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RESEARCH ARTICLE

Tidal Swamps Development in West Kalimantan: Farmers Prefer A Rational-Moderately Strategy

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Abstract The Indonesian government has spent lots of budgets and built more infrastructures to escalate the intensive rice farming in the tidal swamps since 1970s. However, the success story is very limited. This study aims to describe some obstacles in the practice of rice intensification, and also to explain some factors leading to their failure. In explaining this context, we refer them to our-own-experiences in tidal lowlands development project from 2008 to 2009, literatures study, and then it is deepened by doing collectives case study –that is consisting of three studies in the type of-B, C, and D overflows. The local farmers used to reject the intensive rice farming practices. The use of local paddy varieties is a prefer strategy option. It is closely related to minimize the farming cost and also as a strategy so that they have more time to manage another farm activities. Rationally the farmers prefer growing a variety of perrenial crop species that suits their personal needs and strategies. In conclusion, this study showed that agro-ecological based farm could be the most adaptive way in optimizing the indigenous rice farming.

1. Introduction

In Indonesia, the farmlands conversion in last three decades tended to increase. The reasons for the conversion are closely related to the population growth and the expansion of urban areas, especially as occured in Java—the most populated islands (Harini et al., 2012; Dian Wisika Prajanti, 2014; Maryati, Humaira, & Pratiwi, 2018). Currently, the decrease in rice-field areas has been considered as an extraordinary condition, due to its possible serious impacts in threatening the national food sovereignty and the deterioration of environmental quality.

Some efforts have been done by the government to maintain national food sovereignty. One of those efforts is the government declared the regulation concerning farmlands protection, as stated in the National Act 2009 No. 41 about the farmlands protection for food sustainability. Another effort is the government has opened the new paddy farmlands or reclaimed potential land in the tidal swamps areas.

In last three decades, the tidal swampland had become the direction of the government policy for farmlands provision, especially for paddy. This policy refers to the land size potency that spread across in the several provinces in Indonesia. According to Arsyad, Saidi, & Enrizal (2014), referring to the data collected from various sources, the estimation of the tidal swamplands areas in Indonesia is about 20.13-25.82 million hectares. Their distribution is in Sumatera about 8.41 million hectares, Papua 7.49 million hectares, and Kalimantan 6.99 million hectares (Suryadi, 1996). Meanwhile, in West Kalimantan Province the tidal swampland areas that have been reclaimed or cultivated are about 378,936 hectares (Sudana, 2005).

Although the amount of tidal swampland is quite extensive in size, this land type is categorized as marginal land that is located near the coastal areas, so that the ecosystem of these areas is in transition between both terrestrial and the sea. Therefore, the opening of these areas for rice-fields requires specific management, because it is very susceptible to damage. The farming production methods known to have a direct impact on natural resources and the environments around it, either in the form of coastal forests damage or land and water pollutions. Local farmers open up this areas were prudently based on their indigenous knowledge that was inherited from the long term experiences. It was firstly practiced by the Buginese farmers, and then the practice became very well known and well-adopted in the opening of new tidal swamplands not only in West Kalimantan but also in other part of Indonesia.

The above description gives the sense that the population problems in Indonesia have forced the government to look for and develope new farm lands as a substitute of that land use conversion. Based on the potency and its availability, the tidal swamplands are considered to be the most potential land to replace the land loss due to land use conversion, especially those from that of non-tidal swampland area. However, due to some of various problems faced, the efforts to develop the tidal swamplands for rice cultivation might face many obstacles that sometimes relatively difficult to overcome. Some obstacles consist of the problems either at

the farmer level or at technical barriers that closely related to the land resource characteristics.

The complexity of rice farm problems in tidal swamps has also been occured in Kalimantan. The government's efforts to increase the rice farming productivity since1970s had fail to get an optimal results (Panggabean & Wiryawan, 2016; Subagio, 2019), because most farmers tended not to adopt the practice of intensification strategy such as not to grow the high yield paddy varieties (Hidayat, 2016). In other words, the rice intensification program is mostly rejected by farmers in the tidal swamplands. Meanwhile, the indigenous farming practices are considered by the government as no longer in line with fulfilling the need of rapid population growth.

This study is to find out some factors that causing the farmer not to adopt the high yields paddy varieties (intensification) as an effort to obtain the information concerning the rice farming development that more appropriate to both the farmers and the tidal swamp land characteristics. Specifically, this study objective is formulated as follows: (a) to describe some obstacles in applying the rice farming technology in the tidal swamps especially in West Kalimantan, and (b) to analyze some factors that led to the failures of rice intensification programs.

2. The Methods

This study is a critical review and a brief evaluation to the agricultural development process in the tidal swamps of West Kalimantan that has been carried out by the Indonesian government for almost five decades. To understand this context, firstly, we referred our study not only to our experiences concerning the tidal swamps development, but also to literature studies. Secondly, in deepening of these contextual problems, the qualitative case study was also conducted in order to understand various more complicated problems faced by the farmers.

