tidal swamplands?	Local wisdom
Why should the grass be rolled in tidal swamplands?	Local wisdom
Why should the grass be spread in tidal swamplands?	Local wisdom
Does the implementation of this system support sustainable agriculture, especially in tidal swamplands?	Sustainable agriculture

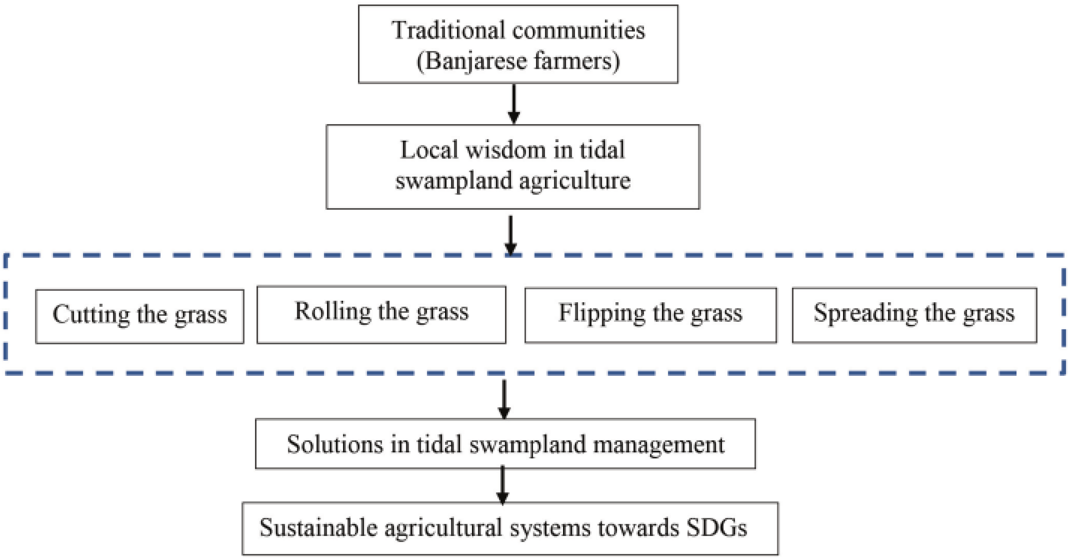

Figure 3: Research framework

Results and Discussion

The utilisation of tidal swamplands as agricultural land is a typical situation. The specificity of this land use is characterised by human activities that use the land as an agricultural area. The use of agricultural land carried out by Banjar tribe farmers has certainly been going on for a long time, and from one generation to the next. The utilisation of agricultural land is accompanied by site selection, management and preservation methods. The typical behaviour of Banjarese Tribe farmers in the use of tidal swamp agricultural land in South Kalimantan involves local wisdom. Local wisdom is a human method that relies on a philosophy of values, ethics, ways, and behaviors that are traditionally institutionalised in the form of values, norms, ethics, beliefs, customs, customary law and special rules. Human interaction with the environment occurs to meet human needs from time to time so that local wisdom is formed in the management of agricultural land.

The tillage in tidal swampland by Banjarese farmers is different from the cultivation of land for agriculture in other areas in Indonesia. Soil cultivation is one of the main activities in plant cultivation. Soil processing in agricultural systems aims to create a state of tillage that allows for physical, chemical and biological planting so that the cultivated plants will grow well. The soil treatment is related to the physical condition of the land, which generally contains a pyrite layer (acid) at the bottom. The period of tillage done by Banjarese farmers took place between December 2017 and February 2018. The tillage using a system consisting of several stages: cutting, rolling, flipping and spreading the grass.

Cutting the Grass

Cutting the grass is an activity of mowing the lawn using a tool called long hoe. Hereditary, Banjarese farmers do not use hoes and tractors in cultivating the land. The tillage in a tidal swampland was done using a long hoe (a type of machete with a long stalk) (Figure 4). The working principle of this tool is to mow the grasses or the remaining rice crops of the previous year by slashing a thin layer of soil (± 5 cm). One of the Banjarese farmers stated that:

> "... we first began to use a long hoe to cultivate the land. By using a long hoe, the soil is reversed slightly so that the sour part of the soil does not go upside down. If the acid soil is reversed, then the rice plant will die of poisoning ..."

