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The assessment of *daleh* Swidden Agriculture, an Innovative Solution for Conventional Swidden under External Pressures to Land and Local Forest Management in the Tropics:
Case study in the Indegenous Bahau Dayak, East Kalimantan Indonesia

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Abstract
Swidden agriculture is still an important livelihood for million of people in the tropics particularly in Kalimantan Island, the number two of the largest tropical islands in the world. However, the existence of swidden agriculture is now under external pressures such as the massive expansion of oil palm plantation, industrial planted forest concession, reluctant of financial and political support from government and even internal constrain. Such external pressures have caused the decreased of land for swidden agriculture and ignorance of local wisdoms in forest and land management which in turn shorten cycle of swidden agriculture. The objectives of the study is to assess socio-cultural and economic aspects of the innovative 'daleh" swidden agriculture as the alternative to conventional swidden agriculture. The study was conducted in an indigenous Bahau Dayak community in Matalibaq, Mahakam Ulu District East Kalimantan, Indonesia. Twenty swiddeners and 6 key informants were interviewed for data collection. Research findings are the expansion of oil palm plantation has ignored the wisdoms in forest and land management and also caused pressure to swidden agriculture in

particular. Under such pressures, 'daleh" swidden agriculture may effective to practice because it can increase land productivity and culturally acceptable. Political will and financial support from District Government are needed to improve the implementation of swidden agriculture.

Key words: daleh swidden agriculture, Bahau Dayak, Mahak Ulu District

A. Background

Swidden agriculture, or shifting cultivation (ladang) is one of the traditional practices of forest and land management by people in the tropics, and suitable with social typology in which there is a high interdependence between people and the environment (Inoue, 2000; Dove, 1993; Colfer et al., 1997). Furthermore, Sardjono (1990) maintains that traditional forms of swidden agriculture reflect an optimum interrelation between the strategy to serve human needs and efforts to maintain ecological balance in tropical regions. Further, these practices can be improved through agroforestry technologies to adapt to local socio-economic dynamics and environmental changes. Conceptually, and indeed practically, swidden agriculture has a close relation with social forestry. Sardjono (2007) Pasaribu (2007), Inoue and Kawai (2013) for example, define social forestry as any conditions and efforts which intimately involve local people in forestry activities to ensure economic, ecological and social benefits, and simultaneously sustain the resources.

Dove (1988) and Inoue (1999) point out that the term of 'shifting cultivation' is often taken to mean that the people are themselves 'shifting' or semi nomadic, even though most of them live in relatively permanent settlements. In fact people use fire and fallow their field after harvest. The field, once set on fire, is called 'swidden'. So, 'swidden agriculture' is preferable to commonly used other than 'shifting cultivation'. In any case, swidden agriculture can be regard as one of the most important local resource management system in the tropics.

Swidden agriculture is estimated to support currently between 300-500 million people worldwide, covering of 30% of exploitable land for agricultural activities. In Asia Pacific, swidden covers area of 73 million ha. In Indonesia, swidden agriculture is widely practiced in some parts and involves an estimated 35 million hectares of land, and some 22 million cultivators (Mubyarto et al., 1991).

Several scholars have studied swidden agriculture as practiced by the Kenyah Dayak people of East Kalimantan (Colfer et al. 1997; Jessup, 1992; Sindju, 2003,). Inoue and Lahjie (1990) tried to develop models of the sustainability of Kenyah agricultural systems, including ladang. Sindju (2003) in a study to compare the practice of swidden between the Kenyah in West Kalimantan Indonesia and the Kenyah in Sarawak Malaysia, qualitatively describes the practice of ladang from the technological aspects.

Inoue (1999) categorized swidden agricultural in term of its sustainability as follows: (1) traditional swidden agriculture: sustainable swidden agriculture practiced by indigenous people. Most are recurrent type with a long fallow period, but pioneer are also included as long as they are sustainable, (2) transitional (quasi-traditional) swidden agriculture: practiced by indigenous people, originating from both from recurrent and pioneer types, but not so sustainable because of short fallow period. Most existing swidden agriculture by indigenous people may include here, (3) non-traditional swidden agriculture: unsustainable slash and burn agriculture often with cash crops usually practiced by new comers, sometimes by indigenous who once practiced traditional swidden agriculture.

The Dayak people have practiced swidden agriculture (ladang) throughout their life for subsistence, including the indigenous Bahau Dayak who just recently had the idea of daleh swidden agriculture. Imang (2004) briefly described that *daleh* is a concept initiated by the local Bahau Dayak in Matalibaq as the response to the disadvantages of conventional swidden, it culturally and economically acceptable by people. Swidden still play important role in rural area, around 65% of Mahakam Ulu people still practicing swidden (BPS Mahakam Ulu, 2016). However, Pannalo (2015) and Wijayanti (2016) suggested that income from swidden agriculture was around Rp. 5-8 million (USD 385 – 615) for six month of one hectare. Beside the low of income, conventional swidden agriculture in particular is now under external pressures such as oil palm expansion which encroach potential land for swidden, coal mining, and industrial planted forest (Hutan Tanaman Industri /HTI) and some other external and even internal factors. Under such conditions, innovative swidden agriculture is needed which is economically more productive and culturally acceptable for local community.

The objectives of the study are (1) to assess the traditional land management under external and internal pressures forest and land, (2) to explore the practices of conventional and daleh swidden agriculture and the problems, (2) to assess socio-cultural and economic aspects and conditions on the practices of daleh swidden agriculture for the successful implementation and culturally accepted by the swiddeners in particular the Dayak people.

B. Method

Research was conducted in July to August 2017 in a remote Matalibaq village, a community of the indigenous Bahau Dayak who lived here for hundred of years. Rationale to choose the village because it has long history of protecting and managing primary forest based on their cultural wises, it has innovative local knowledge in practicing more productive swidden agriculture, and recently the village is under the pressures of expansive oil palm plantation, massive Industrial man-made-Forest *(Hutan Tanaman Industri = HTI)* and other degraded forest and land activities.

Figure 1. Research site

Data and information were collected through indepth interview with Customary Chief (Kepala Adat), Village Chief (Petinggi) former customary chief, five village elders and individual interview with 20 swiddeners. Data and information collected were the traditional wises and concept in managing forest and land, the concept of *"daleh"* system, the merits and demerits of " daleh" system and conventional swidden practice, threat and constraint of swidden agriculture and *daleh* swidden system, and comparation between cost and benefit of conventional swidden agriculture and *daleh* swidden system. Approcah to analyze data and information is descriptive qualitative.

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C. Result and Discussion

1. Traditional knowledge-based forest and land management

Matalibaq village territory covers area of 88,000 km2 was originally dominated by excellent primary forest. In order to protect the forest for sustainable use and for the benefits for people, they allocated the forest and land in some 11 zones based on the resources availability and socio-cultural considerations. The villagers and also non-villagers should keep and utilize natural resources of each zone in accordance with the purpose of land allocation. The forest and land zonations (tana') are as follows: (1) *Tana' Umaq',* land or space for settlement; (2) *Tana' Lumaq*, agricultural areas for swidden agriculture, perennial and annual crops; (3) *Tana' Lepu'un Luma',* the former of earlier swidden that planted with fruits as the sign for individual ownership; (4) *Tana' Bio',* forested customary land in which the customary head implemented strict rule so that nobody can utilize the forest area for any purpose; (5) *Tana' Patai (kale')*, space for cemetery; (6) Tana' Berahan or Belahan, forested area for forest products extraction suc has timber for self consumption and for sale, hunting ground and fishing area; (7)*Tana' Mawa' atau Tana' Pera'* protected forest area for collecting high value forest products such as resin, rattan, honeybee, timber for housing and boat, gaharu and forest fruits. This forest is not allowed to clear for any individual purpose; (8) *Tana' Ang/Hang*, the boundary area with bordering villages in which its utilization must be under the agreement between bordering villages; (9) *Tana' Pukung*, a protected forest area wich is abundant of forest fruit for wild animals' food; (10) *Tana' Kaso*, primary forest specially allocated for hunting because a lot of forest fruits and habitat for many wild animals such as wild pig, deers, monkeys, etc. People are strictly prohibited to disturb the area that allocated for wild animal for breeding because wild animal hunting is also the way of life of the community.

Such traditional land zonations still persisted as it is should be until external influence affected the village such as logging company 1992, small-scale logging (banjir kap and HPHH) in 1999 to 2001 (Imang, 2001). Such degraded forest activities has damaged forest but still outside agricultural zone (tana' lumaq). The most massive forest and land degradation was the land clearing for oil palm plantations since 2014 covering around 6,000 ha of land including primary forest area for hunting and fishing with less respect to land zonation by the villagers. Due to such destructive activities, some of forest and land zones such as hunting and agricultural areas have already converted to oil palm plantation. It resulted to the disturbance of hunting area and some forest zones including agricultural land in particular swidden agriculture. The most significant impact was the decreased of agricultural land especially swidden agriculture land which in turn will shorten the cycle of the swidden agriculture. Alternatively, the community of Matalibaq had the idea to practice the daleh swidden agriculture.

2. The practice of conventional swidden agriculture

Even though swidden agriculture or shifting cultivation is almost similar in practice, local term for each country is different, e.g. tsheri or pangshing tsheri in Bhutan, in Guatemala milpa or tlacolol, in the Philippine Kaingin, in Thailand taungya, in Cameroon si Nda Bot, in Eastern Himalayan Region called jhum, taungya or dongya and in Indonesia widely known as ladang ((Upadhyay, 1995; Imang et al. 2004). The local term of swidden agriculture in research site is lumaq.

Imang (2001) mentioned that Kenyah Dayak people open new ladang through 9 stages, but the Bahau people in field site open the swidden agriculture commonly through 8 stages as follows: (1) slash the shrubs and small trees; (2) cut down the big trees, usually male-task because its risky for female; (3) to chopp the fallen trunk get drying faster and burnt properly. (4) to burn the vegetation not only clears the ground for planting, but to release nutrients from biomass to boost the soil fertility; (5) planting preparation, the fallen trunk and small trees that not properly burnt are collected and burnt, (6) planting, usually initiated by the Customary Chief (Kepala Adat) through a ritual ceremony to decide the most appropriate day to for planting. Planting must be conducted immediately before the ash-bed is blown or leached away, and before the heavy rains cause soil erosion. This is an important stage of swidden, farmers will gather and working together to plant one's swidden area in a labor exchange characterized by direct parity reciprocity (7) weeding, farmer must regularly remove weeds to prevent of taking nutrients away from the crop, (8) harvesting, likely at planting stage, harvesting also a very important stage in swidden agriculture. During the harvesting period farmers usually live in their fields, protecting the

crop from animals and harvest the rice together with neighbors through labor exchange characterized by direct parity reciprocity (daleh).

Swidden agriculture in research site still play important role for the economic life of the community. It is identified that more than 90% of the 156 households of the village are still practicing swidden agrculture. Each farmer has around 4-7 plots of land, the location of the plots spread out anywhere with the distance between plots various 2-6 kilo meters. The average size of the plots is 1.10 ha, and the access to the plot or swidden field is by foot/walk or by boat and just recently some plot has access by motorbike.

Productivity of one hectare of swidden agriculture varies broadly every year depends on the weahther, rainfall, pest and diseases. The average productivity for one hectare at field site was 1,475 kg. The farmers experienced that productivity was a bit lower than of 2015 because of long drought. The productivity was lower than Panalo (2015) who found that swidden productivy in Pampang village, around 650 km away was 1,700 kg, and Wijayanti (2016) found that swidden productivity in Miau Baru village was 1,900 kg per hectare.

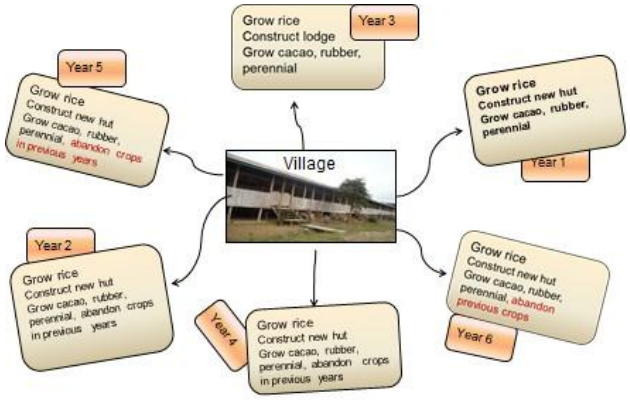

Figure 2. The rotation of land in a-6 year cycle of swidden agrculture

Figure 2 above indicates that the farmer clear land for swidden in a random location/plot, depend on how long the plot of land already fallowed. The location for swidden in year-2 can be located in the opposite direction away from swidden in year-1 and the location for swidden in year-3 or four and five also can be located in diffrerent location. Consequently, the crops they grew in previous years are mostly abandoned after they moved to clear land for swidden in new location. Farmers are only stay for temporary around 6-12 months in one location before move to another location.

The more land he/she has, the longer the cycle and fallow period. The land will be cleared in a rotation or cycle every concecutive year. The purpose to rotate the location for swidden is the strategy to allow the soil to fertile through the accumulation of biomass. The farmers experienced that the longer the cycle the fertile the soil. The biomass from leaves and rotten trees will be released to soil and rice after it burnt properly. This inline with Weinstock and Sunito (1998) who mentioned that swidden agriculture characterized by rotation of land rather than crops, or a rotational agriculture with a fallow period longer than the period of cultivation. Unless faced with population pressure or other constraints, shifting cultivators use land for only one to three years and then fallow it relatively long time of up to 20 years.

Based on farmer's experiences during field observation, the rice planted in the properly-burnt area indicates the rice grows more fertile and more green compared to the rice they planted in non properly-burn area. Therefore, during the land clearing, farmers are preffer if the trees fell down toward inside the swidden area instead of outside. This is also a strategy to protect the fire to spread out to nearby forest when they burn the swidden land.

Table 1. Practices of conventional swidden agriculture of a 6-year cycle

Year	Activities	Product to harvest
1	Open a swidden agriculture and grow rice, develop a small hut/shelter, growing some vegetables and annual crops such as cacao and rubber or pepper	Rice, cucumber, corn, vegetables
2	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper, etc. But,	Rice, cucumber, corn, vegetables

	they abandoned crops they planted in year-1.	
3	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper, etc. But, they abandon the crops they planted in year-1 to year-2.	Rice, cucumber, corn, vegetables
4	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper, etc. But, they abandon the crops they planted in year-1 to year-3.	Rice, cucumber, corn, vegetables
5	Open swidden agriculture in another place, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper menanam karet, kakao atau kebun lainnya	They open new swidden in different place/away with the previous swiddens so that they abandoned the cacao and rubber they planted in year-1 to year-4.
6	Open swidden agriculture in another place, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper	They open new swidden in different place/away with the previous swiddens so that they abandoned the cacao and rubber they planted in year-1 to year-5
7	Return to the plot year-1, and start all steps of swidden from the beginning. They found that annual crops they planted in previous years not productive because not properly maintained	

Source: field observation (2017)

Table 1 above indicates that in a conventional swidden agrciculture, all farmers open a new swidden every year in the same ways with the previous year. They grow rice and harvest rice in the sixth month, and grow perennial crops such as cacao, rubber, etc and then abandon them because they move to another location to open new swidden. It means that they spent a lot labor to open a new swidden they have to develop all supporting facilities everytime they move to a new area for a new swidden.