The collective case study had been conducted in two villages of Kubu Raya Regency —one of the seven regencies in the coastal areas of this province. The selection of this regency was based on the consideration that as the region their overall areas are tidal, while the village selection referred to the representation of the agro-ecological type of-B, C, and D overflows picturing the general condition in West Kalimantan. The selected villages for study sites were the village of Punggur Besar and the village of Punggur Kecil. Although these two villages are adjacent, they differ in their agro-ecological types. Punggur Besar represents the rice farming areas in the type of-B overflow, while Punggur Kecil represents the type of-C or D overflows (Figure 1). Therefore, they are having the agro-ecological type that appropriate for explaining the phenomena being observed in this study.

The data collection was done by conducting field observation, in-depth interviews, and focus group discussions (FGD). Both in-depth interviews and FGD were conducted not only for the farmers, but also for the community leaders, and the village government officers. These participants were determined purposively by referring them to their ability to provide not only the information but also the data diversities. The number of farmers involved was 33 people, it was consisting of 9 farmers in type B overflow and 12 farmers in the type of C and D overflows. Meanwhile, the number of community leaders involved was 5 people and village government officers were 4 people. In practice, all collected information was verified and cross checked. Comprehensively, this study was divided into five parts. Firstly, the overview of the agro-ecological characteristics of each study site. Secondly, the explanation of the rice farming problems and some constrains primarily faced in the technology innovations. Thirdly, the description of the farmer reasons not to use high yield paddy variety as the component of intensification practices. Fourthly, the explanation of the rice farming adaptation based on indigenous knowledge, and finally, the reviews of the agro-ecological aspects as a philosophical background in determining the adaptation of rice farming system in the tidal swamps of West Kalimantan.

3. Results and Discussion

The Agro-ecological Characteristics Overviews

In West Kalimantan, the rice farming practice in the swamplands mostly located in the tidal swamp areas near to the coastal area of the Karimata Strait with the coastal length

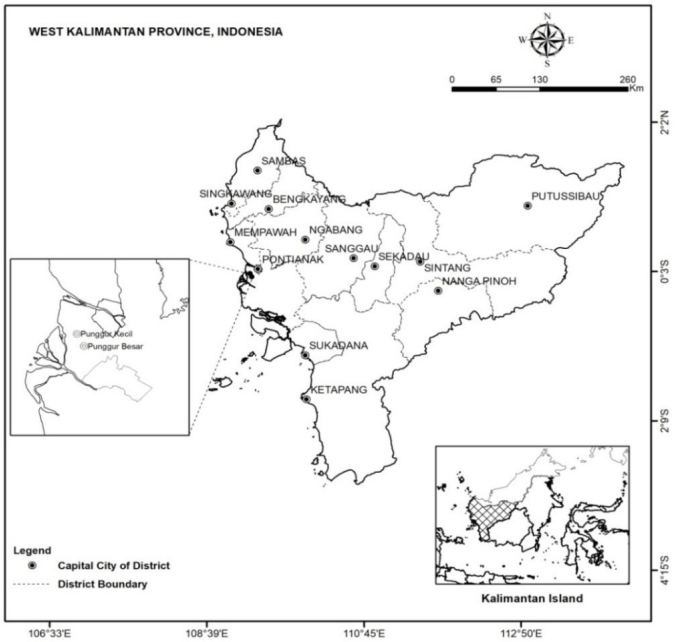

Figure 1. Punggur Kecil and Punggur Besar as the Case Study Site

about 1300 km. Meanwhile, the non-tidal swamps are generally located in the valleys around the hills, known as the shallow swamps. In the tidal swamps, it mostly has the type of-C or D overflow and in a very small amount of it has the type of-A or B overflow. Referring to the potency of land areas, in order to support the achievement of national food sovereignty, the central government has put a serious big attention in the development of these swamp-land areas.

The tidal swamplands, in this province, had been cultivated since more than one century ago when the Buginese migrants arrived in the areas. They built the villages and grow paddy as their main stapple food commodity. It brings up to the most of their land use. However, the source of income is not only dependent on the rice, but also on the perrenial crops as their alternative commercial commodities (Table 1). The topography of this area is commonly flat with the elevation varies from 0 to 2 meters above the sea level.

In the case of study site, the Buginese farmers in the village of Punggur Besar and Punggur Kecil open up the area in along the Punggur River near to the coastline. They commonly build the ditches as drainage channels both for the cultivation of rice and perrenial crops species. Ecologically, the rice-fields in Punggur Kecil are not overflowed during both the small and big tide seasons. One aspect greatly affected by the tide is only the water level fluctuation in aquifer, mainly in the type of-C or D overflow. Conversely, in the village of Punggur Besar, most of rice-fields are always overflowed during the big tide, but not overflowed during the small tide (type-B overflow). Facing these ecological conditions, subsequently it has resulted in some local wisdom especially in land cultivation, including the selection of the crops species adaptive to the local tidal swamps characteristics.

The crops species grown in these villages are very various. Generally, paddy is mainly cultivated in monoculture pattern. On the other hand, perrenial crops such as coconut and *langsat* are cultivated in both ways monoculture and polyculture (agro-forestry). The crop types found in a more complex polyculture commonly consist of coconut, *langsat*, banana, durian, and beetle-nut.