Figure 4: The long hoe

The long hoe is used by swinging it from the top rather than sideways, so it only touches the ground a little. This avoids the exposure of the pyrite layers in soils, which can potentially cause pyrite oxidation. Th long hoe was developed hundreds of years ago as an adaptive equipment. The soil tillage system using a long hoe is known as minimum tillage in modern agriculture. It is reinforced by the results of the study. which explained that Banjarese farmers optimise the tillage by using the long hoe. The tillage was done simultaneously with the management of grasses and straws as a conservation effort for the soil because of the grasses and straws that are returned to the soil function as organic fertilisers (Figure 5).

The key to the success of using swampland is the management of organic matter. This has been realised by local farmers who use weeds, grass, and crop residues in the form of straw to be returned to the soil during land preparation. Organic fertilisers are well-balanced for long-term soil fertility (Nguyen *et al.,* 2019). Aside from being organic fertilisers, the grasses and straws that are evenly spread over the surface of paddy fields also serve as a suppressor of weed (Keeney & Cruse, 2018; Manale *et al.,* 2018). Land preparation with the long hoe is considered better, especially on land with a shallow pyrite layer, because this method of tillage can be carried out without exposing the pyrite layer. Soil cultivation by Banjarese farmers can speed up the process of leaching toxic materials and prevent erosion. Traditional tillage aims to: (1) improve the soil structure so that it can hold water longer and (2) control weeds that grow on the surface for easy planting.

Rolling the Grass

Rolling the grass is the activity of rolling or stacking the grass scattered on the fields after the cutting of the grass, with a diameter of 30 cm to 40 cm and lined up on paddy fields (Figure 6). According to the head of farmers and field officers:

> "... rolling the grass is intended to increase the temperature in the mound of the grass, so that the decomposition process works faster ..."

Figure 5: How to use the long hoe in the cutting the grass process

(a) (b)

Figure 6: (a) Rolling the grass and (b) clumping of grass

The grass is usually rolled around 10 days after the completion of grass clearance. The clumps of grass are arranged in rows of paddy fields to make it easier to spread it. Another activity in addition to rolling the grass is combing the grass. Similar to rolling the grass, combing the grass is aimed at facilitating the decay of grasses that have been cut. In the process, grooves are made from the grasses that have been cut down in the farming area called *baluran* (land mounds) (Figure 7). The difference between rolling the grass and combing the grass is rolling the grass is done when the water in the paddy field is less than 15 cm deep so that the bundle of grasses will not be washed away, while combing the grass is done when the water in the paddy field is more than 15 cm deep.

Farmers know how to speed up the process of decomposing the remaining pieces of grasses and straws by doing a reversal. The process of decomposition and the reversal of grasses and straws can increase and accelerate the decomposition process by the *aerob* bacteria (Moinet *et al.*, 2018). Yusuf *et al.* (2021) showed that the composting process is proven to reduce greenhouse gas emissions and increase rice production. Although farmers do not know the role of these bacteria, they know how to

(a) (b)

Figure 7: (a) Combing the grass and (b) land mounds

effectively decompose the weeds and grasses based on their experiences and the knowledge they have.

Flipping the Grass

Flipping the grass is the activity of flipping the bundles from the bottom to the top, so that the spun grasses quickly decompose. This activity is done approximately 15 to 20 days after the rolling the grass process. According to a respondent:

> "... if there is a delay in soil processing that results in an imperfect process of decomposition, then the grasses and straws in the paddy fields are not going to be disseminated ..."

The bundles will be transported to the edge of the paddy field. If the bundles are formed at the edge of the paddy field, then it will be kept in the same place. The activity of transporting the remaining pieces of grasses and straws is known as *baangkut* (lifting the grass) and done manually or with the help of a tool called *kakakar* (pitchfork*)* (Figure 8).

Spreading the Grass

Spreading the grass is the activity of spreading the grasses in the form of decaying bundles that are used for additional nutrients in the soil (Figure 9a). This activity is generally conducted about 10 to 15 days after the flipping the grass process. After grasses and straws are mowed, paddy fields are then given lime with a dose according to the abilities of the farmers (averaging about 350 kg/ha). Several studies have shown that the provision of various types of ameliorants, such as ash and acid, can improve some of the chemical properties of the soil, as well as the total phosphorus and nitrogen contents, which will positively affect the productivity of crops in swamplands (Maftu'ah & Nursyamsi, 2019; Moinet *et al.,* 2018; Susilawati *et al.,* 2019; Yadav & Pandita, 2019). After the grass has been completely spread, the land is ready for planting (Figure 9b).