Table 2. The disadvantages of conventional swidden agriculture

No	Disaadvantages
1	Swiddener has to develop a new hut or shelter each time they open new swidden which need time and resources and even even cash to buy materials
2	To open new swidden in another place resulted the increased of input because they always to prepare the same facilities from the beginning step.
3	Cacao, rubber, pepper or other crops they grew in the previous years not properly productive or even not productive at all because of not proper maintained, the crops damaged by pest, diseases and severe weeds.
4	Swiddeners cannot raise livestock such as pig, poultry other livestocks at swidden land (surrounding the hut) because they always move to another place every year so that no body take care their livestocks in particular at night. The location of individual swidden is mostly away from neighbors' swidden, and most of the swiddeners will return home in the evening and return to swidden field in the morning next day.
5	There's no supply of organic fertilizers from livestocks for rice and crops, only depending on the existing insufficient nutrient.
6	In some cases, the former or ex-swidden areas may overlapping and claimed by other farmers because the fromer swidden already abandoned for long.

Source: field observation (2017)

3. The practices of *daleh* swidden agriculture

The cultural background of the daleh swidden is the "gotong royong", the cultural-spirit of working together of around 10 to 50 even more farmers in one's swidden field, usually on the stage of planting or harvesting. The labor exchange in gotong royong is characterized by direct parity reciprocity. The spirit of *daleh* is actually can be practiced at any stage of swidden agriculture from the slash to harvesting, but usually done on two stages: planting and harvesting.
However, the spirit of gotong royong in a conventional swidden has some weaknesess such as: (1) land productivity is low because only produce rice, (2) production costs are relatively high compared to low and single ouput, only rice, (3) cacao, rubber or other crops they grew in the previous year are mostly abandoned because the farmer clear the new swidden away from the previous year, (4) it is difficult to practice an integrative farming because the farmer usually stay only temporary and short time at the same swidden location.
Under the external pressures to the practice of conventional swidden which is need long fallow period for soil to fertile, an innovative and integrative swidden system is needed to improve the land productivity and income improvement. Based on indepth interview with respondents, the concept and steps of a cluster of swidden agriculture are as follows:

(1) One cluster (kelompok) of daleh system consisted of at least 4 households (kepala keluarga) that have land in certain area that borders each other so that they can take care and help each other anytime they need (see Figure 3).
(2) One household/farmer of the cluster should have one hectar respectively or more, so that the swiddener can devide his/her land in 4 plots, each plot 0.25 ha. Each plot will be cleared every year from year-1 to year-4 (see Figure 4).
(3) The huts or shelters of the 4 group members are located in the central of their swidden field at the proper area so that they can raise pig or chicken surrounding their huts. When someone will leave swidden field return to stay overnight at village/home, other group members will take care of his pigs or chickens from the attack of predators. Pig and chicken has played very important role in the socio-cultural of the Bahau Dayak people for hundred of years. They always scarify some pigs and chickens for every ceremony held in the village. Manure of the livestock can be used as fertilizer for farming. On the other hand, domestic wastes and agricultural wastes/side-products can be used to feed the pig and chicken.

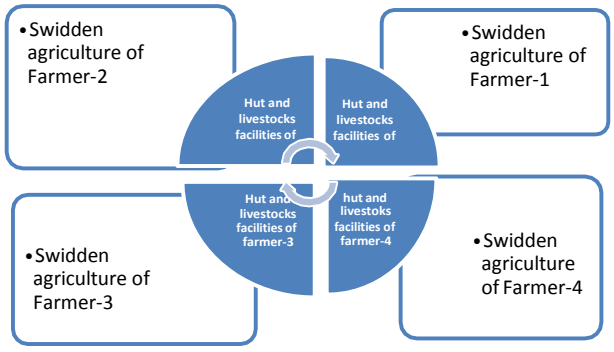

Figure 3. A cluster of daleh swidden agriculture consist of four farmers.

Figure 3 above is a cluster of a daleh swidden agriculture consisted of four farmers/housholds, respectively has one hectare of land. Figure 4 below is the detail of how each farmer devides or allocates and how to use the plot of land for agriculture. Firstly, the farmer devided the land into 6 smaller plots. The number of plot depends on the size of land or depending on how large of land can be cleared by farmer. Secondly, farmer will clear one plot every year from year-1 to year-6 in the same way and also similar crops.

(1) In the first year, the swiddener cleared plot-1 and grew rice, corn, cucumber, vegetables at the same time. After six month, the rice could be ready to harvest. After the 0.25 ha of swidden already harvested, the swiddener can grow cacao, rubber, vegetables in former of the swidden field.
(2) In the second year, it is the turn for the second plot or plot-2 to clear for swidden in the same way and similar crops with the plot-1 in year-1. At the same time, the swiddener can maintain the crops he/she planted in the previous year so that the crops grow well.
(3) In the next year-3 and year-4, the swiddener also repeat the same ways as in the previuos years until all of the 4 plots completed to clear for rice and for other crops. In year-4, the one-hectare of land is already planted with some annual and perennial crops, and ready to harvest.

(4) In year-5, the swiddener can move to other nearby area to open new swidden while also maintaining the crops in the previous years and rasining livestocks. Cacao and rubber or other crops are ready to harvest in year-5 or year-6.

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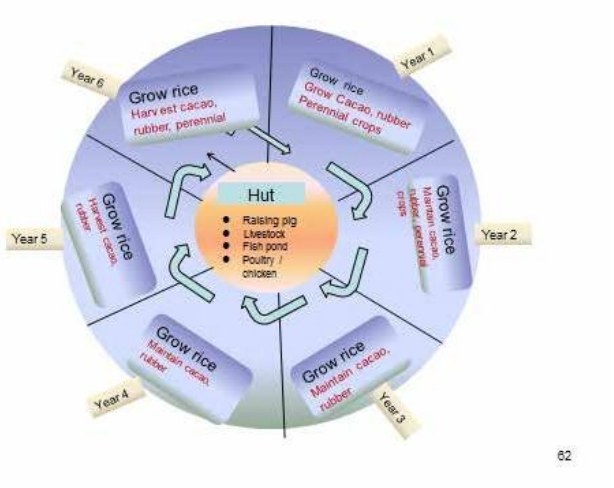

Figure 4. Detail utilization of one hectare for daleh swidden agriculture

Figure 4 above shows the detail of how one farmer allocates his/her land in the daleh swidden agriculture. The farmer only builds hut or shelter in year-1 so that the farmer can save labor and cash to build the hut. The farmer also builds other facilities for example cage to raise livestocks in year-1 or year-2 in which the hut and cage can be last for more than 5 years. Table 3 below shows the the practice of daleh swidden agriculture and what benefits they get every year.

Table 3. Practice of "daleh" swidden system in a 4 plots of land

Year	Daleh Swidden agriculture practices	Pruducts to harvest
1	Plot-1 is cleared for swidden to grow rice, cucumber, corn, vegetables at the same time. Swiddener also develop a proper hut/shelter in the year-1. While waiting the rice to harvest, swiddener prepares cage for pig and poultry. After rice harvesting the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field.	Harvest rice, corn, cucumber, vegetables, chicken
2	Plot-2 is cleared for swidden to grow rice, cucumber, corn, vegetables at the same time. No need to develop new hut/shelter. Swiddener continues to raise pig and poultry or even fish pond. After rice harvesting the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and raise livestocks
3	Plot-1 is cleared for swidden to grow rice, cucumber, corn, vegetables at the same time. Swiddener also develop a proper hut/shelter in the year-1. While waiting the rice to harvest, swiddener prepares cage for pig and poultry. After rice harvesting the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and raise livestocks
4	Plot-4 is cleared for swidden and after rice harvesting, swiddener grow cacao, rubber or pepper or other annual and perennial crops. In parallel, the swiddener also	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also

	maintain crops they planted in plot-1 to plot-3.	maintain crops they planted in previous years, and keep to raise livestocks
5	To open new swidden outside the previous area and undertake the same activities with the previous daleh system. Farmers also benefit from the pig and poultry, they can use waste to feed the livestocks, and conversely the livestocks provide manure/fertilizers for crops. This is an integrated farm that also acceptable to socio-cultural of the swiddeners.	Cacao and rubber they planted in year-1 plot-1 ready to harvest, while they also maintain the crops they planted in year-2 to year-4. They also benefit from the livestocks

Sumber: field observation (2017)

4. Comparison of conventional and daleh swidden agrculture

The infrastructure development, in-migration, massive expansion of oil palm, rubber and other commodities seems to be continued in East Kalimantan which supported by national private companies. On the other hand the rural people are still practicing swidden agriculture for subsistence as well as the way life. In Matalibaq village in particular where more than 90% of villagers practicing conventional agriculture are becoming aware of the need to improve the swidden system for a better economic. However they still unsure of the economic advantages of the *daleh* system, so that during the field observation they were interviewed about the swidden system and the conclusion as shown on Table 4 below.

Table 4. Comparison between conventional swidden and daleh swidden

Crops	**Conventional swidden Year**						**daleh swidden system Year**					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
Rice	GMP	GMP	GMP	GMP	GMP		GMP	GMP	GMP	GMP	GMP	GMP
Rubber	GM	A	A	A	AP-		GM	GM	GM	GM	GMP	GMP
Cakao	GM	A	A	A	AP-		GM	GM	GM	GM	GM	GMP
Banana	GM	P-	P-	P-	P-		GM	MP	MP	MP	MP	MP
Chicken	GMP	0	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Pig	0	0	0	0	0		GM	GMP	GMP	GMP	GMP	GMP
Vegetables	GMP	GMP	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Manure	0	0	0	0	0		P	P	P	P	P	P

Legends:

G = Grow/plant or raise livestocks /poultry
M = Maintain the crops
A = Abandoned/not properly maintained
P = Production or harvest, good production or manure
P- = Production but less
F = Fail, no product because the crops are abandoned
O No agricultural activity/no raise livestock

Source: field observation (2017)

Table above shows the activities and products/output or harvesting frequency of harvesting comparison between conventional swidden agriculture and daleh system. Table indicates that in year-1, both conventional swidden and daleh system have the same activities suc has to grow (G) and maintain (M) and to harvest similar product (P) suc has rice, corn, cucumber and vegetables.

In year-2, table indicates the differences between conventional swidden and daleh system in terms of maintaining the crops they grew in previous year, excluded rice. For conventional swidden agriculture in year-2, the farmers repeat the activities they did in year-1 but away from the location of year-1 so that rubber and cacao or other crops they grew in year-1 are abandoned or not properly maintained. On the other hand, in daleh system, farmers can keep maintain the crops because the location of such crops just near the previous year so that easier for farmers to maintain in paralell with agricultural activities in year-2.

In conventional swidden agriculture, farmers do not build cage or facilities to raise chicken/poultry or pig and other livestocks because they only live at the swidden field for around 6 months to one year. After rice harvesting, the farmers move to another swidden field away.

On the other hand, in daleh system, all crops they grew in the previous years are maintained properly because the next swidden is located at same cluster with the swidden field in the previous years. So that it is easier to maintain the crops for good yields.

As mentioned above that a daleh swidden is multi-products agrcicultural system because it involves mutualistic symbiosis between some elements such as rice, crops, livestocks and poultry. Interaction of two or more elements may fulfill the need of input for another element, for example the waste of rice and un-husked rice when harvesting can be utilized to feed poultry and piq, while the manures of poultry and piq can used for organic fertilizer. The central element of daleh system is the farmer and family who will control and maintain all elements, and at the same time get multiple benefits from rice, crops and livestocks. Figure 1 below shows the interaction among the elements of a daleh swidden agriculture system.

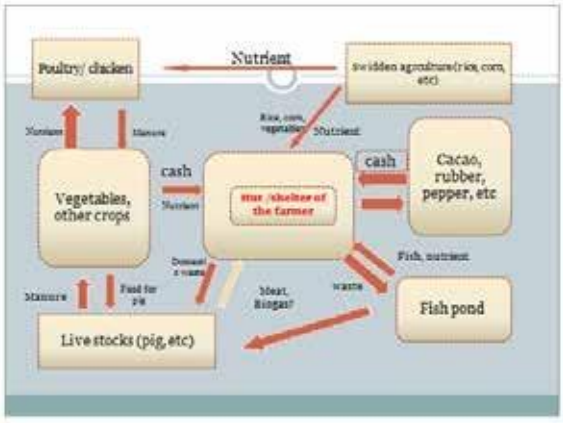

Figure 5. Interaction between elements in *daleh* swidden agriculture

5. Basic problem to develop swidden agrculture

The basic principle of shifting cultivation or swidden agriculture is to clear a plot of land and to plant with rice, and move to another plot of land in the next years in a cycle for the purpose to let the land to fertile naturally through the biomasss. The long of one cycle is various around 5-10 years depend on the fertility of the land/soil or other considerations of the farmers. It is mean that one farmer supposed to have at least 5 plots of land so that the soil has enough time to form sufficient nutrient from biomass.

However, the excistence and improvement of swidden agriculture facing some constraint and problems among others the expansion of oil palm plantation that decreased of suitable land for swidden agriculture. The narrower the land for swidden also means that the cycle became shorter, less than 5 years which in turn will decreased land productivity because no sufficient nutrient. Table below shows main problem for the existence of swidden agriculture in particular at the research site.

Table 5. Constraints and threats to the existence of swidden agrculture

No	Constraint and threat	Note
1	Expansion of oil palm plantation and Industrial Tree-Planted Forest (Hutan Tanaman Industri) that caused the conversion of agricultural lands to oil palm plantation	Some of fertile land zones such Tana' berahan, Tana' Kaso dan Tana' Mawa' have been converted to oil palm plantation and man-made forest trees (HTI = hutan

		tanaman industri).
2	The friction of land into smaller plots of land so that it is more difficult to practice daleh swidden agriculture.	A cluster of daleh system needs around 4 to 6 ha of land for the effective of the system for a sufficient land fallow.
3	The decreasing interest of young generation to work in farm because of manual works and low of income to fulfill daily needs of subsistence and cash, uncertainty of market for agricultural products.	Panalo (2016) found that average ouput of one hectare of swidden agiculture is Rp. 8.6 million. It means that average income for one month is Rp. 1.1 million
4	Innovation of technology for swidden agriculture is very low compared to wet rice, all stage of activities are done manually so that land productivity is low.	The spread out of location of the swidden field also blamed for field officer reluctant to develop their agricultural activities.
5	There's no finance scheme to develop swidden agriculture compared to wetland rice which gets finance support for development	Financial support provided to wetland rice where as wetland rice not really acceptable for farmers.
6	The emerging of negative perception to the swidden farmer who clear land using fire which is also blamed for the forest fire.	There's a West Kutai District Regulation (Peraturan Daerah) regarding prohibition to use fire for land clearing. In this case, government does not accomodate the wisdom and culture of swidden agriculture

Source: field observation (2017)

D. Conclusion

(1) The introduction and expansion of oil palm plantation, logging and industrial planted forest *(HTI= hutan tanaman industri*) in the village territory ignored and not recognized the traditional wises of forest and land management. The concession argued they were granted concession from Provincial and Distrcit Government, and Customary Institution not strong enough against the concession.

(2) Swidden agriculture still play important role for the economic life of the community because more than 90% of the household still active practicing swidden agriculture every year regargless the disadavantages. The pressures to the existence of conventional swidden agriculture need innovative alternative swidden which is can improve land productivity and generate better farmer's income. The daleh swidden agriculture is an alternative because it can improve land productivity, and importantly it culturally acceptable for the community. Unfortunately, District Government not provides financial and agricultural-technological supports as well as facilitators to organize the farmers to practice a more productive swidden agrculture.

(3) The daleh swidden system is considered can accommodate the phsycological and cultural constraint for a better farming because it combines the traditional swidden agriculture with livestocks and other crops in one plot, called integrated swidden farming (daleh system). The mutualistic symbiosis between elements in the integrated system may improve land productivity and farmers' income.