Rice Farming Problems and Some Constrains in Technology Application: A Field Experience

Rice intensification in the tidal swamplands requires special attention related to the complexity of the land

Table 1. Some Crop Types as Source of Farmers Income in the Tidal Swamps of West Kalimantan

Crops Types	Scale	Important Characteristics
Paddy (*Oryza sativa L.*)	Belong to many farmers Farm size about 0.5 to 1 hectare	• No tillage • Local paddy varieties: *Ketumbar, Pulut Sagu, Pulut Hitam, Ring-kak Condong, Ringkak Semut, Siam Ketupat, Pelimbung, Renden, Sirendah, Sirendah Bulat* ++, *etc.* • Low dose chemical fertilizers • Planting frequency: once a year • Productivity: 1.5-3 ton ha^{-1}
Coconut (*Cocosnucifera L.)*	Belong to small number of households. Farm size about 0.5 to 2 hectares	• Local coconut variety: *Kelapa Dalam*++ • Harvested quarterly • Main production is copra, and left sold as granule • Planted either as monoculture or as mixed polyculture, inter-cropped with durian, banana, beetle nut, etc.
Langsat++ (*L. domesticum var. pubes-cent*)	Belong to small number of households	• Harvested annually and planted monoculturally • Only in certain villages such as Punggur Besar & Punggur Kecil, about 20 km from Pontianak** • Households important income • Belong to the high social status person
Siam citrus *(Citrus nobilis var. micro-carpa)*	Belong to many farmers	• In certain district–such as Sambas, about 300 km from Pontia-nak** • Households important income
Beetle nut (*Areca catechu L.*)	Belong to small number of households	• Harvested periodically • Planted as the border plants, side of ditches or irrigation channels
Rubber (*Heveabrasiliensis M.*)	Belong to small number of households	• Harvested periodically • Commonly planted as monoculture in the type of-D overflow areas • Households important income

Keys: ++ local name, ** the capital city of West Kalimantan Province (see Figure 1).

resources characteristics. The main technical problems associated with the presence of pyrite layers in the soil which further lead to the increase of the soil acidity levels, nutrient deficiency, or the possibly of poisoning by certain elements (such as Al^{3+}, Fe^{2+}, organic acids) that might inhibit the paddy growth (Nurita & Saleh, 2016). Therefore, scientifically, to improve the rice productivity in tidal swamp land requires more specific water arrangement which is different from that of water management in the irrigated rice -fields. Generally, some specific problems and constrains refer to the literature studies and our-own-experience as illustrated in Table 2.

Water management in the tidal swamp lands requires water channels which consist of secondary, tertiary, and quarterly channels, as well as the ditches in the farm lands. The existence of these water channels is a part of technology package in water management. When the tide occurs, to retain the water into the rice-fields, the water channels must be equipped with the gates. The water channels and gates are operated both to flood rice fields when paddy crops need more water, and to drive out water when paddy crops need less water. In addition, in early growth periods, when paddy crops are still young, the water in the rice fields must be periodically flushed out. The water excluding is executed when the water in rice-field already contains high acidity levels, and then it needs to be replaced with the new fresh water.

This above water management technology has long been introduced by the government since New Order reign era. In West Kalimantan, it was firstly introduced in the resettlement program areas in the coastal and then continued in many places. The water channels in these areas were completed with sliding gate with door walls made of iron plates or wood that water resistant (Figure 2). Unfortunately, these water channels and gates were not operated effectively by the farmers, because this "new" technology was not followed up with the training for both their operation and maintenance. Because of lack understanding on maintenance of this technology, in fact, most of the gates had never been operated until they finally impaired. Up to now, common farmers still not understand yet concerning the wanted purposes of this technology. It was also found that the operation procedures of the sliding gate is impractical, so that it is very difficult for the farmers to operate them. As an illustration, who is the person will be responsible for opening and closing the gates when the tide is occured. Generally, there is no one responsible for operating the gate. There is also a difficulty, when the gate is far away from the farmer's settlements. This fact also shows the weakness found in the community level that there is no specific farmer group or organization responsible for a good water management in this study area.

In the future to overcome the ineffectiveness of the present sliding gate operation, the government should introduce a flap gate technology that made of fiber material (Figure 2). The flap gate technology is considered more practical and more effective because the operation is so simple, and it can be operated easily by the farmers. The operation is only by shifting of the flap gate, that is the flap gate is placed in the inside (facing to the farmlands) when the rice-field needs watering, and then the flap gate is shifted back facing on the outside (facing to the secondary channels) when less water needed in the rice-field.

For the first time, the flap gate technology was introduced by the Indonesian government in Telang Saleh, South Sumatera. It was supported by the Dutch government through a pilot study of the Land and Water Management Tidal Lowlands (LWMTL). It has so far shown a significant success in increasing the rice productivity that reached about 6 tons ha^{-1}, and more importantly currently the paddy crops

Table 2. The Rice Farming Intensification Problems and Constrains in Tidal Swamplands of West Kalimantan

Types of Problems and Constrains	Important Characteristics	Implications
Land characteristics	• The presence of pyrite layer in the soil • Nutrient deficiency • The possibility of poisoning by certain elements: Al^{3+}, Fe^{2+}, and organic acids	• Soil acidity • Inhibit paddy growth that implicate to the low productivity
Water management	• To overcome soil acidity, it needs proper water management • It requires both the gates and water channels which comprises the secondary, tertiary, and quarterly channels, as well as the ditches in the farmlands	• Very expensive investment • It needs well-organized farmers to operate and maintenance the gates and channels, and also it requires a togetherness in planting the crops types at the tertiary channels.
Physical characteristics	• In some places, there are sandy soil layer found beneath the soil surface	• Frequent leaks and landslide occured near the dike
Institutional Characteristics	• Land tenure problems: in many places, the rice field in a small cluster of the farmland area, although it was cultivated by many farmers, the land only belong to a very few farmers	• The sense of belonging to the farmlands is very poor • It is difficult to built a strong spirit of togetherness among the farmers • This institutional barrier is very difficult to overcome