(a) (b)

Figure 8: (a) Lifting grass and (b) using a pitchfork

(a) (b)

Figure 9: (a) Spreading the grass and (b) land ready for planting

With local wisdom, Banjarese farmers have managed the layers of the swamp soil by not performing excessive tillage so that it is safe for the plants. Using soil knowledge, we can design land uses based on the type of land and crop needs (Sulaiman e*t al.,* 2019). This kind of farming activity creates sustainable agricultural activities. The traditional ecological knowledge in local wisdom is essential for the sustainability of natural resources and agroecosystems (Altieri, 2018; Molnár & Berkes, 2018; Nelson & Shilling, 2018).

In the system of cutting, rolling, flipping and spreading the grass system, grasses and straws are mowed then left to decompose naturally so that it is returned to the land as organic fertilisers. Organic fertilisers are environmentally sustainable and can maintain soil health when used in intensive rice agriculture (Moe *et al.,* 2019). In tidal swamplands the source of organic matter to increase soil fertility comes from the combination of rice straw with other vegetation that grows on the land (Yusuf *et al.,* 2021). Traditional land preparation is a fairly good organic matter management system. Therefore, traditional farmers rarely or only a few, use artificial fertilisers.

The minimum tillage accompanied by 30% and 60% mulch closure can improve soil physical properties, including increasing the soil organic content, and aeration and water pores (Jena, 2019; Kaurin *et al.,* 2018; Wells *et al.,* 2019). Land set up by Banjarese farmers is different from the farmers' community in Pachmarhi Biosphere Reserve in India. The farmer community in Pachmarhi Biosphere Reserve set the agricultural land by burning bushes and weeds, believing it will increase soil fertility. Banjarese farmers do not do so because it is believed otherwise that it will make the soil infertile. Burning rice stalks makes some of the nutrients disappear, especially volatile nutrients and the make other nutrients for plants unavailable, causing the soil to become infertile (Jena, 2019; Kulsawat *et al.,* 2019).

Since ancient times, Banjarese farmers have not applied inorganic fertilisers because the type of rice grown is a local type that is not suitable for inorganic fertilisation. Based on the information from the field officers, the restoration of straws to paddy fields is the same as giving potassium fertilisers because 80% of the potassium content in rice plants is found in straws. Rice straws are a very important source of organic matter in local rice cultivation in tidal land. This is due to the fact that compost rice straw can increase the availability of phosporus, potassium, calcium and magnesium in the soil (Noor *et al.,* 2014). Therefore, rice straws (crop residues) have a high strategic value for paddy fields. Continuous soil cover, by live vegetation (cover crop) or dead crop residues mulch, is essential to the effectiveness of conservation agriculture (Kulsawat *et al.,* 2019; Singh *et al.,* 2018; Zhang *et al.,* 2019). Crop residue retention as residue mulching (rice straw) significantly improve crop productivity, microbial biota, and enzymatic activities of the soil, but it increases the energy consumption and carbon footprints by around 10% (Lal *et al.,* 2019). Crop residues are materials (non-photosynthetic plants) left on cultivated soils after the crops have been harvested. They are considered an effective measure against erosion because they can improve soil structure, increase the soil organic matter content, reduce evaporation, and fix the carbon dioxide content in the soil (Durán-Lara *et al.,* 2020). Moreover, they can be used in the production of biofuel, and this is reinforced by the results of a study by Noor *et al.* (2014) that showed that 2.5 tonnes/ha of rice straws restoration can decrease the acidity or the soil pH from about 3.5 to 4.5 and increase the potassium content. Other benefits of using (organic) mulch include the conservation of soil and its moisture, regulation of soil temperature and reduction of pests and diseases (Sims *et al.,* 2018). In addition, mulch with organic matter can increase soil nutrition, maintain optimal soil temperature, and inhibit weed growth (Ranjan *et al.,* 2017). Based on the results of some studies, it can be concluded that the restoration of organic material in the system of cutting, rolling, flipping and spreading the grass was able to improve the acidity and fertility of the soil.