E. Recommendation

(1) In order to protect the agricultural potential land for swidden, the government should recognize the local wisdoms on forest and land management. The introduction and expansion of oil palm plantation, logging and man-made industrial forest (HTI= hutan tanaman industry) in the village territory ignored or not recognized the traditional wises of forest and land management. The concession argued they granted concession from Provincial and Distrcit Government, and customary institution (adat) alone not robust enough against the concession. The adat still need strong support from government to keep the traditional forest and land management.

(2) District government should provide financial scheme and facilitation supports to improve the practice and productivity of both conventional and daleh swidden agriculture in accordance with the local characteristics and needs. The supports are important because most of the indigenous Dayak in particular the Bahau people in rural areas are highly relying on the swidden systems.

(3) Beside the economic benefits of swidden agriculture, the Bahau community exspects that "daleh" swidden agriculture in the future will become an "agricultural tourism object" in particular at the two most important stages: "planting" and "harvesting" stages. Therefore, the district government should support the implementation of daleh swidden agriculture by involving all the communities in big scale.

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The authors gratefully acknowledge the financial support from Islamic Development Bank/IDB through University of Mulawarman that enables me to undertake the research. Very special thanks and acknowledgements are addressed to the Village Chief (Petinggi), Customary Chief (Kepala Adat) and the people of Matalibaq village who were voluntarily provided their value time to share experiences and expectation in swidden agriculture during the field observation. We also appreciate perspective comment and constructive critiques from anonymous reviewers of this manuscript.

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Dear Rujehan (*corresponding author*): (25 Februari 2018)

Thank you for submitting the manuscript, **"The Assessment of daleh Swidden Agriculture, an Innovative Solution for Conventional Swidden under External Pressures to Local Forest Management in the Tropic of Kalimantan, Indonesia**" to Biodiversitas Journal of Biological Diversity. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Submission URL: https://smujo.id/biodiv/authorDashboard/submission/2373
Username: rujehan56

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Ahmad Dwi Setyawan

Dear Dr Setyawan (Reviewer),

Pl find the edited version of the paper sent for review. The paper was written with poor focus and continuity. I have tried my best to improve its style and content. It may be accepted if resubmitted after incorporating the changes and clarifications sought.

My general comments are:

1. The paper needs clarity in its objectives

2. More details of daleh swidden, such as complete scientific list of crops, products, economicaspects, etc is desirable.

3. References needs careful scrutiny. Some papers cited in the body are not mentioned in theReferesnces section.

Regards

Editor

Dear editor, (13 April 2018)

This is the revised version of article **titled Assessment of *Daleh* swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia** after it has been reviewed by reviewer. Please kindly check the article and inform me for any further information.

Best Regards,

Rujehan
(corresponding Author)

Assessment of *Daleh* swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia

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Abstract. Swidden agriculture is still an important livelihood for millions of people in the tropics. In Kalimantan Island of Indonesia, swidden agriculture is currently facing many external pressures such as massive expansion of oil palm plantations, concession for industrial plantations, and non-availability of financial and political support from the government. The above external pressures which ignore local wisdoms in forest and land management have reduced the land available for swidden agriculture. The external pressures, in turn, have shortened the cycle of swidden agriculture and decreased the productivity of swidden agriculture. The objectives of the present study is to assess socio-cultural and economic aspects of the innovative *daleh* agriculture as an alternative to conventional swidden agriculture under these conditions. The study was conducted in an indigenous *Bahau Dayak* community of East Kalimantan, Indonesia. Twenty swiddeners and 6 other key informants were interviewed for data collection. Research findings confirm that the expansion of oil palm plantations has ignored the wisdoms in forest and land management, in general, and caused pressure on swidden agriculture, in particular. Under such pressures, *daleh* swidden agriculture may be effectively practiced because it can increase land productivity and is also culturally acceptable. Further, financial and facilitation support from district government is needed to improve the practice of swidden agriculture in the study area.

Keywords: *Daleh* swidden agriculture, *Dayak people*, Kalimantan

INTRODUCTION

Swidden agriculture or shifting cultivation, locally called *ladang*, is one of the traditional practices of forest and land management by people in the tropics and is suitable to social typology in which there is a high interdependence between people and the environment Dove, 1993; Colfer *et al*., 1997 and Inoue, 2000). Furthermore, Sardjono (1990) maintains that traditional forms of swidden agriculture reflect an optimum interrelation between the strategy to serve human needs and efforts to maintain ecological balance in tropical regions. These practices can be further improved through agroforestry technologies to adapt to local socio-economic dynamics and environmental changes. Conceptually, swidden agriculture has a close relation with social forestry. Sardjono (2007), Pasaribu (2007), and Inoue and Kawai (2013) define social forestry as any conditions and efforts which intimately involve local people in forestry activities to ensure economic, ecological and social benefits, and simultaneously sustain the resources.

Dove (1988) and Inoue (1999) point out that the term 'shifting cultivation' is often taken to mean that the people are themselves 'shifting' or semi nomadic, even though most of them live in relatively permanent settlements. In fact, people use fire and fallow their field after harvest. The field, once set on fire, is called 'swidden'. So, 'swidden agriculture' is preferable to commonly used term 'shifting cultivation'.

Swidden agriculture is estimated to support 300-500 million people worldwide, covering about 30% of exploitable land for agricultural activities. In Asia Pacific, swidden covers an area of 73 million hectares and, in Indonesia, it involves 35 million hectares of land and about 2.2 million cultivators (Mubyarto , 1991).

Several scholars have studied swidden agriculture as practiced by the *Kenyah Dayak* people of East Kalimantan (Jessup, 1992; Colfer *et al*., 1997; Sindju, 2003). Inoue and Lahjie (1990) tried to develop models for the sustainability of *Kenyah* agricultural systems, including *ladang*. Sindju (2003), in a comparative study of *ladang* practiced by the *Kenyah* of West Kalimantan, Indonesia and the *Kenyah* of Sarawak, Malaysia, has qualitatively described the technological aspects of the practice.

Inoue (1999) categorized swidden agriculture in term of its sustainability as follows: (i) traditional swidden agriculture - sustainable swidden agriculture practiced by indigenous people, (ii) transitional (quasi-traditional) swidden agriculture - practiced by indigenous people, originating from both recurrent and pioneer types, but not so sustainable because of short

fallow period, and (iii) non-traditional swidden agriculture - unsustainable slash and burn agriculture, often with cash crops, usually practiced by new comers to village.

Though Swidden continue to play an important role in rural areas as indicated by the fact that around 65% of Mahakam Ulu people are still practicing swidden (BPS Mahakam Ulu, 2016), the income from swidden agriculture was as low as Rp. 5-8 million (USD 385 – 615) for one hectare (Pannalo, 2015; Wijayanti, 2016). Besides the low economic returns, conventional swidden agriculture is also under external pressures, such as expansion of oil palm cultivation, coal mining and industrial forests *(Hutan Tanaman Industri = HTI)* which reduce the extent of potential land available for swidden agriculture. Under these conditions, an innovative alternative to traditional swidden agriculture is desirable which is economically more productive and culturally more acceptable to local community.

The *Dayak* people have practiced swidden agriculture from many generations for subsistence and the indigenous *Bahau Dayak* have recently developed the practice of *daleh* swidden agriculture. Imang (2004) described that *daleh* is a concept initiated by the local *Bahau Dayak* in Matalibaq as the response to the disadvantages of conventional swidden and is culturally and economically more acceptable to people. In the present study, we have assessed the potential of this recently emerged practice of *daleh* agriculture as an alternative to the conventional swidden agriculture.

The specific objectives of the study are (i) to assess the traditional practices of land management under external and internal pressures on forest and land, (ii) to explore and compare the practices of conventional and *daleh* swidden agriculture and the associated problems, (iii) to assess socio-cultural and economic aspects of *daleh* swidden agriculture responsible for its successful implementation and culturall acceptance by the swiddeners, particularly the *Dayak* people.

MATERIALS AND METHODS

The present study was conducted in Matalibaq village, Long Hubung Sub-district, West Kutai District, East Kalimantan, Indonesia from July to August 2017. Data was gathered from indigenous *Bahau Dayak* community who lived here for over hundreds of years. The reasons behind choosing this village are: i) it has a long history of protecting and managing primary forest based on the cultural wisdom, ii) it has innovative local knowledge pertaining to the practice of more productive swidden agriculture, and iii) recently the village is facing the pressures of activities like oil palm plantation expansion, massive Industrial Forest expansion, and other types of forest and land degradation.

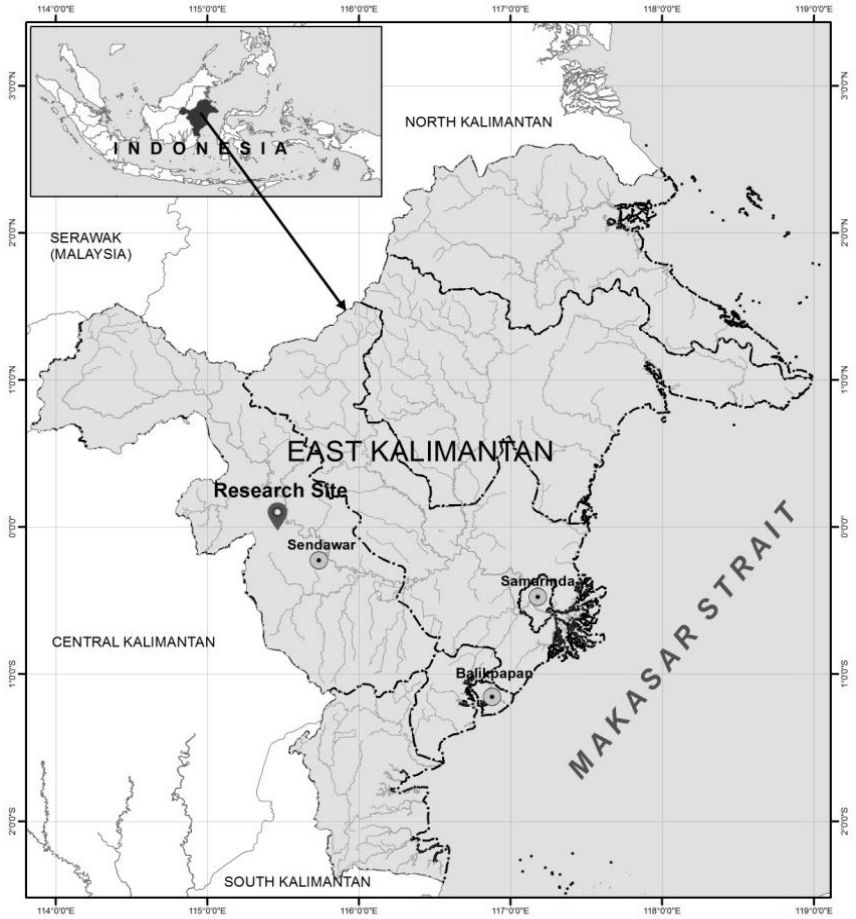

Figure 1. Map of the research site in Matalibaq village, West Kutai District, East Kalimantan, Indonesia

Data and information were collected through in-depth interviews with Customary Chief *(Kepala Adat),* Village Chief *(Petinggi),* former customary chief, five village elders and 20 swiddeners. Data and information collected pertains to the traditional wisdom and concept of managing forest and land, the concept and practices of conventional and *daleh* swidden system, their merits and demerits, threats and constraints and benefits involved.

RESULTS AND DISCUSSION

Traditional knowledge-based forest and land management:

Matalibaq village territory covers an area of 88,000 km^2 which was originally dominated by excellent primary forest. In order to protect the forest for sustainable local benefits, the available forest and land was allocated in 10 zones based on the availability of resources and socio-cultural considerations. The forest and land zonations are as follows: (1) *Tana' Umaq'*, land for settlement; (2) *Tana' Lumaq*, areas for swidden agriculture, perennial and annual crops; (3) *Tana' Lepu'un Luma'*, the former swidden area that planted with fruits, in which the fruits are considered the proof of individual ownership; (4) *Tana' Bio'*, forested customary land in which the customary head implemented strict rules so that nobody can utilize the forest area for any purpose; (5) *Tana' Patai (kale')*, space for cemetery; (6) *Tana' Berahan* or *Belahan*, forested area for extraction of forest products such as timber for self consumption and for sale, hunting ground and fishing area; (7) *Tana' Mawa'* protected forest area for collecting high value forest products such as resin, rattan, honey, timber for housing and boat making, eagle wood (*gaharu)*and forest fruits; (8) *Tana' Ang/Hang*, the boundary area between adjacent villages wherein its utilization must be according to the agreement among bordering villages; (9) *Tana' Pukung*, a protected forest area which is abundant in forest fruits for wild animals' as food; (10) *Tana' Kaso*, primary forest specially allocated for hunting because it is habitat for many wild animals such as wild pigs, deers and monkeys. People are strictly prohibited from disturbing the area that is allocated for breeding of wild animals because wild animal hunting is also a way of life of the community.

Such traditional land zonations persisted until external influences such as establishment of a logging company in 1992 and small-scale logging from 1999 to 2001 started affecting the village (Imang, et al, 2004. Such degradation activities have damaged forests outside the agricultural zone *(tana' lumaq).* The most massive forest and land degradation was caused by the land clearing for oil palm plantations taking place since 2014, covering around 6,000 hectares of land including primary forest area marked for hunting and fishing, without respecting the land zonation system followed traditionally by the villagers. Due to such destructive activities, some of the forest and land zones, such as those allocated for hunting and agricultural areas, have already been converted into oil palm plantations. Consequently, these activities have negatively impacted the practice of swidden agriculture. The most significant impact was a decrease in the land available for agriculture in general and swidden agriculture, in particular. This, in turn, shortened the cycle of conventional swidden agriculture. Under such a situation, the *Bahau Dayak* community of Matalibaq developed the concept of *daleh* swidden agriculture.

The practice of conventional swidden agriculture:

Even though the practice of swidden agriculture is almost similar across countries, the local term in each country is different, e.g. *tsheri* or *pangshingtsheri* in Bhutan, *milpa* or *tlacolol* in Guatemala, *Kaingin* in Philippines, *taungya* in Thailand, *si Nda Bot* in Cameroon and in Indonesia, it is popularly known as *ladang* (Upadhyay, 1995; Imang *et al*. 2004). The local term for swidden agriculture in the research site of the present study is *lumaq*.

According to Imang (2001), the *Kenyah Dayak* people open new *ladang* through 9 stages. However, the *Bahau Dayak* people of Matalibaq village open their swidden agriculture commonly through 8 stages which are as follows: (1) slash the shrubs and small trees; (2) cut down the big trees, which is usually a male-task because its risky for female; (3) chop the fallen trunk for faster drying and proper burning; (4) burn the vegetation which not only clears the ground for planting, but also releases nutrients from the biomass to increase the soil fertility; (5) planting preparation by removing the twigs; (6) planting which is usually initiated by the Customary Chief *(Kepala Adat)* through a ritual ceremony to decide the most appropriate day for planting. Otherwise, the villagers believe that the harvests may not be good. This is an important stage of swidden in which the farmers gather and work together to plant one's swidden area in a labor exchange manner characterized by direct parity reciprocity; (7) weeding, (8) harvesting, like at planting stage, harvesting also a very joyful stage because the farmers will harvest together of 10 to 20 farmers and even more.