(a) Flap Gate (b) Sliding Gate

Figure 2. The Flap Gate and Sliding Gate for Water Management in the Tidal Swamplands

can be planted twice a year. The success is likely to be achieved through a continuous coaching and training programs in an integrated ways during a 4-year periods. Technology applications include applying a better tillage methods, using high yield paddy variety, regularly fertilizing application, pests and plant diseases controlling, good water managment plan in the farmland to control soil acidity levels, and good post-harvest management, and products marketing (LWMTL Report, 2006).

After the success in South Sumatera, similar project was attempted in West Kalimantan through a pilot study the Strengthening Tidal Lowlands Development (STLD). This study was conducted in two different locations for two consecutive years. First location was in the village of Bintang Mas of Kubu Raya Regency and second location was in the village of Tekarang of Sambas Regency. It appeared that, in West Kalimantan, the introduction of new technology in development of swamp land showed a different results. The farmers were generally less responsive to this kind of intensive technology.

There are several aspects that can be discussed related to the cases occur in West Kalimantan. These aspects are related to both the technical and institutional barriers in managing the tidal swamplands. For example, when the pilot study was about to be implemented, the STLD's teams found it difficult to determine a more suitable and ideal study site. It is mainly related to land tenure problems in a location. The rice field in one location, although it was cultivated by many farmers, the land only belong to a very few farmers. Therefore, the sense of belonging to the farmlands is found to be very poor. This typical of location is less prospective to be used for the purposes of this technology application. It is likely due to difficulty in building a strong spirit of togetherness among the farmers, something urgently needed, in maintaining all supporting facilities that have been built. To the farmers, this fact is an institutional barrier that is very difficult to overcome.

Another obstacle is related to technical barrier faced in the field. In some cases, it was difficult to construct the gate at tertiary channel due to a sandy soil layer found beneath the soil surface. The existence of this sandy soil layer is likely to make it easily eroded by the runoff, so that it will result a leakage surround the gate. It is not surprisingly that there were found leaks and landslide occured near the dike. These conditions showed that in order to build and maintain the channels, dike, and gates facilities requires a very expensive investment.

Some Farmer's Reasons Not to Adopt Intensive Rice Farming: The Case Study

The local government efforts to increase rice productivity in the villages of Punggur Besar and of Punggur Kecil had been done around 1970s in line with the central government policy to develop the tidal swamps since 1969 (Noor & Rahman, 2015). That is in the form of the rice intensification program through the introduction of the high yield paddy varieties, regular fertilization, and insect and diseases controlling, water management, and post harvest handling. At the beginning of the program, the farmers were able to applied all of the rice farming intensification practices, because they got a specific grant scheme including the high yield paddy seeds, fertilizers, and coaching/training program. However, when the program was over, there were no more the grants provided. As a results the farmers returned back to their indigenous farming practices by planting the local paddy seeds, applying less fertilizers, and practicing a minimum pest and disease control. It means the production improvement program through agricultural extension could not be applied yet independently by the farmers.

There might be a different perspectives in viewing the rice intensification practices in the tidal swamps. On the one hand, the government's viewpoint referred to the national interest aspect. Hence, the production and productivity must be improved, as one of the ways is through the use of high yield paddy variety. On the other hand, the local farmer's viewpoint referred to the adaptation aspect in facing many problems that ought to be overcome in the tidal swamps. For this reasons, the farmers were more likely to apply the indigenous farming that was marked by using the local paddy seeds. The indigenous farming is a cultivation practice that refers to the naturally knowledge, provided through a deep connectivity to the environments or lands (Kapyrka & Dockstator, 2012). In other word, the indigenous farming is a tradition practice that has been developed in a long time referring to the knowledge, wisdom, and the communities learning as a form of the adaptation to the tidal swamps environmental characteristics and the handicaps.

The farmer option to grow local paddy varieties is closely related to their subsistence orientation. The rice farming is not for a commercial purpose, but it is intended merely to fulfill the household food security needs. In this case, it can be inferred from the farmer's attitude that there is no budget provided to support the numbers of insistent in the rice productivity improvement program.

Although the local paddy varieties need more cultivation periods (about 5 to 7 months), it is more preferred by the farmers because when planted they do not require much fertilizers. Besides that, the flavor and nature of the local rice varieties are also preferred because they are likely to fully satisfy in longer period. Conversely, the nature of rice of high yield paddy variety is softer, so that according to the farmers, it will cause being hungry quickly. It will disrupt the farmers' activities when they are working all day in the rice-fields. Moreover, according to the wives, the flour of local rice varieties is also very suitable for making the traditional cakes. It is known that the farmer's wives are skillful in preparing food dishes, either for the need of a traditional ceremony or for sale in the local markets. In addition, the price of local rice is also more expensive than that of high yield varieties and the local un-hulled-dried paddy is also more durable stored as food reserve. Referring to the farmer's experience, it can be stored for more than one year.