The conservation rules in the system of cutting, rolling, flipping and spreading the grass are a form of environmentally friendly tillage by maintaining the originality of the land to create sustainable agricultural activities. That sustainable agriculture means utilising natural resources (land and water) by minimising environmental damage to meet the needs of human life (Chen *et al.,* 2018; Tricase *et al.,* 2018). In addition, the system of cutting, rolling, flipping and spreading the grass owned by Banjarese farmers also meet traditional conservation principles. This conservation principle is the main source of traditional knowledge (Garg, 2018). Traditional knowledge can provide real-life experiences in dealing with changes in the surrounding environment. The following are the explanation of traditional conservation principles: (a) Respect that promotes harmony of human relationships with the natural surroundings. In this case, traditional societies tend to view themselves as a part of nature itself, (b) The sense of belonging among the community over a region or natural resource as a communal property resource. This sense of ownership bonds all citizens to look after and secure these shared, (c) Local knowledge systems give communities the capabilities to solve problems they face using limited natural resources, (d) Adaptive ability in using modest technology with expeditious and efficient energy in accordance with local natural conditions, (e) The system of allocation and enforcement of customary rules that can secure common resources from excessive use, either by the society itself or by outsiders (migrants). In this case, traditional society already has customary rules and laws governing all aspects of social life in a particular form of social unity and (f) The equity mechanism (distribution) of crops or shared resources can prevent excessive inequalities in traditional society. The absence of jealousy or social anger will prevent the theft or use of resources beyond the applicable customary rules (Nowak & Korsching, 2018; Pradhan *et al.,* 2018; Prestele *et al.*, 2018).

Besides having conservation rules, the system of cutting, rolling, flipping and spreading the grass is also included in the minimum tillage. Minimum tillage is a soil conservation technique in which mechanical disturbance to the soil kept at a minimum (Nowak & Korsching, 2018). The use of zero tillage promotes an increase in soil density by the end of the vegetation period to 1.36 in the upper 0-10 cm of the soil layer (Sherer & Chumanova, 2017). Apart from a clean environment, soil health was also improved by the adoption of zero tillage in terms of the nitrogen, phosphorus and potassium content, the labile pool of carbon and enzymatic activities; the population of all the microbiota was increased, which was around 21.3%, 51.2% and 27.6% higher in terms of bacteria, fungi and actinomycetes, respectively (Lal *et al.*, 2019). The application of minimum tillage has a positive impact on enzyme activity in the soil to improve soil quality (Sherer & Chumanova, 2017; Tarfasa *et al.,* 2018). Minimum tillage aims to improve soil health and reduce negative impacts caused by intensive farming. This is supported by Li *et al.* (2020), who stated that minimum tillage aims to improve soil health and reduce the negative impacts caused by intensive farming. Furthermore, Kassam *et al.* (2019) described the advantages of the application of minimum tillage, which are (1) avoiding damage to the soil structure, (2) reducing surface flow and erosion, (3) slowing the mineralistion process, so the use of nutrients in organic materials is more sustainable, (4) less labour and (5) can be applied to marginal land, such as tidal swamplands.

The system of cutting, rolling, flipping and spreading the grass is also included in environmentally friendly technologies. The principle of environmentally friendly technology is not to damage and pollute the environment in regards to natural resource utilisation, waste disposal and the safety of the surrounding environment (Adnan *et al.*, 2018; Ram *et al.,* 2018). The application of environmentally friendly technologies are in line with organic farming goals by the International Federation of Organic Movements (IFOAM), in which organic farming should preserve and improve the health of the soil, plants, animals, humans and the planet as one and indivisible (IFOAM, 2021).

To apply technology, we need to consider local citizen participation, integrative development, integrated management and local wisdom. The sustainability of agriculture in tidal swamplands is an indicator of success in managing ecosystems, so the ecosystem provides results over a relatively long period of time (Hastuti *et al.,* 2019a). Sustainable agriculture can raise productivity and meet sustainability criteria to satisfy increasing human needs while contributing to the recovery and sustainability of landscapes, the biosphere, and the earth systems (Hu *et al.,* 2019). Moreover, ecoagriculture aims to manage the resources of rural communities to improve their welfare, preserve biodiversity and ecosystem services, and develop more productive and sustainable farming systems (Wang *et al.,* 2019; Zhang, 2019). Overall, the complex knowledge stems the possibility of exploitation of sustainable sources of energy in the region. For sustainable agricultural development to be successful, a comprehensive and synergistic collaboration between the community and stakeholders is needed (Noor & Sosiawan, 2019).