Swidden agriculture is still playing an important economic role in the study area. It is observed that more than 90% of the 156 households of the village are still practicing swidden agriculture. Each farmer has around 4-7 plots of land and the location of these plots are spread out with the distance between plots varying from 2 to 6 kilometers. The average size of the plots is 1.10 hectares and the mode of access to the plot or swidden field is either by foot/walk or by boat, and some farmers have recently started accessing the plots by motor bikes.

Productivity of swidden agriculture varies widely over years, depending on the weather, rainfall, pests and diseases. The average productivity per hectare in the study area in February 2017 was 1,475 kg. The farmers feel that productivity was a bit lower than that of previous year of 2015 because of prolonged drought. Further, this productivity is lower than the swidden productivity of 1700 kg obtained in Pampang village which is around 650 km away from Matalibaq (Panalo, 2015) and of Miau Baru village where it was 1,900 kg per hectare (Wijayanti, 2016).

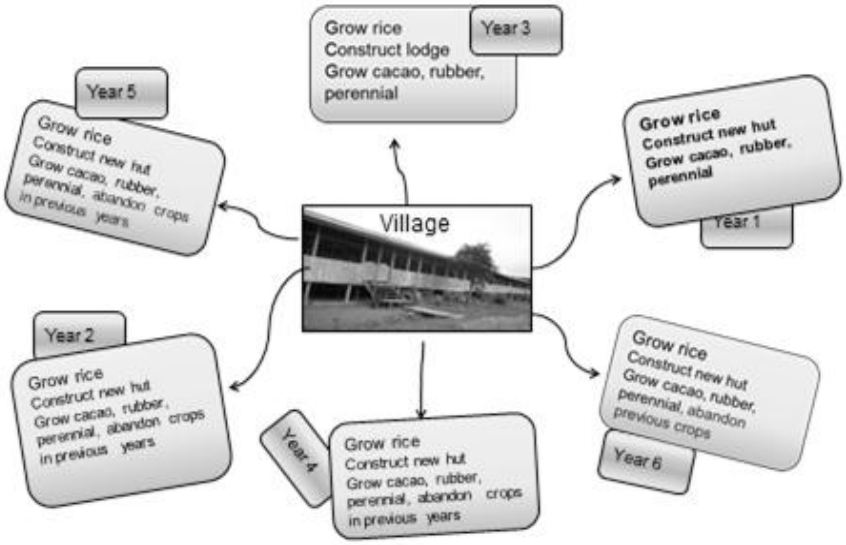

Figure 2. Utilization of land plots during different years in conventional swidden agriculture

The farmers start swidden cultivation by clearing land in a randomly chosen location or plot, depending on how long the plot of land has been previously fallowed. The swidden plot for year-2 is located in the opposite direction away from swidden plot of year1 and the plots for subsequent years are selected in different locations. Consequently, the crops grown in previous years are mostly abandoned after moving to a new location for land clearing, for next years swidden. Farmers stay temporarily for 6 to12 months in one location, before moving to another location.

The more land a farmer has, the longer the swidden cycle and fallow period. Each plot of land is cleared in a rotation every year. The rotation of swidden locations is a strategy to allow the soil to regain its fertility through accumulation of biomass. The farmers have learnt by experience that the longer the swidden cycle, more fertile the soil becomes. The biomass from leaves and decomposed trees will be released to soil after it is burnt properly. This is in line with Weinstock and Sunito (1998) who mentioned that swidden agriculture is characterized by rotation of land rather than crops, or a rotational agriculture with a fallow period longer than the period of cultivation.

Farmers, through their experience, know that the rice planted in properly burnt area better growth compared to the rice planted in improperly burnt area. Properly burnt according to farmers is when leaves, twigs and small branches are completely burnt so that soil looks black. Therefore, during land clearing, farmers prefer felling trees towards inside of the swidden area instead of outside. This is also a strategy to prevent spreading of the fire to nearby forest areas during the burning of the swidden land.

Table 1. Practices of conventional swidden agriculture of a 6-year cycle in the study area.

Year	Activities	Harvested products
1	Open a swidden agriculture and grow rice, build a small hut/shelter, grow some vegetables and annual crops such as cacao, rubber or pepper.	Rice, corn, and vegetables.
2	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper. But, they abandon crops planted in year-1.	Rice, corn, vegetables.
3	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-2.	Rice, corn, vegetables.
4	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year -3.	Rice, corn, vegetables.
5	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were abandoned
6	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were not maintained well.
7	Return to the plot of year-1, and start all steps of swidden from the beginning. The crops they planted in previous years not grow well because they abandoned.	Cacao, rubber or pepper not harvested because they were not maintained well.

Source: Field observation by authors (2017)

Table 2. The disadvantages of conventional swidden agriculture as observed in the study area

No	Disadvantages
1	Swiddeners have to construct a new hut or shelter each time they open a new swidden which requires time and resources, both physical and financial.
2	Opening new swidden in another place results in increase of inputs because all of the previous years activities are repeated.
3	Cacao, rubber, pepper or other crops grown in the previous years are less productive or even not productive at all because of improper maintenance, crop damage by pests, diseases and weeds.
4	Swiddeners cannot raise livestock such as pig, poultry and others in swidden land (surrounding the hut) because they move to another place every year. The location of individual swidden is mostly away from neighbors' swidden, and most of the swiddeners will return home in the evening and return to swidden field in the next morning. Therefore, their livestocks and poultry may attacked by predators such as panther and weasel when farmer stay over night away from huts.
5	There is no availability of organic manures from livestocks for rice and crops, and farmers are left to depend only on the existing insufficient of natural soil fertility.
6	In some cases, the long abandoned former or ex-swidden areas of one farmer may be overlapping with the plots of other farmers or encroached by other farmers.

Source: Field observation by authors (2017)

The practices of *daleh* swidden agriculture:

The cultural background of the *daleh* swidden is *gotong royong*, the cultural-spirit of 10 to 50 even more farmers working together in the swidden field of a farmer, usually in the stages of planting or harvesting. The labor exchange in *gotong royong* is characterized by direct parity reciprocity. Though the spirit of *daleh* can be practiced at any of the stages of swidden agriculture starting from slashing to harvesting, but the stages of planting and harvesting are the most suitable stages for *gotong royong*.

The concept and steps of *daleh* swidden agriculture are as follows: (i) *Daleh* system consiss of adjacent agriculture fields belonging to at least 4 households that are bordering each other, forming a cluster so that they can help each other whenever needed (Figure 3). (ii) Each household or farmer of the cluster should have at least one hectare of land, so that it can be divided into 4 plots, each measuring 0.25 hectares or more. One plot is cleared every year during the swidden cycle of 4 years (Figure 4). (iii) The huts or shelters of the all the minimum 4 swidden group members are located in the centre of their swidden field in a proper location so that they can raise pig, chicken or fishes surrounding their huts. When any swidden group member leaves the swidden field for overnight stay at village/home, other group members take care of his/her pigs or chickens and protect them from predators. Pigs and chickens have played a very important socio-cultural role in the life of *Bahau Dayak* people for hundreds of years. They offer pigs and chickens as sacrifices in every village ceremony. Manure of these livestock used as fertilizer for farming. On the other hand, domestic and agricultural wastes/bye products are used to feed them.

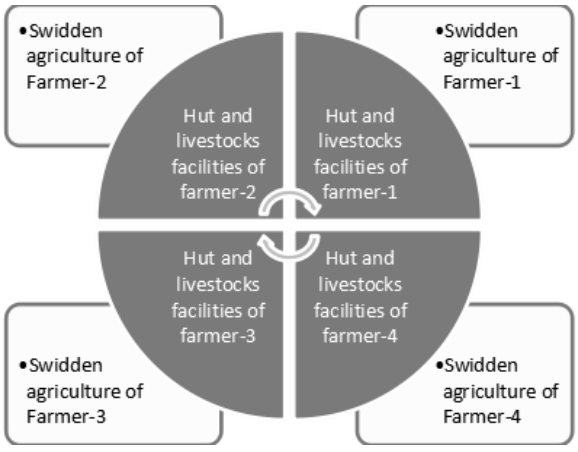

Figure 3. A cluster of *daleh* swidden agriculture consisting of four farmers.

Firstly, the farmer divided the land into some smaller plots. The number of plot depends on the size of land or depending on how large of land can be cleared by farmer, usually 4-6 plots In this part, we use a case of 6 plots, while in Table 3 below is a case of 4 plots. Secondly, farmer will clear one plot every year from year-1 to year-6 in the same way and also similar crops.

(1) In the first year, the swiddener cleared plot-1 and grew rice, corn, cucumber, vegetables at the same time. After six month, the rice could be ready to harvest. After the 0.25 ha of swidden already harvested, the swiddener can grow cacao, rubber, vegetables in former of the swidden field.

(2) In the second year, it is the turn for the second plot or plot-2 to clear for swidden in the same way and similar crops with the plot-1 in year-1. At the same time, the swiddener can maintain the crops he/she planted in the previous year so that the crops grow well.
(3) In the next year-3 and year-4, the swiddener also repeat the same ways as in the previous years until all of the 4 plots completed to clear for rice and for other crops. In year-4, the one-hectare of land is already planted with some annual and perennial crops, and ready to harvest.
(4) In year-5, the swiddener can move to other nearby area to open new swidden while also maintaining the crops in the previous years and raising livestocks. Cacao and rubber or other crops are ready to harvest in year-5 or year-6.

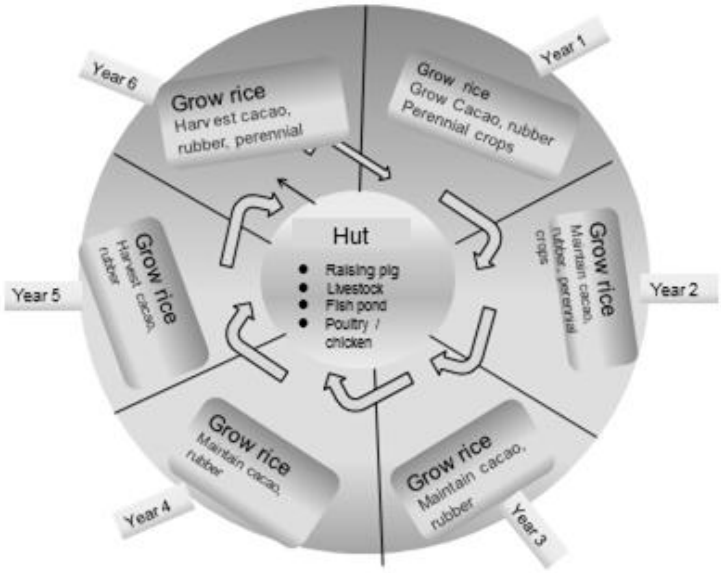

Figure 4. Details of utilization of one hectare land in *daleh* swidden agriculture practice

Figure 4 shows the details of how a farmer allocates his/her land during *daleh* swidden agriculture. The hut or shelter is built only once in the first year. They also build other facilities like cages to raise livestocks either in year 1 or year 2. These huts and cages built once lasts for more than 5 years because of which farmers save time, labor, and economic and material resources otherwise spent every year for these works. Further details such as the pattern of plot clearing, crops grown, animals raised and products harvested in the practice of *daleh* swidden agriculture are shown in table 3.

Table 3. Practices of *daleh* swidden system in 4 plots of land;

Year	***Daleh* Swidden agriculture practices**	**Harvested Products**
1	Plot-1 is cleared for swidden to grow rice, corn, and vegetables at the same time. Swiddener also build a proper hut/shelter. While waiting for the harvest of rice, swiddener prepares cage for pig and poultry. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field Just after the rice is harvested.	Rice, corn, cucumber, vegetables, chicken.
2	Plot-2 is cleared to grow rice, cucumber, corn, vegetables at the same time. No need to build a new hut/shelter. Swiddener continues to raise pig and poultry or fish pond. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field.	Rice, corn, cucumber, vegetables, chicken, pig, fishes. Parallely, they can also maintain crops planted in previous years, and raise livestocks such as chicken or pig.
3	Plot-3 is cleared for swidden to grow rice, corn and vegetables at the same time. Swiddener also build a proper hut/shelter in the year-1. While waiting the rice to harvest, swiddener prepares cage for pig and poultry. After rice harvesting the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field after rice is harvested..	Harvest rice, corn, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and raise livestocks such as chicken..
4	Plot-4 is cleared for swidden and after rice harvesting, swiddener grow cacao, rubber or pepper or other annual and perennial crops. In parallel, the swiddener also maintain crops they planted in plo-1 to 3.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and keep to raise livestocks
5	Open new swidden outside the previous area and repeat the same activities. Farmers also benefit from the pig and poultry, they can use waste to feed the livestocks, and conversely the livestocks provide manure/fertilizers for crops. This is an integrated farm that also acceptable to socio-cultural of the	Cacao and rubber they planted in year-1 plot-1 ready to for harvest, while they also maintain the crops they planted in year-2 to year-4. They also benefit from the

swiddeners.	livestocks.

Source: Field observations by authors (2017)

Economic comparison between conventional and *daleh* swidden agriculture:

Table 4. Economic comparison between conventional swidden and *daleh* swidden systems of agriculture:

Crops	**Conventional swidden**						***Daleh* swidden system**					
	Year						**Year**					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
Rice	GMP	GMP	GMP	GMP	GMP		GMP	GMP	GMP	GMP	GMP	GMP
Rubber	GM	A	A	A	AP-		GM	GM	GM	GM	GMP	GMP
Cacao	GM	A	A	A	AP-		GM	GM	GM	GM	GM	GMP
Banana	GM	P-	P-	P-	P-		GM	MP	MP	MP	MP	MP
Chicken	GMP	0	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Pig	0	0	0	0	0		GM	GMP	GMP	GMP	GMP	GMP
Vegetables	GMP	GMP	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Manure	0	0	0	0	0		P	P	P	P	P	P

Legends:

G	=	Grow/ raise livestocks and/or poultry
M	=	Maintain the crops
A	=	Abandoned/not properly maintained
P	=	Production of crops, or manure of livestocks
P-	=	Production but less
F	=	Fail, no production because the crops are abandoned
O	=	No agricultural activity/no raising of livestock

Table 4 summarizes the economic comparison between conventional and *daleh* agriculture in terms of the various activities involved and products harvested. It is evident from the table that both systems have the same activities such as growing (G), maintaining (M) and harvesting products (P) such as rice, corn, and vegetables.

The differences are observed from second year onwards, the notable ones are: i) The crops grown in previous years, excluding rice, are maintained in *daleh* system because the subsequent years plots are close to the first year's plot. However, they are abandoned or neglected in conventional swidden agriculture due to the distance between first year's plot and subsequent years plots. ii) In conventional swidden agriculture, farmers do not build cages or facilities to raise chicken/poultry or pig and other livestocks because they live at the swidden site only for about 6 months to a year. After harvesting rice, they move to another swidden plot located far away from the first one. But in *daleh*, livestock is maintained as they live in the same location throughout the swidden cycle.

As mentioned above, the *daleh* swidden is a multi-product agricultural system as it involves mutual symbiosis between different elements such as rice, crops (cacao, rubber, pepper), livestocks and fish. In this system, products or bye products of one element supports or sustains the other elements and this enhances the overall productivity of the whole system. For example, the waste products resulting from rice cultivation is utilized to feed poultry and pig, while the manure of poultry and pig is used as organic fertilizer for crops. The central element of *daleh* system is the farmer and his/her family who control and maintain all elements, and at the same time, get multiple benefits from rice, other crops and livestocks. Figure 5 shows the multifarious interactions among the different elements of a *daleh* swidden agriculture system.