Sometimes, the experience about the difficulties and failures in cultivating the high yield paddy variety has created the negative views concerning the intensification technology.

However, the farmers do not fully reject the modern farming technology. Evidently, they have started to use the chemical fertilizers in low dose, apply herbicides and pesticides in limit occasion. The chemical fertilizers adoption in indigenous farming is inseparable from the offensive programs of government in supporting the achievement of productivity and production targets. This government program is an agriculture extension package that is conducted by the agricultural board at district level. Usually in every village, there are farmer groups formed for more easily in facilitating and coordinating the program. The complementary practice between indigenous and modern knowledge is a new adaptation as the most common response of the farmers in finding the best manner to suits their needs (Moyo, 2009).

Economically, the farmer's strategy to use local paddy varieties at least gives two positive benefits. Firstly, it is minimize farming costs, and secondly, the farmers have more time to do another job which has higher economic profit than that of rice. The perrenial crops cultivation is one of a strategy option. This is because the perrenial crops not only have higher profit, but also it generates income in cash periodically. Therefore, the crops types in the tidal swamplands tend to be more varied, as a form of the farming diversification (Table 1). Some commodities from these villages that have been marketed routinely to the local market include banana, durian, *langsat*, and coconut, while the beetle nut is produced for export market (Figure 3). Meanwhile in some other areas, there are also palm oil and Aloe Vera cultivated as commercial crops. Another option for livelihood strategies, some farmers work in the non-farm sectors or sometimes as fisherman too.

The farmer strategies above are very rational if it is based on the calculation of the farming cost when they use the high yield paddy varieties. The farming cost for rice intensification includes purchasing seeds, chemical fertilizers, pesticides, and agricultural lime. On the one hand, the standard of fertilizing consists of the nitrogen fertilizer (*Urea*) about 250 kg ha^{-1}, phosphor fertilizer (*Super Phosphate-36*) 150 kg ha^{-1}, potassium fertilizer (*Potassium Chloride (KCl)*) 100 kg ha^{-1}, and the agricultural lime about 300 kg ha^{-1}. On the other hand, the productivity is difficult to achieve the optimal target. Based on the observation of the LWMTL's team, the farmers in the tidal swamplands will not switch to the high yield paddy varieties if the yields do not achieved 6 tons ha^{-1} (LWMTL Report, 2006). In line to this context, a study shows that the local rice farming based on indigenous knowledge is more economically efficient than that of migrant farmers which are relied on conventional ways (Kurniawan & Aurbacher, 2015). Nationally, the fact shows that the production potency through modern input of 700 thousands hectares was about 6.5 million ton of dried paddy year^{-1}, but in reality, it only got about 600-700 thousand tons (Noor & Rahman, 2015). Briefly, the comparison between the intensive rice farming and the indigenous farming knowledge is illustrated in Table 3.

(a) Beetle Nut (b) "*Langsat*"

Figure 3. Some Commercial Products from the Tidal Swamps: Beetle Nut for Export Market and "*Langsat*" for Local Market

All the above description proves that the rice farming intensification program in tidal swamplands is relatively unsuccessful. It does not a dichotomy between the indigenous and the modern knowledge, but it is difference choices in determining the livelihood strategies and adaptation to the land resources characteristics. It means that the tidal swamplands potency have not fully supported yet the national food sovereignty. Thus, as policy implication, the protection of the irrigated farmlands from the conversion cases, especially in Java, must be a priority.

In last decades, there are available more alternatives of commercial crops to be potentially cultivated in the tidal swamplands, namely palm oil, rubber, etc. As the result, there arise an opportunity for rice field to be converted into those of some commercial crops plantation, such as occurred in Belawang-South Kalimantan (Panggabean & Wiryawan, 2016) and in Tanjung Jabung Timur, Jambi Province (Adam et al., 2013). In line with these phenomena, the rice field conversion has also been occurring in the tidal swamps of West Kalimantan following the increase of palm oil business development, particularly occured in the types of-C or D overflow areas. For instance, the rice-fields conversion into independent smallholders palm oil had been occurred in some places in Sambas Regency—about 300 km from Pontianak.

Rice Farming Adaptation Based on Indigenous Knowledge: The Case Study

In both villages of Punggur Besar and Punggur Kecil, the rice cultivation process consists of nursery, land clearing, planting, fertilizing, maintaining, and harvesting. The land clearing process is begun by spraying to the lawns and shrubs using herbicides, slashing, and herbicide spraying again, then continued by planting. The planting practice is conducted using specific local apparatus, called *tugal* (see Table 3). This practice is as a consequence of no tillage method.