The importance of sustainable agriculture is in terms of management and conservation based on natural resources, ensuring the fulfillment of current and future human needs. Sustainable agricultural development aims to preserve the soil, water and genetic resources of plants and animals, and not damage the environment, and is technically and economically feasible and acceptable to the community. The sustainable agriculture programme set by the government should pay attention to the local wisdom factor owned by the local community as they are in direct contact with the environment of the object of development.

The practice of local wisdom by Banjarese farmers in tidal swamplands shows that the land needs time to restore nutrients with organic materials before the replanting process is carried out. Traditional agricultural technology that is environmentally friendly and in accordance with appropriate technology will provide economic benefits for the community and it was developed as an effective response to increasing production on the basis of market demand. Synergistic and harmonious integration in the management of land and water resources between the government, environmentalists and local wisdom and the culture of a community is expected to be an effective strategy for soil and water conservation (Maridi, 2015).

Conclusion

Banjarese farmers own the local wisdom of tillage in tidal swamplands, known as the system of cutting, rolling, flipping and spreading the grass. In this system, grasses and straws are mowed and then are left to decompose naturally so that it can be returned to the land as organic fertilisers. The tool used to cultivate the land in this system is the long hoe. It prevents the exposure of the pyrite layer, which can increase soil acidity. The local wisdom in the system of cutting, rolling, flipping and spreading the grass owned by Banjarese farmers shows the value of conservation for tidal swamplands. Land conservation by Banjarese farmers through this system certainly supports the realisation of the sustainable agriculture concept, especially in tidal swamplands.

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Appendix

Appendix 1: Secondary data and list of agencies

No.	Data	Data Source
1	Geography and demographics of the research area	The Central Bureau of Statistics of Mekarsari District
2	Number of farmers	The Agricultural Extension Centre
3	Agricultural land area	The Agricultural Extension Centre
4	Variety of paddy, type of swampland	The Department of Agriculture, Food Crops and Horticulture of Barito Kuala District, South Kalimantan

Appendix 2: Interview summary

No.	Informant Code	Information	Rationale
1	Informant 1, 2, 3 7, 8, 16, head of farmer	The first thing to do on tidal rice fields is to prepare rice seeds to be used. This work coincides with preparing the fields. This is done so that when the rice seedlings are mature enough to be planted, the rice fields are. Because rice fields in tidal swamps needs to undergo an extensive process until the land is ready for planting.	Tidal swampland agriculture
2	Informant 2, 4, 5, 6, 8 and 12	The first thing to do before planting rice is to clean the straw and grass in the fields.	Local wisdom in tidal swamplands
3	Informant 1, 6, 7, 9, 10, 11 and 16	Grasses that have been cut are twisted or combed so that it decays quickly. If the water is deep, the grasses are just combed, but if the water is not that deep, the grasses can be rolled.	Local wisdom in tidal swamplands
4	Informant 1, 2, 3, 11, 12, 13, 14, 15, head of farmer and field officers	The rolling activity is intended to increase the temperature in the mound/spill of the grasses, so that the decomposition process runs faster.	Local wisdom in tidal swamplands
5	Informant 4, 5, 6, 12, 15 and 16	The spun or combed grasses are then turned over so that they decay quickly.	Local wisdom in tidal swamplands
6	Informant 1, 2, 3, 4, 5, 15, 16 and field officers	After about two weeks, the grasses that have been turned over are then spread onto the rice fields (this decayed grass acts like fertilisers) so that the rice plants can thrive.	Local wisdom in tidal swamplands
7	Informant 5, 6, 7, 15, 16 and head of farmer	We have been using *tajak* to cultivate the land here. By using a tread, the soil is only slightly overturned so that the acid soil does not tip over. If the acid soil is turned upside down, the rice plants will die of poisoning.	Local wisdom in tidal swamplands
8	Head of farmer and field officers	The activities of cutting, rolling, flipping, and spreading the grass is a land management method that can prevent soil degradation and increase soil organic matter content.	Sustainability agriculture

No.	Informant Code	Information	Rationale
9	Head of farmer and field officers	The process of tillage carried out by Banjarese farmers is minimum tillage process and is included in the rules of land conservation, where minimum tillage and land conservation is one of the concepts of sustainable agriculture.	Sustainability agriculture

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