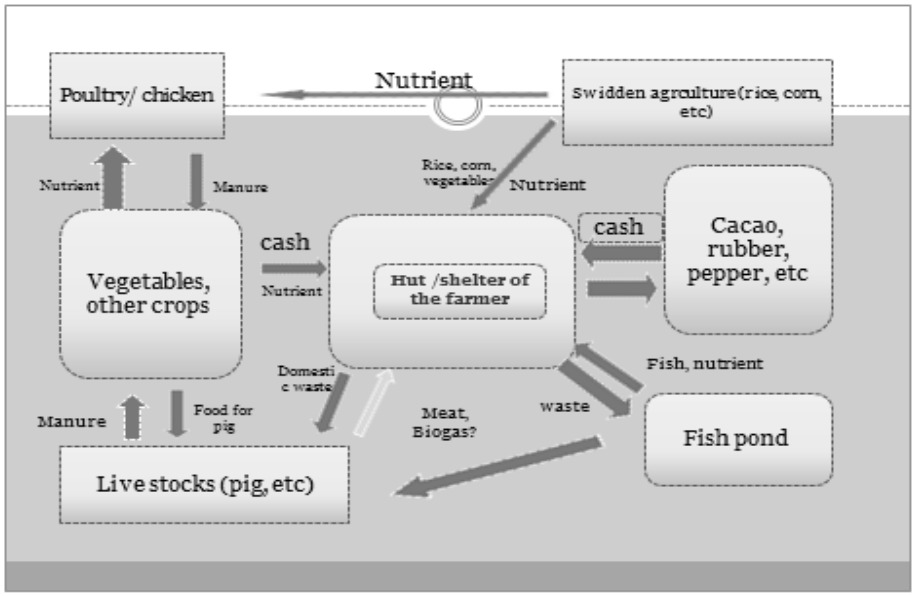

Figure 5. Interactions between different elements in a *daleh* swidden agriculture system.

Threats to swidden agriculture:

The basic principle of shifting cultivation or swidden agriculture is the availability of sufficient time gap for the fallowed lands to regain their natural fertility, between successive swidden cycles. The usual duration of one cycle varies from 5 to 10 years, depending on the fertility of the land/soil and other considerations of the farmers. This implies that a farmer should have at least 5 plots of swidden land to maintain this cycle by allowing enough time to the soil to become fertile after one swidden cultivation.

However, the expansion of oil palm plantation has decreased the availability of suitable land for swidden agriculture. The narrower the extent of land available for swidden, shorter the swidden cycle becomes. Shortening of swidden cycle to less than 5 years, in turn, decreases land productivity because of insufficient nutrients in soil. This is one of the major threats to the continued practice of swidden agriculture, particularly at the study area. There are also other threats and constraints to swidden agriculture in general which are summarized in Table 5.

Table 5. Constraints and threats to swidden agriculture in the study area:

No	Constraints/ threats	Remarks
1	Expansion of oil palm plantations and Industrial Forests (*HTI*) that caused the conversion of agricultural lands to commercial plantations	Some of the fertile land zones such *Tana' berahan, Tana' Kaso dan and Tana' Mawa'* have been converted to oil palm plantations and man-made tree forests (*HTI*).
2	The division of land into smaller plots so that it is more difficult to practice *daleh* swidden agriculture.	A cluster of *daleh* system needs at least 4 to 6 hectares of land for its effective practice and a sufficient land fallow.
3	The decreasing interest of young generation towards farm work because of reasons such as hard manual labor involved, low income which is insufficient to fulfill their daily needs of subsistence and monetary requirement, uncertain market for agricultural products, etc.	Panalo (2016) found that average output of one hectare of swidden agriculture is Rp. 8.6 million. It means that the average income for one month is Rp. 1.1 million
4	Technological innovations in the area of swidden agriculture is lacking when compared to wet rice cultivation. Therefore, all stages of swidden activities are done manually which is also a reason for its low productivity.	The remote location of the swidden agriculture also a constraint for agricultural officer to develop agricultural activities.
5	There is no schemes of financial support to develop swidden agriculture compared to wetland rice which gets financial support for development	Financial support provided to wetland rice where as farmers more prefer to swidden agriculture.
6	The emerging negative perception about swidden farmers who clear land using fire which is also blamed as a cause for forest fire.	There is a West Kutai District Regulation (*Peraturan Daerah = PERDA*) regarding prohibiting the use of fire for land clearing. In this case, government did not consider the wisdom and culture of swidden agriculture.

Conclusion:

The introduction and expansion of oil palm plantations, logging and industrial planted forests (*HTI*) in the village territory ignored and did not recognize the traditional wisdom of forest and land management. These activities were granted concession by Provincial and District Government and Customary Institution not strong enough to protect their lands that taken over by concession such as oil palm or industrial forest. Swidden agriculture still plays an important role in the economic life of the community because more than 90% of the households still actively practicing swidden agriculture every year, despite of its disadvantages. The pressures and threats to the continued existence of conventional swidden agriculture has necessitated an innovative alternative swidden method which can improve land productivity and generate better income to farmers. The *daleh* swidden agriculture which is an integrated swidden farming combining the traditional swidden agriculture with livestocks and other crops in one plot, has the potential to become such an alternative because it improves land productivity, increases returns to farmers, and more importantly, it is culturally acceptable to the community. Unfortunately, District Government is not providing any financial assistance and agri-technological support neither to organize farmers in practicing more productive swidden agriculture.

In order to protect the agriculturally potential land for the purpose of swidden, the government should recognize the local wisdoms on forest and land management and should consider providing financial and facilitation support for the practice and improvisation of both conventional and *daleh* systems. Besides the economic benefits of swidden agriculture, the *Bahau* community also of the opinion that the *daleh* swidden agriculture may also become an "agricultural tourism object" in the future, particularly at its two most important stages of planting and harvesting.

ACKNOWLEDGMENTS

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Dear editor, (18 April 2018)

The second revision of manuscript Assessment of *Daleh* swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia is attached in this email. Please kindly check the attachment file. Thank you.
Best Regards,

Rujehan
(corresponding Author)

Assessment of *Daleh* swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia

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Abstract. *Imang N, Rujehan, Duakaju NN. 2018. Assessment of* Daleh *swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia. Biodiversitas 19: xxxx.* Swidden agriculture is still an important livelihood for millions of people in the tropics. In Kalimantan Island of Indonesia, swidden agriculture is currently facing many external pressures such as massive expansion of oil palm plantations, concession for industrial plantations, and non-availability of financial and political support from the government. The above external pressures which ignore local wisdoms in forest and land management have reduced the land available for swidden agriculture. The external pressures, in turn, have shortened the cycle of swidden agriculture and decreased the productivity of swidden agriculture. The objectives of the present study is to assess socio-cultural and economic aspects of the innovative *daleh* agriculture as an alternative to conventional swidden agriculture under these conditions. The study was conducted in an indigenous *Bahau Dayak* community of East Kalimantan, Indonesia. Twenty swiddeners and 6 other key informants were interviewed for data collection. Research findings confirm that the expansion of oil palm plantations has ignored the wisdoms in forest and land management, in general, and caused pressure on swidden agriculture, in particular. Under such pressures, *daleh* swidden agriculture may be effectively practiced because it can increase land productivity and is also culturally acceptable. Further, financial and facilitation support from district government is needed to improve the practice of swidden agriculture in the study area.

Keywords: *Daleh* swidden agriculture, *Dayak people*, Kalimantan

INTRODUCTION

Swidden agriculture or shifting cultivation, locally called *ladang*, is one of the traditional practices of forest and land management by people in the tropics and is suitable to social typology in which there is a high interdependence between people and the environment (Dove 1993; Colfer et al. 1997; Inoue 2000). Furthermore, Sardjono (1990) maintains that traditional forms of swidden agriculture reflect an optimum interrelation between the strategy to serve human needs and efforts to maintain ecological balance in tropical regions. These practices can be further improved through agroforestry technologies to adapt to local socio-economic dynamics and environmental changes. Conceptually, swidden agriculture has a close relation with social forestry. Pasaribu (2007), Sardjono (2007), and Inoue and Kawai (2013) define social forestry as any conditions and efforts

which intimately involve local people in forestry activities to ensure economic, ecological and social benefits, and simultaneously sustain the resources.

Dove (1988) and Inoue (1999) point out that the term 'shifting cultivation' is often taken to mean that the people are themselves 'shifting' or semi nomadic, even though most of them live in relatively permanent settlements. In fact, people use fire and fallow their field after harvest. The field, once set on fire, is called 'swidden'. So, 'swidden agriculture' is preferable to commonly used term 'shifting cultivation'.

Swidden agriculture is estimated to support 300-500 million people worldwide, covering about 30% of exploitable land for agricultural activities. In Asia Pacific, swidden covers an area of 73 million hectares and, in Indonesia, it involves 35 million hectares of land and about 2.2 million cultivators (Mubyarto 1991).

Several scholars have studied swidden agriculture as practiced by the *Kenyah Dayak* people of East Kalimantan (Jessup 1992; Colfer et al. 1997; Sindju 2003). Inoue and Lahjie (1990) tried to develop models for the sustainability of *Kenyah* agricultural systems, including *ladang*. Sindju (2003), in a comparative study of *ladang* practiced by the *Kenyah* of West Kalimantan, Indonesia and the *Kenyah* of Sarawak, Malaysia, has qualitatively described the technological aspects of the practice.

Inoue (1999) categorized swidden agriculture in term of its sustainability as follows: (i) traditional swidden agriculture-sustainable swidden agriculture practiced by indigenous people, (ii) transitional (quasi-traditional) swidden agriculture-practiced by indigenous people, originating from both recurrent and pioneer types, but not so sustainable because of short fallow period, and (iii) non-traditional swidden agriculture-unsustainable slash and burn agriculture, often with cash crops, usually practiced by new comers to village.

Though Swidden continue to play an important role in rural areas as indicated by the fact that around 65% of Mahakam Ulu people are still practicing swidden (BPS Mahakam Ulu 2016), the income from swidden agriculture was as low as Rp. 5-8 million (USD 385 – 615) for one hectare (Pannalo 2015; Wijayanti 2016). Besides the low economic returns, conventional swidden agriculture is also under external pressures, such as expansion of oil palm cultivation, coal mining and industrial forests *(Hutan Tanaman Industri = HTI)* which reduce the extent of potential land available for swidden agriculture. Under these conditions, an innovative alternative to traditional swidden agriculture is desirable which is economically more productive and culturally more acceptable to local community.

The *Dayak* people have practiced swidden agriculture from many generations for subsistence and the indigenous *Bahau Dayak* have recently developed the practice of *daleh* swidden agriculture. Imang et al. (2004a) described that *daleh* is a concept initiated by the local *Bahau Dayak* in Matalibaq as the response to the disadvantages of conventional swidden and is culturally and economically more acceptable to people. In the present study, we have assessed the potential of this recently emerged practice of *daleh* agriculture as an alternative to the conventional swidden agriculture.

The specific objectives of the study are (i) to assess the traditional practices of land management under external and internal pressures on forest and land, (ii) to explore and compare the practices of conventional and *daleh* swidden agriculture and the associated problems, (iii) to assess socio-cultural and economic aspects of *daleh* swidden agriculture responsible for its successful implementation and cultural acceptence by the swiddeners, particularly the *Dayak* people.

MATERIALS AND METHODS

The present study was conducted in Matalibaq village, Long Hubung Sub-district, West Kutai District, East Kalimantan, Indonesia from July to August 2017. Data was gathered from indigenous *Bahau Dayak* community who lived here for over hundreds of years. The reasons behind choosing this village are: i) it has a long history of protecting and managing primary forest based on the cultural wisdom, ii) it has innovative local knowledge pertaining to the practice of more productive swidden agriculture, and iii) recently the village is facing the pressures of activities like oil palm plantation expansion, massive Industrial Forest expansion, and other types of forest and land degradation.

Data and information were collected through in-depth interviews with Customary Chief *(Kepala Adat)*, Village Chief *(Petinggi)*, former customary chief, five village elders and 20 swiddeners. Data and information collected pertains to the traditional wisdom and concept of managing forest and land, the concept and practices of conventional and *daleh* swidden system, their merits and demerits, threats and constraints and benefits involved.

RESULTS AND DISCUSSION

Traditional knowledge-based forest and land management

Matalibaq village territory covers an area of 88,000 km^2 which was originally dominated by excellent primary forest. In order to protect the forest for sustainable local benefits, the available forest and land was allocated in 10 zones based on the availability of resources and socio-cultural considerations. The forest and land zonations are as follows: (i) *Tana' Umaq'*, land for settlement; (ii) *Tana' Lumaq*, areas for swidden agriculture, perennial and annual crops; (iii) *Tana' Lepu'un Luma'*, the former swidden area that planted with fruits, in which the fruits are considered the proof of individual ownership; (iv) *Tana' Bio'*, forested customary land in which the customary head implemented strict rules so that nobody can utilize the forest area for any purpose; (v) *Tana' Patai (kale')*, space for cemetery; (vi) *Tana' Berahan* or *Belahan*, forested area for extraction of forest products such as timber for self consumption and for sale, hunting ground and fishing area; (vii) *Tana' Mawa'* protected forest area for collecting high value forest

products such as resin, rattan, honey, timber for housing and boat making, eagle wood (*gaharu)*and forest fruits; (viii) *Tana' Ang/Hang*, the boundary area between adjacent villages wherein its utilization must be according to the agreement among bordering villages; (ix) *Tana' Pukung*, a protected forest area which is abundant in forest fruits for wild animals' as food; (x) *Tana' Kaso*, primary forest specially allocated for hunting because it is habitat for many wild animals such as wild pigs, deers and monkeys. People are strictly prohibited from disturbing the area that is allocated for breeding of wild animals because wild animal hunting is also a way of life of the community.

Such traditional land zonations persisted until external influences such as establishment of a logging company in 1992 and small-scale logging from 1999 to 2001 started affecting the village (Imang et al. 2004a). Such degradation activities have damaged forests outside the agricultural zone *(tana' lumaq).* The most massive forest and land degradation was caused by the land clearing for oil palm plantations taking place since 2014, covering around 6,000 hectares of land including primary forest area marked for hunting and fishing, without respecting the land zonation system followed traditionally by the villagers. Due to such destructive activities, some of the forest and land zones, such as those allocated for hunting and agricultural areas, have already been converted into oil palm plantations. Consequently, these activities have negatively impacted the practice of swidden agriculture. The most significant impact was a decrease in the land available for agriculture in general and swidden agriculture, in particular. This, in turn, shortened the cycle of conventional swidden agriculture. Under such a situation, the *Bahau Dayak* community of Matalibaq developed the concept of *daleh* swidden agriculture.