In the village of Punggur Kecil (types-C or D overflow), the paddy crops sometimes were fertilized with the minimum dosage of chemical fertilizers, and it is commonly applied once following the cultivation practices. The aim of applying chemical fertilizer is just to add some nutrients for supporting a better paddy growth. It is applied about 1 to 2 months after planted or it is immediately done following the weeding. In average, the dose of chemical fertilizers applied in Punggur Kecil tended to be more than that of in Punggur Besar (type-B overflow). Even in many cases there were no chemical fertilizers applied in Punggur Besar. According to the farmers, their rice-fields in Punggur Besar are belief to be more fertile than that of in Punggur Kecil, so that there is no need to apply fertilizers, such as it is expressed by a key informer, as follows:

> "*The tide overflowed into the rice-fields in Punggur Besar functions like a fertilizer, so that the paddy crops do not required the chemical fertilizers*"

The paddy growth in Punggur Besar is closely related to the tide. When there is a big tide, it will clean the rice-fields from acid compounds, so that it will decrease the soil acidity levels. Hence, it will make it being a beneficially conducive environment for the paddy growth. Furthermore, in some

Table 3. General Comparison between Intensification and Indigenous Strategy in Rice Farming

Element of comparison	Intensification	Indigenous
Seeds	High yield varieties: *Inpara 2, Inpara 3, Inpara 4, Inpara 5, Ciherang, Pioneer*[++]	Local varieties: *Serandang, Sempurna, Ringkak Semut, Ringkak Krawang, Ringkak Tumpang, Buntut Krawang, Simpang, Siam Ketupat, Ketumbar*[++], etc.
Land preparation	Using herbicide, slash, and then tillage	Using herbicide, slash, and second herbicide application, no tillage
Planting	Conventional ways	Using local instrument, called *tugal*[+++]
Fertilizing	Applying intensive chemical fertilizers (frequency: twice times)	Less intensive chemical fertilizer (frequency: once)[++++], or no fertilizers
Maintaining	More intensive, more workers	Less intensive, less labors
Weeding	Using herbicide	Using herbicide
Pest Controlling	Using pesticides[**]	Using minimum amount of pesticide
Irrigation	Well-equipped irrigation channels and ditches	Simple irrigation channel and ditches
Farming cost	High-expensive	Less-expensive
Cultivation periods	3 month-the planting frequency: once a year[##]	5-7 month[***]-the planting frequency: once a year[##]
Yield	4.1 ton ha^{-1}[###]	1.5-3 ton ha^{-1}
Time and schedule	Stricted time schedule, limited time for pursuing another income sources	Relatively unstricted time schedule, more spare time for pursuing another income sources

Notes: [++] = Local name
[+++] = Local hand made instrument from pointed wooden-stick (dibble)
[++++] = Nitrogen fertilizer dosage (*Urea*) in Types-C or D overflow is about 100-125 kg ha^{-1}, while in types-B overflow is no chemical fertilizer used.
[**] = High yield paddy varieties are more susceptible to pests and diseases than that of local varieties (Noor & Rahman, 2015)
[***] = More paddy varieties (the variety's age of 5, 6, and 7 months) planted in one rice field.
[##] = The planting frequency is only once a year –it is closely related to the rice farming orientation that commonly just for the farmer's household subsistence.
[###] = STLD Report (2008)

circumstances the tide also bring about some useful nutrients for paddy crops. Conversely, in the village of Punggur Kecil, the rice-fields are less-over flowed by the tide, so that the washing process is fully relied on the rainfall.

The weeding process is usually done either by applying a chemical or mechanical method, depending on the circumstances. Under certain conditions, the farmer do not do a weeding activities, especially when there is not much weeds grow in the rice-fields. When the paddy crops are about 3 to 4 months old, there is not much weeds grow under circumstance already covered by paddy canopy. The next period is harvest waiting time.

Pertaining to these processes, the rice farming in the tidal swamplands in West Kalimantan is carried out using low cost traditional manner. This adaptation can be regarded as a way in optimizing the indigenous farming management which has wisdom values; for instance the farming practices could not be regarded as the polluter agent to the environment because the farmers apply only low dose of the chemical fertilizers. In this context, there is a common deep resiprocal bind among economic, social, and cultural in operating the indigenous knowledge (Briggs & Moyo, 2012).

This wisdom has taught about the important role of the indigenous knowledge. Basically, the local origin farmers who have stayed long in a location are supposed to know much about the circumstances and the numerous aspects of the local environmental conditions. The farmers in Punggur Besar already have their own knowledges about the farming practice in the tidal swamp lands. For instance, they have established ditches in farmland for drainage purposes. They do not allowed any puddles occur in their garden land. Hence, they set up small dikes around the farmland to hold the overflow of the tide. Even, in Punggur Besar, it had existed since the past time which applied the flap gate principle traditionally to protect the farmlands. The farmers made the flap gate by using simple equipment. It consists of a pipe that is equipped by the gate which made of from cement's bag, such as it is shown in Figure 4. This flap gate construction is cheaper than that of modern ways, but it has long durability because it is made of from water resistant material. The flap gate in Figure 4, it is four years old without damage.

Concerning some adaptations above, according to Hidayat (2016), the farmers adaptations behavior in facing the modern technological pressure will produce three adaptation forms as follows: if the presence of the modern technology is to eliminate the local knowledge, it will express a domination form, whereas if they do the substitution, it will produce a coexistence form, and if the modern technology intervention is complementary, it will tend to present a hybrid form between indigenous and modern knowledge. Referring to this opinion, the forms of the local farmers adaptation in this study site can be illustrated in Table 4.

(a)Traditional Water Channel

(b) Traditional Flap Gate

Figure 4. The Traditional Water Channel and Flap Gate as Evidence of Local Wisdom

Indigenous Knowledges and Agro-ecological Aspects: A Brief Review

Some problems in the tidal swamps as described above actually have given a sense of concerning the important aspects of putting people first principle in economic development. This aspect is also consistent to the local wisdom paradigm as a rich source of the appropriate technology (Tharakan, 2015a). It might be unproductive when contrasting between indigenous and modern knowledge in terms of involving the indigenous knowledge in the development that strong and sustainable (Agrawal, 1995). When it is referred to this belief, the farming system in tidal swamps must be able to look after the local knowledge wisely practiced by local farmers. This farming practice is a way of the cultivation with the primary objective to maximize the long-term benefits, which is intended to achieve the household food sovereignty, improvement quality of life, environmental conservation, and the rural development.

By adopting the mentioned above goals and referring it as the sustainable agricultural pattern,it has actually reinforced the paradigm of alternative agricultural development that emphasizes to agro-ecology aspects (Altieri, 2009; Valenzuela, 2016). Therefore, the ecological based agriculture is considered as the most adaptive way to develop the rice farming in the tidal swamps. The rice farming culture in tidal swamplands which traditionally has been done by the farmers is the agro-ecological based farm practice. The application of no tillage methods, the use of local paddy varieties, and the use of low dose of chemical fertilizers are a form of wisdom in adaption to the tidal swamp characters. The use of no tillage method is to avoid the negative impact of the pyrite layers on the soil, reduce erosion, and to minimize the farming costs, while the use of local paddy varieties is because they are not only very adaptive to soil acidity, but also they do not require large amounts of fertilizer. Therefore, it can minimize the farming costs and avoid both land and water pollution. Moreover, the use of nitrogen fertilizer such as urea in low dose is also a wise option, because the application of this fertilizer in high dose actually can enhance the pest population (Baehaki, 2013).

The indigenous knowledge is one of the potential alternative to response to the complicated tidal swamps problems. In its simple concept, this indigenous farming practice still provides the opportunity to combine both indigenous and modern knowledge such as the use of minimum amount of chemical fertilizer. This practice is still in line with the agro-ecological principles, because in this concept it still allows the use of chemical inputs (Bellon et al., 2011). It is based on the belief that the agricultural development model must not only be environmentally accepted but also economically viable by promoting the low production cost principle through the use of local resources efficiently. Therefore, in this context, the rice farming model characterized by using local paddy varieties should be the primary choice.

A traditional small-scale agriculture around the world has put the agro-ecological approach as its mainstream of practices. The approach is based on the long term experience, a learning by doing process, environmental perspective, the cultural process, and social institutions. Then it will also encourage the adaptive natural resource management. Therefore, according to Altieri, Funes-Monzote, & Petersen (2012) this agro-ecological approach will give resiliency as a result of the achievement of food sovereignty, energy, and technology. This approach is more emphasis on the naturally process. In Africa, the small-scale agriculture based on indigenous knowledge has shown a significant resilience, particularly in household food security and the maintenance of soil fertility (Briggs & Moyo, 2012). Referring to this context, the agricultural development in the tidal swamps should be in agreement with the environmental aspects, because the tidal swamps ecosystem is not only play an important role in production, but also as an environmental buffer; for examples for flood protection, water purification, food chain support, and biodiversity buffer, etc. When the environmental function declines, the

Table 4. Some Farmer Adaptation Forms in the Tidal Swamps Rice Farming Practice

Farming Practices	Punggur Besar (Type B overflow)	Punggur Kecil (Type C-D overflow)	Types of Adaptation
Land preparation	Using herbicide No tillage	Using herbicide No tillage	Complementary (hybrid)
Planting	*Tugal*++	*Tugal*++	No adaptation
Fertilizing	No chemical fertilizers	Low dose chemical ferti-lizers	No adaptation in Punggur Besar, but the complementary adaptation in Punggur Kecil
Weeding	Mechanical and or using herbicide	Mechanical and or using herbicide	Complementary (hybrid)
Harvesting	Using sickle, thresher, & *Pengetam*++	Using sickle, thresher, & *Pengetam*++	Substitution (coexistence)
Protecting the garden from the tide	Traditional (farmer made) flap gate	-	Complementary (hybrid)

Note: ++ = Local name

production function may also be disrupted.

The tidal swamps are an area susceptible to damage. Hence, in order to succesfully introduce new technology in its development, the application processes must be wisely prepared and cautiously selected. The use of chemical fertilizers excessively in rice intensification program can cause the environmental problems to the coastal or rivers around the farmland, such as the disruption of aquatic biota. Therefore, to maintain the quality of environmental aspects, the development of small-scale rice farm in the tidal swamps should be focused on four aspects as follows: (a) to ensure the food sovereignty as a precondition for the achievement of food security, (b) to minimize the farming costs by optimizing the application of indigenous farming practices, (c) to apply diversification concepts as an effort to overcome the various risks that may occur, and (d) to maintain adaptive agricultural technology as an effort to keep not only the sustainability of economic system, but also cultural and natural resources.