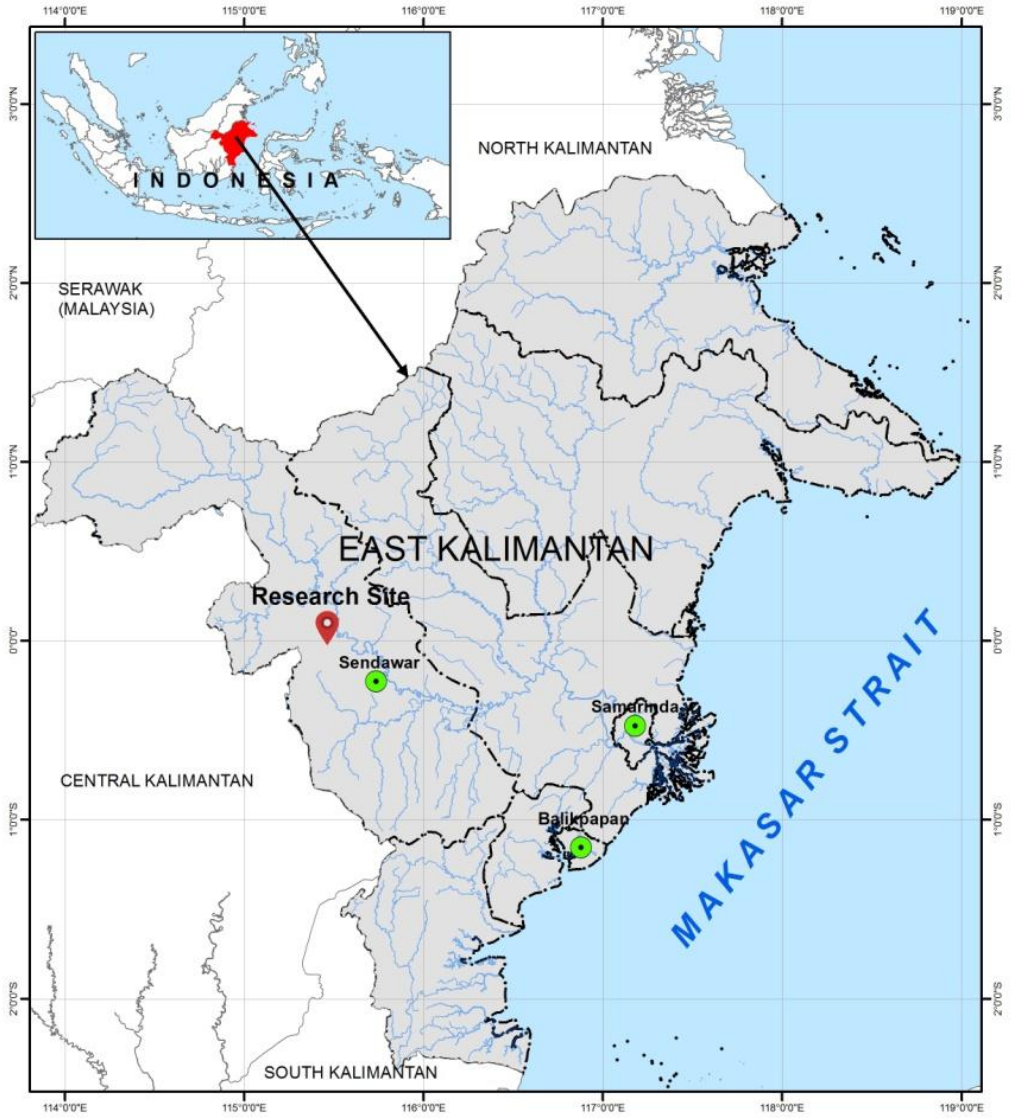

Figure 1. Map of the research site in Matalibaq village, West Kutai District, East Kalimantan, Indonesia

The practice of conventional swidden agriculture

Even though the practice of swidden agriculture is almost similar across countries, the local term in each country is different, e.g., *tsheri* or *pangshingtsheri* in Bhutan, *milpa* or *tlacolol* in Guatemala, *Kaingin* in Philippines, *taungya* in Thailand, *si Nda Bot* in Cameroon and in Indonesia, it is popularly known as *ladang* (Upadhyay 1995; Imang et al. 2004a). The local term for swidden agriculture in the research site of the present study is *lumaq*.

According to Imang (2004), the *Kenyah Dayak* people open new *ladang* through 9 stages. However, the *Bahau Dayak* people of Matalibaq village open their swidden agriculture commonly through 8 stages which are as follows: (i) slash the shrubs and small trees; (ii) cut down the big trees, which is usually a male-task because its risky for female; (iii) chop the fallen trunk for faster drying and proper burning; (iv) burn the vegetation which not only clears the ground for planting, but also releases nutrients from the biomass to increase the soil fertility; (v) planting preparation by removing the twigs; (vi) planting which is usually initiated by the Customary Chief *(Kepala Adat)* through a ritual ceremony to decide the most appropriate day for planting. Otherwise, the villagers believe that the harvests may not be good. This is an important stage of swidden in which the farmers gather and work together to plant one's swidden area in a labor exchange manner characterized by direct parity reciprocity; (vii) weeding, (8) harvesting, like at planting stage, harvesting also a very joyful stage because the farmers will harvest together of 10 to 20 farmers and even more.

Swidden agriculture is still playing an important economic role in the study area. It is observed that more than 90% of the 156 households of the village are still practicing swidden agriculture. Each farmer has around 4-7 plots of land and the location of these plots are spread out with the distance between plots varying from 2 to 6 kilometers. The average size of the plots is 1.10 hectares and the mode of access to the plot or swidden field is either by foot/walk or by boat, and some farmers have recently started accessing the plots by motor bikes.

Productivity of swidden agriculture varies widely over years, depending on the weather, rainfall, pests and diseases. The average productivity per hectare in the study area in February 2017 was 1,475 kg. The farmers feel that productivity was a bit lower than that of previous year of 2015 because of prolonged drought. Further, this productivity is lower than the swidden productivity of 1700 kg obtained in Pampang village which is around 650 km away from Matalibaq (Panalo 2015) and of Miau Baru village where it was 1,900 kg per hectare (Wijayanti 2016).

The farmers start swidden cultivation by clearing land in a randomly chosen location or plot, depending on how long the plot of land has been previously fallowed. The swidden plot for year-2 is located in the opposite direction away from swidden plot of year1 and the plots for subsequent years are selected in different locations. Consequently, the crops grown in previous years are mostly abandoned after moving to a new location for land clearing, for next years swidden. Farmers stay temporarily for 6 to12 months in one location, before moving to another location.

The more land a farmer has, the longer the swidden cycle and fallow period. Each plot of land is cleared in a rotation every year. The rotation of swidden locations is a strategy to allow the soil to regain its fertility through accumulation of biomass. The farmers have learnt by experience that the longer the swidden cycle, more fertile the soil becomes. The biomass from leaves and decomposed trees will be released to soil after it is burnt properly. This is in line with Weinstock and Sunito (1998) who mentioned that swidden agriculture is characterized by rotation of land rather than crops, or a rotational agriculture with a fallow period longer than the period of cultivation.

Farmers, through their experience, know that the rice planted in properly burnt area better growth compared to the rice planted in improperly burnt area. Properly burnt according to farmers is when leaves, twigs and small branches are completely burnt so that soil looks black. Therefore, during land clearing, farmers prefer felling trees towards inside of the swidden area instead of outside. This is also a strategy to prevent spreading of the fire to nearby forest areas during the burning of the swidden land.

The practices of *daleh* swidden agriculture

The cultural background of the *daleh* swidden is *gotong royong*, the cultural-spirit of 10 to 50 even more farmers working together in the swidden field of a farmer, usually in the stages of planting or harvesting. The labor exchange in *gotong royong* is characterized by direct parity reciprocity. Though the spirit of *daleh* can be practiced at any of the stages of swidden agriculture starting from slashing to harvesting, but the stages of planting and harvesting are the most suitable stages for *gotong royong*.

The concept and steps of *daleh* swidden agriculture are as follows: (i) *Daleh* system consiss of adjacent agriculture fields belonging to at least 4 households that are bordering each other, forming a cluster so that they can help each other whenever needed (Figure 3). (ii) Each household or farmer of the cluster should have at least one hectare of land, so that it can be divided into 4 plots, each measuring 0.25 hectares or more. One plot is cleared every year during the swidden cycle of 4 years (Figure 4). (iii) The huts or shelters of the all the minimum 4 swidden group members are located in the centre of their swidden field in a proper location so that they can raise pig, chicken or fishes surrounding their huts. When any swidden group member leaves the swidden field for overnight stay at village/home, other group members take care of his/her pigs or chickens and protect them from predators. Pigs and chickens have played a very important socio-cultural role in the life of *Bahau Dayak* people for hundreds of years. They offer pigs and chickens as sacrifices in every village ceremony. Manure of these livestock used as fertilizer for farming. On the other hand, domestic and agricultural wastes/bye products are used to feed them.

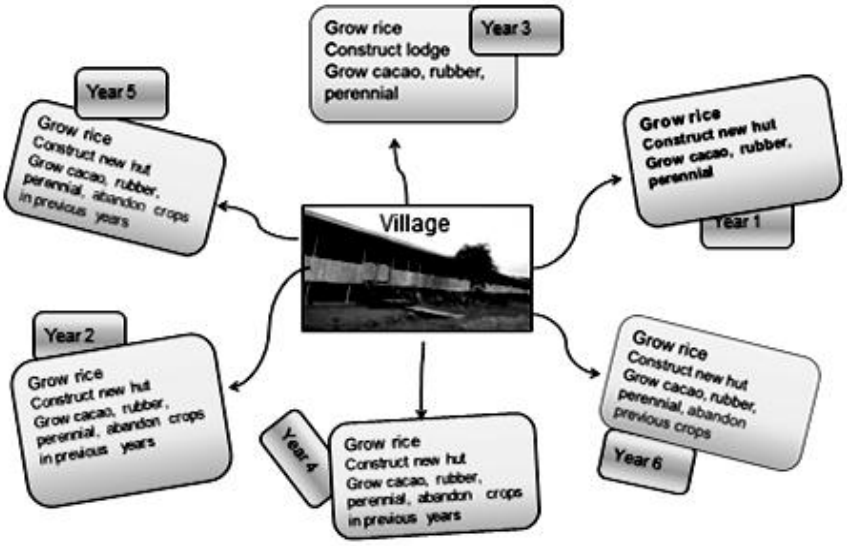

Figure 2. Utilization of land plots during different years in conventional swidden agriculture

Table 1. Practices of conventional swidden agriculture of a 6-year cycle in the study area.

Year	Activities	Harvested products
1	Open a swidden agriculture and grow rice, build a small hut/shelter, grow some vegetables and annual crops such as cacao, rubber or pepper.	Rice, corn, and vegetables.
2	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper. But, they abandon crops planted in year-1.	Rice, corn, vegetables.
3	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-2.	Rice, corn, vegetables.
4	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-3.	Rice, corn, vegetables.
5	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were abandoned
6	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were not maintained well.
7	Return to the plot of year-1, and start all steps of swidden from the beginning. The crops they planted in previous years not grow well because they abandoned.	Cacao, rubber or pepper not harvested because they were not maintained well.

Table 2. The disadvantages of conventional swidden agriculture as observed in the study area

Disadvantages
Swiddeners have to construct a new hut or shelter each time they open a new swidden which requires time and resources, both physical and financial.
Opening new swidden in another place results in increase of inputs because all of the previous years activities are repeated.
Cacao, rubber, pepper or other crops grown in the previous years are less productive or even not productive at all because of improper maintenance, crop damage by pests, diseases and weeds.
Swiddeners cannot raise livestock such as pig, poultry and others in swidden land (surrounding the hut) because they move to another place every year. The location of individual swidden is mostly away from neighbors' swidden, and most of the swiddeners will return home in the evening and return to swidden field in the next morning. Therefore, their livestocks and poultry may attacked by predators such as panther and weasel when farmer stay over night away from huts.
There is no availability of organic manures from livestocks for rice and crops, and farmers are left to depend only on the existing insufficient of natural soil fertility.
In some cases, the long abandoned former or ex-swidden areas of one farmer may be overlapping with the plots of other farmers or

encroached by other farmers.

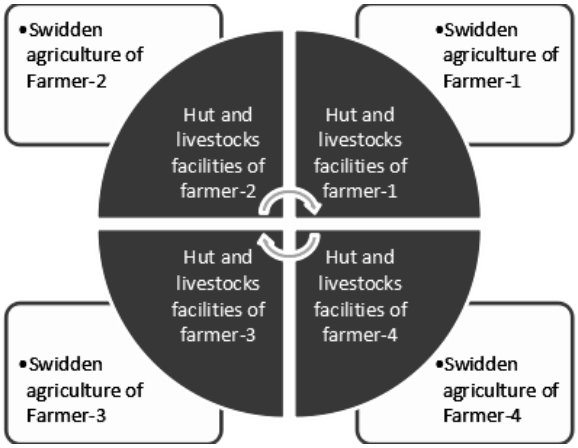

Figure 3. A cluster of *daleh* swidden agriculture consisting of four farmers

Firstly, the farmer divided the land into some smaller plots. The number of plot depends on the size of land or depending on how large of land can be cleared by farmer, usually 4-6 plots In this part, we use a case of 6 plots, while in Table 3 below is a case of 4 plots. Secondly, farmer will clear one plot every year from year-1 to year-6 in the same way and also similar crops. (i) In the first year, the swiddener cleared plot-1 and grew rice, corn, cucumber, vegetables at the same time. After six month, the rice could be ready to harvest. After the 0.25 ha of swidden already harvested, the swiddener can grow cacao, rubber, vegetables in former of the swidden field. (ii) In the second year, it is the turn for the second plot or plot-2 to clear for swidden in the same way and similar crops with the plot-1 in year-1. At the same time, the swiddener can maintain the crops he/she planted in the previous year so that the crops grow well. (iii) In the next year-3 and year-4, the swiddener also repeat the same ways as in the previous years until all of the 4 plots completed to clear for rice and for other crops. In year-4, the one-hectare of land is already planted with some annual and perennial crops, and ready to harvest. (iv) In year-5, the swiddener can move to other nearby area to open new swidden while also maintaining the crops in the previous years and raising livestocks. Cacao and rubber or other crops are ready to harvest in year-5 or year-6.

Figure 4 shows the details of how a farmer allocates his/her land during *daleh* swidden agriculture. The hut or shelter is built only once in the first year. They also build other facilities like cages to raise livestocks either in year 1 or year 2. These huts and cages built once lasts for more than 5 years because of which farmers save time, labor, and economic and material resources otherwise spent every year for these works. Further details such as the pattern of plot clearing, crops grown, animals raised and products harvested in the practice of *daleh* swidden agriculture are shown in Table 3.

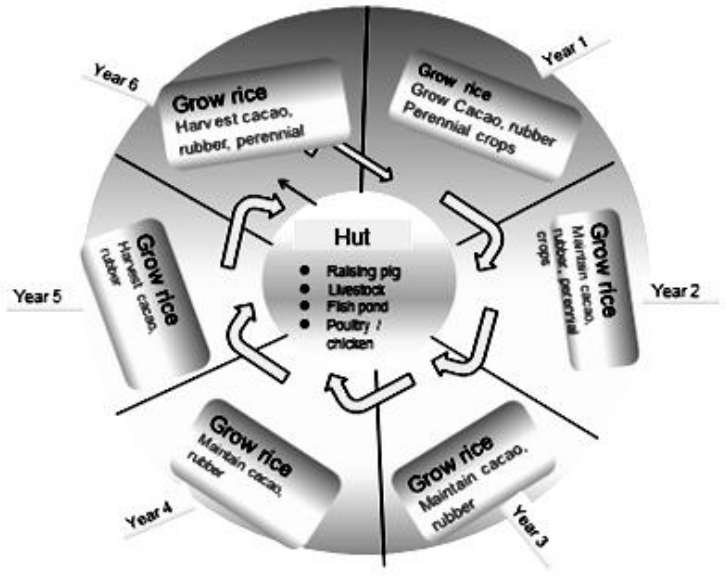

Figure 4. Details of utilization of one hectare land in *daleh* swidden agriculture practice

Table 3. Practices of *daleh* swidden system in 4 plots of land

Year	*Daleh* swidden agriculture practices	Harvested products

1	Plot-1 is cleared for swidden to grow rice, corn, and vegetables at the same time. Swiddener also build a proper hut/shelter. While waiting for the harvest of rice, swiddener prepares cage for pig and poultry. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field Just after the rice is harvested.	Rice, corn, cucumber, vegetables, chicken.
2	Plot-2 is cleared to grow rice, cucumber, corn, vegetables at the same time. No need to build a new hut/shelter. Swiddener continues to raise pig and poultry or fish pond. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field.	Rice, corn, cucumber, vegetables, chicken, pig, fishes. Parallely, they can also maintain crops planted in previous years, and raise livestocks such as chicken or pig.
3	Plot-3 is cleared for swidden to grow rice, corn and vegetables at the same time. Swiddener also build a proper hut/shelter in the year-1. While waiting the rice to harvest, swiddener prepares cage for pig and poultry. After rice harvesting the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field after rice is harvested..	Harvest rice, corn, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and raise livestocks such as chicken..
4	Plot-4 is cleared for swidden and after rice harvesting, swiddener grow cacao, rubber or pepper or other annual and perennial crops. In parallel, the swiddener also maintain crops they planted in plo-1 to 3.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and keep to raise livestocks
5	Open new swidden outside the previous area and repeat the same activities. Farmers also benefit from the pig and poultry, they can use waste to feed the livestocks, and conversely the livestocks provide manure/fertilizers for crops. This is an integrated farm that also acceptable to socio-cultural of the swiddeners.	Cacao and rubber they planted in year-1 plot-1 ready to for harvest, while they also maintain the crops they planted in year-2 to year-4. They also benefit from the livestocks.

Economic comparison between conventional and *daleh* swidden agriculture

Table 4 summarizes the economic comparison between conventional and *daleh* agriculture in terms of the various activities involved and products harvested. It is evident from the table that both systems have the same activities such as growing (G), maintaining (M) and harvesting products (P) such as rice, corn, and vegetables.

The differences are observed from second year onwards, the notable ones are: i) The crops grown in previous years, excluding rice, are maintained in *daleh* system because the subsequent years plots are close to the first year's plot. However, they are abandoned or neglected in conventional swidden agriculture due to the distance between first year's plot and subsequent years plots. ii) In conventional swidden agriculture, farmers do not build cages or facilities to raise chicken/poultry or pig and other livestocks because they live at the swidden site only for about 6 months to a year. After harvesting rice, they move to another swidden plot located far away from the first one. But in *daleh*, livestock is maintained as they live in the same location throughout the swidden cycle.

As mentioned above, the *daleh* swidden is a multi-product agricultural system as it involves mutual symbiosis between different elements such as rice, crops (cacao, rubber, pepper), livestocks and fish. In this system, products or bye products of one element supports or sustains the other elements and this enhances the overall productivity of the whole system. For example, the waste products resulting from rice cultivation is utilized to feed poultry and pig, while the manure of poultry and pig is used as organic fertilizer for crops. The central element of *daleh* system is the farmer and his/her family who control and maintain all elements, and at the same time, get multiple benefits from rice, other crops and livestocks. Figure 5 shows the multifarious interactions among the different elements of a *daleh* swidden agriculture system.

Table 4. Economic comparison between conventional swidden and *daleh* swidden systems of agriculture:

Crops	**Conventional swidden Year**					***Daleh* swidden system Year**					
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**
Rice	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP
Rubber	GM	A	A	A	AP-	GM	GM	GM	GM	GMP	GMP
Cacao	GM	A	A	A	AP-	GM	GM	GM	GM	GM	GMP
Banana	GM	P-	P-	P-	P-	GM	MP	MP	MP	MP	MP
Chicken	GMP	0	0	0	0	GMP	GMP	GMP	GMP	GMP	GMP
Pig	0	0	0	0	0	GM	GMP	GMP	GMP	GMP	GMP
Vegetables	GMP	GMP	0	0	0	GMP	GMP	GMP	GMP	GMP	GMP
Manure	0	0	0	0	0	P	P	P	P	P	P

Note: G: Grow/ raise livestocks and/or poultry, M: Maintain the crops, A: Abandoned/not properly maintained, P: Production of crops, or manure of livestocks, P-: Production but less, F: Fail, no production because the crops are abandoned, O: No agricultural activity/no raising of livestock

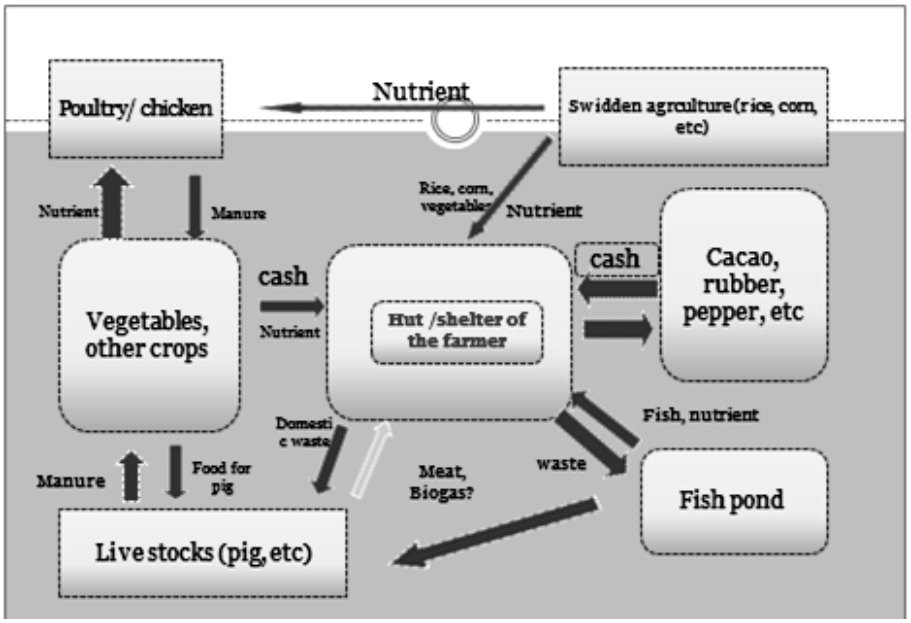

Figure 5. Interactions between different elements in a *daleh* swidden agriculture system

Threats to swidden agriculture:

The basic principle of shifting cultivation or swidden agriculture is the availability of sufficient time gap for the fallowed lands to regain their natural fertility, between successive swidden cycles. The usual duration of one cycle varies from 5 to 10 years, depending on the fertility of the land/soil and other considerations of the farmers. This implies that a farmer should have at least 5 plots of swidden land to maintain this cycle by allowing enough time to the soil to become fertile after one swidden cultivation.

However, the expansion of oil palm plantation has decreased the availability of suitable land for swidden agriculture. The narrower the extent of land available for swidden, shorter the swidden cycle becomes. Shortening of swidden cycle to less than 5 years, in turn, decreases land productivity because of insufficient nutrients in soil. This is one of the major threats to the continued practice of swidden agriculture, particularly at the study area. There are also other threats and constraints to swidden agriculture in general which are summarized in Table 5.

Conclusion

The introduction and expansion of oil palm plantations, logging and industrial planted forests (*HTI*) in the village territory ignored and did not recognize the traditional wisdom of forest and land management. These activities were granted concession by Provincial and District Government and Customary Institutions are not strong enough to protect their lands that are taken over by concession such as oil palm or industrial forest. Swidden agriculture still plays an important role in the economic life of the community because more than 90% of the households still actively practicing swidden agriculture every year, despite of its disadvantages. The pressures and threats to the continued existence of conventional swidden agriculture has necessitated an innovative alternative swidden method which can improve land productivity and generate better income to farmers. The *daleh* swidden agriculture, which is an integrated swidden farming combining the traditional swidden agriculture with livestocks and other crops in one plot, has the potential to become such an alternative because it improves land productivity, increases returns to farmers, and more importantly, it is culturally acceptable to the community. Unfortunately, District Government is not providing any financial assistance and agri-technological support to organize farmers for practicing more productive swidden agriculture.

In order to protect the agriculturally potential land for the purpose of swidden, the government should recognize the local wisdoms on forest and land management and should consider providing financial and facilitation support for the practice and improvisation of both conventional and *daleh* systems. Besides the economic benefits of swidden agriculture, the *Bahau* community also of the opinion that the *daleh* swidden agriculture may also become an "agricultural tourism object" in the future, particularly at its two most important stages of planting and harvesting.

Table 5. Constraints and threats to swidden agriculture in the study area

No	Constraints/ threats	Remarks
1	Expansion of oil palm plantations and Industrial Forests (*HTI*) that caused the conversion of agricultural lands to commercial	Some of the fertile land zones such *Tana' berahan, Tana' Kaso dan and Tana' Mawa'* have been converted

	plantations	to oil palm plantations and man-made tree forests (*HTI*).
2	The division of land into smaller plots so that it is more difficult to practice *daleh* swidden agriculture.	A cluster of *daleh* system needs at least 4 to 6 hectares of land for its effective practice and a sufficient land fallow.
3	The decreasing interest of young generation towards farm work because of reasons such as hard manual labor involved, low income which is insufficient to fulfill their daily needs of subsistence and monetary requirement, uncertain market for agricultural products, etc.	Panalo (2016) found that average output of one hectare of swidden agriculture is Rp. 8.6 million. It means that the average income for one month is Rp. 1.1 million
4	Technological innovations in the area of swidden agriculture is lacking when compared to wet rice cultivation. Therefore, all stages of swidden activities are done manually which is also a reason for its low productivity.	The remote location of the swidden agriculture also a constraint for agricultural officers to develop agricultural activities.
5	There is no schemes of financial support to develop swidden agriculture compared to wetland rice which gets financial support for development	Financial support provided to wetland rice where as farmers preference is towards swidden agriculture.
6	The emerging negative perception about swidden farmers who clear land using fire which is also blamed as a cause for forest fire.	There is a West Kutai District Regulation (Peraturan Daerah = PERDA) prohibiting the use of fire for land clearing. In this case, government did not consider the wisdom and culture of swidden agriculture.

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Assessment of *Daleh* swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia

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Abstract. Swidden agriculture is still an important livelihood for millions of people in the tropics. In Kalimantan Island of Indonesia, swidden agriculture is currently facing many external pressures such as massive expansion of oil palm plantations, concession for industrial plantations, and non-availability of financial and political support from the government. These external pressures which ignore local wisdoms in forest and land management have reduced the land available for swidden agriculture. This, in turn, has shortened the cycle and decreased the productivity of swidden agriculture. The objectives of the present study is to assess socio-cultural and economic aspects of the innovative *daleh* agriculture as an alternative to conventional swidden agriculture under these conditions. The study was conducted in an indigenous *Bahau Dayak* community of East Kalimantan, Indonesia. Twenty swiddeners and 6 other key informants were interviewed for data collection. Research findings confirm that the expansion of oil palm plantations has ignored the wisdoms in forest and land management, in general, and caused pressure on swidden agriculture, in particular. Under such pressures, *daleh* swidden agriculture may be effectively practiced because it can increase land productivity and is also culturally acceptable. Further, financial and facilitation support from district government is needed to improve the practice of swidden agriculture in the study area.

Keywords: *Daleh* swidden agriculture, *Dayak people*, Kalimantan

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INTRODUCTION

Swidden agriculture or shifting cultivation, locally called *ladang*, is one of the traditional practices of forest and land management by people in the tropics and is suitable to social typology in which there is a high interdependence between people and the environment (Inoue, 2000; Dove, 1993; Colfer *et al*., 1997). Furthermore, Sardjono (1990) maintains that traditional forms of swidden agriculture reflect an optimum interrelation between the strategy to serve human needs and efforts to maintain ecological balance in tropical regions. These practices can be further improved through agroforestry technologies to adapt to local socio-economic dynamics and environmental changes. Conceptually, swidden agriculture has a close relation with social forestry. Sardjono (2007), Pasaribu (2007), and Inoue and Kawai (2013) define social forestry as any conditions and efforts which intimately involve local people in forestry activities to ensure economic, ecological and social benefits, and simultaneously sustain the resources.

Dove (1988) and Inoue (1999) point out that the term 'shifting cultivation' is often taken to mean that the people are themselves 'shifting' or semi nomadic, even though most of them live in relatively permanent settlements. In fact, people use fire and fallow their field after harvest. The field, once set on fire, is called 'swidden'. So, 'swidden agriculture' is preferable to commonly used term 'shifting cultivation'.

Swidden agriculture is estimated to support 300-500 million people worldwide, covering about 30% of exploitable land for agricultural activities. In Asia Pacific, swidden covers an area of 73 million hectares and, in Indonesia, it involves 35 million hectares of land and about 22 million cultivators (Mubyarto *et al*., 1991).

Several scholars have studied swidden agriculture as practiced by the *Kenyah Dayak* people of East Kalimantan (Colfer *et al*., 1997; Jessup, 1992; Sindju, 2003). Inoue and Lahjie (1990) tried to develop models for the sustainability of *Kenyah* agricultural systems, including *ladang*. Sindju (2003), in a comparative study of *ladang* practiced by the *Kenyah* of West Kalimantan, Indonesia and the *Kenyah* of Sarawak, Malaysia, has qualitatively described the technological aspects of the practice.

Inoue (1999) categorized swidden agriculture in term of its sustainability as follows: (i) traditional swidden agriculture-sustainable swidden agriculture practiced by indigenous people, (ii) transitional (quasi-traditional) swidden agriculture - practiced by indigenous people, originating from both recurrent and pioneer types, but not so sustainable because of short fallow period, and (iii) non-traditional swidden agriculture - unsustainable slash and burn agriculture, often with cash crops, usually practiced by new comers to village.

Though Swidden continue to play an important role in rural areas as indicated by the fact that around 65% of Mahakam Ulu people are still practicing swidden (BPS Mahakam Ulu, 2016), the income from swidden agriculture was as low as Rp. 5-8 million (USD 385 – 615) for one hectare (Pannalo, 2015; Wijayanti, 2016). Besides the low economic returns, conventional swidden agriculture is also under external pressures, such as expansion of oil palm cultivation, coal mining and industrial forests *(Hutan Tanaman Industri = HTI)* which reduce the extent of potential land available for swidden agriculture. There are other external and internal factors also. Under these conditions, an innovative alternative to traditional swidden agriculture is desirable which is economically more productive and culturally more acceptable to local community.

The *Dayak* people have practiced swidden agriculture throughout their life for subsistence and the indigenous *Bahau Dayak* have recently developed the practice of *daleh* swidden agriculture. Imang (2004) described that *daleh* is a concept initiated by the local *Bahau Dayak* in Matalibaq as the response to the disadvantages of conventional swidden and is culturally and economically more acceptable to people. In the present study, we have assessed the potential of this recently emerged practice of *daleh* agriculture as an alternative to the conventional swidden agriculture.

The specific objectives of the study are (i) to assess the traditional practices of land management under external and internal pressures on forest and land, (ii) to explore and compare the practices of conventional and *daleh* swidden agriculture and the associated problems, (iii) to assess socio-cultural and economic aspects of *daleh* swidden agriculture responsible for its successful implementation and culturall acceptance by the swiddeners, particularly the *Dayak* people.

MATERIALS AND METHODS

The present study was conducted in Matalibaq village, Long Hubung Sub-district, West Kutai District, East Kalimantan, Indonesia from July to August 2017. Data was gathered from indigenous *Bahau Dayak* community who lived here for over hundreds of years. The reasons behind choosing this village are: i) it has a long history of protecting and managing primary forest based on the cultural wisdom, ii) it has innovative local knowledge pertaining to the practice of more productive swidden agriculture, and iii) recently the village is facing the pressures of activities like oil palm plantation expansion, massive Industrial Forest expansion, and other types of forest and land degradation.