Another alternative concept is combining the agro-ecological principle and organic farming system. The implementation of organic farming system is not only having a social and science background, but also meaningful as rural development strategy (Valenzuela, 2016). Some advantages include the increasing of agro-ecosystems diversity, increasing inproductivity and efficiency through the use of low external inputs, the increasing rate of recycling, and integrating between crop and livestock (Altieri, Funes-Monzote, & Petersen, 2012). Some study proved that organic fertilizer application could increase the average of rice productivity than that of conventional rice farming which highly relies on the use of chemical (Deshpande & Devasenapathy, 2010). Similarly, in Africa, it is also revealed that organic and semi-organic farming methods had increased agricultural productivity and it could have boosted African food security (Altieri, 2009).

Currently, it is still relevant for Indonesia with the population of more than 265 million people to apply the agro -ecological concept. This is because the agro-ecological paradigm refers to the design of agricultural development and the food system aimed to achieve the national food sovereignty. In addition, this concept has been recognized as a scientific framework and regarded as an 'umbrella' for alternative agriculture, while the organic farming concept can be a supporting part at the implementation level (Bellon et al., 2011). In other word, the agro-ecological and organic farming principle can be a mutual complement to each other. At present it is crucial to develop rice varieties (cultivars) that are more tolerant to tidal swamps characteristics, and it is also necessary to study the optimal combination of land use and water management practices to find out a sustainable farming models (Verhoeven & Setter, 2010). Meanwhile, some other researchers emphasize the importance of combining between indigenous knowledge and appropriate modern technology (Tharakan, 2015b). An appropriate technology such as the application of liquid organic fertilizers (bio-fertilizer) is possible to increase rice productivity (Farah, Dagash, & Yagoob, 2014; Nurita & Saleh, 2016; Siregar, Tulus, & Lubis, 2017).

Furthermore, it is still relevant to state that the rice farming sustainability in tidal swamps is determined by the selection of paddy varieties that are both resistant to pests and diseases, and also efficient in using the fertilizers (Baehaki, Irianto, & Widodo, 2016). The farmer's strategy of using local paddy varieties —as a characteristic of agro-ecological based farm practices, is in line with above statement. Therefore, optimizing of local rice farming must be the basis in managing agricultural development in the tidal swamps, particularly in West Kalimantan.

As the closing, based on the description above, there are three important aspects of local knowledge that must be a concern in tidal swamps rice farming development. Those three aspects are briefly described in Table 5.

4.Conclusions

Rice intensification in the tidal swamp farms in West Kalimantan are facing a complicated problems. It is related not only to some technical barriers in farming practices, but also to the complexity of the institutional problems at the farmer level. The land tenure is one of the problems that is difficult to overcome. Due to ecological barriers, local farmers prefer to reject and not to adopt the intensive

Table 5. The Main Types of Indigenous Knowledge in the Tidal Swamps Rice Farming of West Kalimantan

Types of Indigenous Knowledge	Benefit	Important Characteristics
No tillage method	• Avoiding negative impact of pyrite layer • Reducing land erosion • Minimizing farming cost	• In West Kalimantan, no tillage method for rice farming is not only in tidal lowlands areas but also it is an important practice in dry land farming. It means the rice farming practice in tidal swamps is still very similar to the rice cultivation practice in dry land. As proof, there are still many plot of lands of paddy fields in tidal swamps that without dike
Using of local paddy varieties	• Very adaptive to soil acidity • It isn't require large amount of fertilizer	• It is essential to develop local paddy varieties that are more tolerant to the tidal swamplands characteristics and appropriate for the farmers needs and strategies
Using of low dose chemical fertilizer	• Avoiding water pollution • Reducing pest attack	• It is still in line with the agro-ecological principles • Relevant to this indigenous knowledge context, the organic farming concept can complement the agro-ecological principles • It is as complementary adaptation form between indigenous and modern knowledge

farming practices, especially the use of high yield paddy varieties. Another reason is associated to the rice farming goal that is only intended to be a subsistence farm. In facts, this is a part of a farmer's strategic options that has two positive benefits. Firstly, the use of local paddy varieties has an effect on the ways of land preparation, planting method, fertilizer amounts applied, crop maintenance, and in overall it also has the final consequences on the cost minimizing. Secondly, the farmers have more spare time to manage another farm-land or other activities having higher economic profits than that of rice cultivation, such as perrenial crops cultivation or working as fishermen or being a worker in a non-farm sector.

Another reason not to grow high yield paddy variety is closely related to its "unsatisfied taste". Most of the farmers stated that consuming the rice of high yield paddy variety makes them quickly feeling hungry. Conversely, consuming rice of local paddy varieties makes them more satisfy and full of energy in longer period, so that it is able to support the farmers to work a whole day in the fields. Furthermore, local rice flour is also known more suitable for making traditional preferred cakes. Then, local un-hulled dried paddy is more robust, long lasting when stored as food reserves. Finaly, the local rice variety is also more expensive in farmer level than that of high yield varieties.

Furthermore, the local farmers still adopt not only the use of chemical fertilizers, although it is in a minimum dose, but also apply herbicide and pesticide in limited occasions. It means the farmers not totally reject the intensification practices. It is likely that they prefer to combine both indigenous and modern knowledges. The combination of both knowledges could be regarded as agro-ecological based farming and it is likely the most adaptive way in optimizing the productivity of indigenous rice farming. Thus, the agro-ecological based farming practice should be promoted as a mainstream in the development of the tidal swamps land, especially in West Kalimantan.

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