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Figure 1. Map of the research site in Matalibaq village, Long Hubung Sub-district, West Kutai District, East Kalimantan, Indonesia

Data and information were collected through in-depth interviews with Customary Chief *(Kepala Adat)*, Village Chief *(Petinggi)*, former customary chief, five village elders and 20 swiddeners. Data and information collected pertains to the traditional wisdom and concept of managing forest and land, the concept and practices of conventional and *daleh* swidden system, their merits and demerits, threats and constraints and, costs and benefits involved.

RESULTS AND DISCUSSION

Traditional knowledge-based forest and land management:

Matalibaq village territory covers an area of 88,000 km^2 which was originally dominated by excellent primary forest. In order to protect the forest for sustainable local benefits, the available forest and land was allocated in 11 zones based on the availability of resources and socio-cultural considerations. The forest and land zonations are as follows: (1) *Tana' Umaq'*, land for settlement; (2) *Tana' Lumaq*, areas for swidden agriculture, perennial and annual crops; (3) *Tana' Lepu'un Luma'*, the former of earlier swidden that planted with fruits as the sign for individual ownership; (4) *Tana' Bio'*, forested customary land in which the customary head implemented strict rules so that nobody can utilize the forest area for any purpose; (5) *Tana' Patai (kale')*, space for cemetery; (6) *Tana' Berahan* or *Belahan*, forested area for extraction of forest products such as timber for self consumption and for sale, hunting ground and fishing area; (7) *Tana' Mawa'* protected forest area for collecting high value forest products such as resin, rattan, honey, timber for housing and boat making, *gaharu* and forest fruits; (8) *Tana' Ang/Hang*, the boundary area between adjacent villages wherein its utilization must be according to the agreement among bordering villages; (9) *Tana' Pukung*, a protected forest area which is abundant in forest fruits for wild animals' as food; (10) *Tana' Kaso*, primary forest specially allocated for hunting because it is habitat for many wild animals such as wild pigs, deers and monkeys. People are strictly prohibited from disturbing the area that is allocated for breeding of wild animals because wild animal hunting is also a way of life of the community.

Such traditional land zonations persisted until external influences such as establishment of a logging company in 1992 and small-scale logging from 1999 to 2001 started affecting the village(Imang, 2001). Such degradation activities have

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damaged forests which are outside the agricultural zone *(tana' lumaq).* The most massive forest and land degradation was

caused by the land clearing for oil palm plantations taking place since 2014, covering around 6,000 hectares of land including primary forest area marked for hunting and fishing, without respecting the land zonation system followed traditionally by the villagers. Due to such destructive activities, some of the forest and land zones, such as those allocated for hunting and agricultural areas, have already been converted into oil palm plantations. Consequently, these activities have negatively impacted the practice of swidden agriculture. The most significant impact was a decrease in the land available for agriculture in general and swidden agriculture, in particular. This, in turn, shortened the cycle of conventional swidden agriculture. Under such a situation, the *Bahau Dayak* community of Matalibaq developed the concept of *daleh* swidden agriculture.

The practice of conventional swidden agriculture:

Even though the practice of swidden agriculture is almost similar across countries, the local term in each country is different, e.g. *tsheri* or *pangshingtsheri* in Bhutan, *milpa* or *tlacolol* in Guatemala, *Kaingin* in Philippines, *taungya* in Thailand , *si Nda Bot* in Cameroon and in Indonesia, it is popularly known as *ladang* ((Upadhyay, 1995; Imang *et al*. 2004). The local term for swidden agriculture in the research site of the present study is *lumaq*.

According to Imang (2001), the *Kenyah Dayak* people open new *ladang* through 9 stages. However, the *Bahau Dayak* people of Matalibaq village open their swidden agriculture commonly through 8 stages which are as follows: (1) slash the shrubs and small trees; (2) cut down the big trees, which is usually a male-task because its risky for female; (3) chop the fallen trunk for faster drying and proper burning; (4) burn the vegetation which not only clears the ground for planting, but also releases nutrients from the biomass to increase the soil fertility; (5) planting preparation by removing the twigs; (6) planting which is usually initiated by the Customary Chief *(Kepala Adat)* through a ritual ceremony to decide the most appropriate day for planting. Otherwise, the villagers believe that the product may not be good. This is an important stage of swidden in which the farmers gather and work together to plant one's swidden area in a labor exchange manner characterized by direct parity reciprocity; (7) weeding, farmers regularly remove weeds which otherwise detrimental to the crop plants; (8) harvesting, like at planting stage, harvesting also a very important stage in swidden agriculture .

Swidden agriculture is still playing an important economic role in the study area. It is observed that more than 90% of the 156 households of the village are still practicing swidden agriculture. Each farmer has around 4-7 plots of land and the location of these plots are spread out with the distance between plots varying from 2 to 6 kilometers. The average size of the plots is 1.10 hectares and the mode of access to the plot or swidden field is either by foot/walk or by boat, and some farmers have recently started accessing the plots by motor bikes.

Productivity of swidden agriculture varies widely over years, depending on the weather, rainfall, pests and diseases. The average productivity per hectare in the study area was 1,475 kg. The farmers feel that productivity was a bit lower than that of previous year of 2015 because of prolonged drought. Further, this productivity is lower than the swidden productivity of 1700 kg obtained in Pampang village which is around 650 km away from Matalibaq (Panalo, 2015) and of Miau Baru village where it was 1,900 kg per hectare (Wijayanti, 2016).

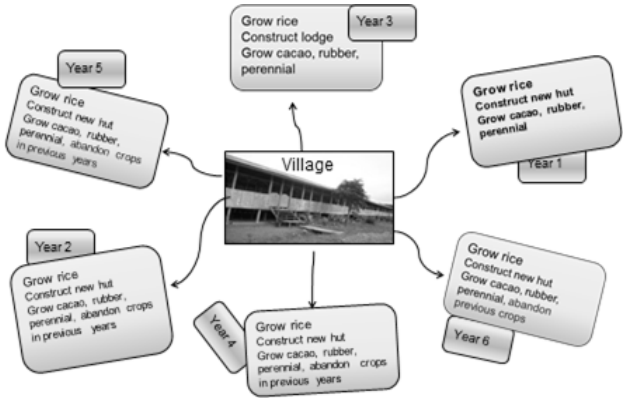

Figure 2. Utilization of land plots during different years in conventional swidden agriculture

The farmers start swidden cultivation by clearing land in a randomly chosen location or plot, depending on how long the plot of land has been previously fallowed. The swidden plot for year-2 is located in the opposite direction away from swidden plot of year1 and the plots for subsequent years are selected in different locations. Consequently, the crops

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grown in previous years are mostly abandoned after moving to a new location for land clearing, for next years swidden. Farmers stay temporarily for 6 to12 months in one location, before moving to another location.

The more land a farmer has, the longer the swidden cycle and fallow period. The land is cleared in rotation or cycle, every year. The rotation of swidden locations is a strategy to allow the soil to regain its fertility through accumulation of biomass. The farmers have learnt by experience that the longer the swidden cycle, more fertile the soil becomes. The biomass from leaves and rotten trees will be released to soil and rice after it is burnt properly. This is in line with Weinstock and Sunito (1998) who mentioned that swidden agriculture is characterized by rotation of land rather than crops, or a rotational agriculture with a fallow period longer than the period of cultivation.

Farmers, through their experience, know that the rice planted in properly burnt area grows more fertile and more green when compared to the rice planted in improperly burnt area. Therefore, during land clearing, farmers prefer felling trees towards inside of the swidden area instead of outside. This is also a strategy to prevent spreading of the fire to nearby forest areas during the burning of the swidden land.

Table 1. Practices of conventional swidden agriculture of a 6-year cycle in the study area.

Year	Activities	Harvested products
1	Open a swidden agriculture and grow rice, develop a small hut/shelter, grow some vegetables and annual crops such as cacao, and rubber or pepper.	Rice, corn, cucumber, vegetables.
2	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper. But, they abandon crops planted in year-1.	Rice, cucumber, corn, vegetables.
3	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-2.	Rice, cucumber, corn, vegetables.
4	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year -3.	Rice, cucumber, corn, vegetables.
5	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	They open new swidden in different place/away with the previous swiddens so that they abandoned the cacao and rubber they planted in year-1 to year-4.
6	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	They open new swidden in different place/away with the previous swiddens so that they abandoned the cacao and rubber they planted in year-1 to year-5.
7	Return to the plot of year-1, and start all steps of swidden from the beginning. They found that annual crops they planted in previous years not productive because not properly maintained.	

Source: Field observation by authors (2017)

Table 2. The disadvantages of conventional swidden agriculture as observed in the study area

No	Disadvantages
1	Swiddeners have to construct a new hut or shelter each time they open a new swidden which requires time and resources, both physical and financial.
2	Opening new swidden in another place results in increase of inputs because all of the previous years activities are repeated.
3	Cacao, rubber, pepper or other crops grown in the previous years are less productive or even not productive at all because of improper maintenance, crop damage by pests, diseases and weeds.
4	Swiddeners cannot raise livestock such as pig, poultry and others in swidden land (surrounding the hut) because they move to another place every year. The location of individual swidden is mostly away from neighbors' swidden, and most of the swiddeners will return home in the evening and return to swidden field in the next morning.
5	There is no availability of organic manures from livestocks for rice and crops, and farmers are left to depend only on the existing insufficient nutrients.
6	In some cases, the long abandoned former or ex-swidden areas of one farmer may be overlapping with the plots of other farmers or encroached by other farmers.

Source: Field observation by authors (2017)

The practices of *daleh* swidden agriculture:

The cultural background of the *daleh* swidden is *gotong royong*, the cultural-spirit of 10 to 50 even more farmers working together in the swidden field of a farmer, usually in the stages of planting or harvesting. The labor exchange in

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Commented [g32]: Cucumber is also a vegetable. Arrange the products according to any criterion.

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2. The harvesting of cacao and rubber is not mentioned anywhere.

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gotong royong is characterized by direct parity reciprocity. Though the spirit of *daleh* can be practiced at any of the stages of swidden agriculture starting from slashing to harvesting, it is usually done in two stages, planting and harvesting.

The concept and steps of *daleh* swidden agriculture are as follows: (i) *Daleh* system consiss of adjacent agriculture fields belonging to at least 4 households that are bordering each other, forming a cluster so that they can help each other whenever needed (Figure 3). (ii) Each household or farmer of the cluster should have at least one hectare of land, so that it can be divided into 4 plots, each measuring 0.25 hectares or more. One plot is cleared every year during the swidden cycle of 4 years (Figure 4). (iii) The huts or shelters of the all the 4 swidden group members are located in the centre of their swidden field in a proper location so that they can raise pig or chicken surrounding their huts. When any swidden group member leaves the swidden field for overnight stay at village/home, other group members take care of his/her pigs or chickens and protect them from predators. Pigs and chickens have played a very important socio-cultural role in the life of *Bahau Dayak* people for hundreds of years. They offer pigs and chickens as sacrifices in every village ceremony. Manure of these livestock used as fertilizer for farming. On the other hand, domestic and agricultural wastes/bye products are used to feed them.

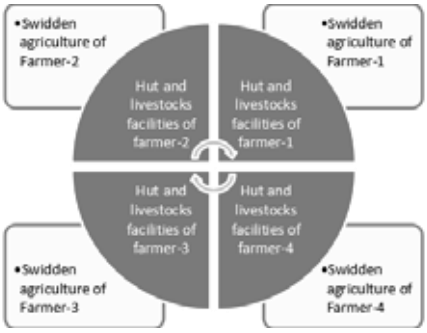

Figure 3. A cluster of *daleh* swidden agriculture consisting of four farmers.

Firstly, the farmer divided the land into 6 smaller plots. The number of plot depends on the size of land or depending on how large of land can be cleared by farmer. Secondly, farmer will clear one plot every year from year-1 to year-6 in the same way and also similar crops.

(5) In the first year, the swiddener cleared plot-1 and grew rice, corn, cucumber, vegetables at the same time. After six month, the rice could be ready to harvest. After the 0.25 ha of swidden already harvested, the swiddener can grow cacao, rubber, vegetables in former of the swidden field.

(6) In the second year, it is the turn for the second plot or plot-2 to clear for swidden in the same way and similar crops with the plot-1 in year-1. At the same time, the swiddener can maintain the crops he/she planted in the previous year so that the crops grow well.

(7) In the next year-3 and year-4, the swiddener also repeat the same ways as in the previous years until all of the 4 plots completed to clear for rice and for other crops. In year-4, the one-hectare of land is already planted with some annual and perennial crops, and ready to harvest.

(8) In year-5, the swiddener can move to other nearby area to open new swidden while also maintaining the crops in the previous years and raising livestocks. Cacao and rubber or other crops are ready to harvest in year-5 or year-6.

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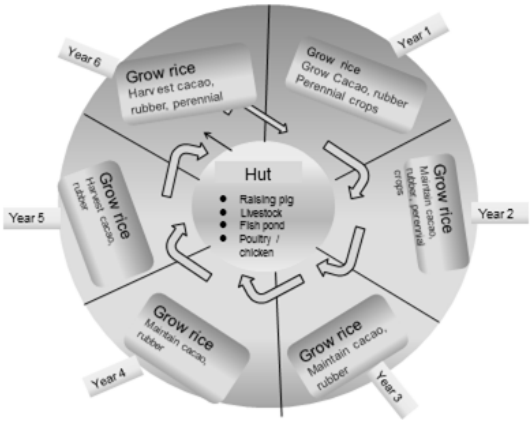

Figure 4. Details of utilization of one hectare land in *daleh* swidden agriculture practice

Figure 4 shows the details of how a farmer allocates his/her land during *daleh* swidden agriculture. The hut or shelter is built only once in the first year... They also build other facilities like cages to raise livestocks either in year1 or year 2. These huts and cages built once lasts for more than 5 years because of which farmers save time, labor, and economic and material resources otherwise spent every year for these works. Further details such as the pattern of plot clearing, crops grown, animals raised and products harvested in the practice of *daleh* swidden agriculture are shown in table 3. of

Table 3. Practices of *daleh* swidden system in 4 plots of land;

Year	***Daleh* Swidden agriculture practices**	**Harvested Products**
1	Plot-1 is cleared for swidden to grow rice, corn, cucumber and other vegetables at the same time. Swiddener also build a proper hut/shelter . While waiting for the harvest of rice, swiddener prepares cage for pig and poultry. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field.	rice, corn, cucumber, vegetables, chicken.
2	Plot-2 is cleared to grow rice, cucumber, corn, vegetables at the same time. No need to build a new hut/shelter. Swiddener continues to raise pig and poultry or fish pond. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field.	rice, corn, cucumber, vegetables, chicken, pig, fishes. Parallely, they can also maintain crops planted in previous years, and raise livestocks.
3	Plot-3 is cleared for swidden to grow rice, cucumber, corn, vegetables at the same time. Swiddener also develop a proper hut/shelter in the year-1. While waiting the rice to harvest, swiddener prepares cage for pig and poultry. After rice harvesting the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and raise livestocks.
4	Plot-4 is cleared for swidden and after rice harvesting, swiddener grow cacao, rubber or pepper or other annual and perennial crops. In parallel, the swiddener also maintain crops they planted in plo-1 to 3.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and keep to raise livestocks
5	Open new swidden outside the previous area and repeat the same activities. Farmers also benefit from the pig and poultry, they can use waste to feed the livestocks, and conversely the livestocks provide manure/fertilizers for crops. This is an integrated farm that also acceptable to socio-cultural of the swiddeners.	Cacao and rubber they planted in year-1 plot-1 ready to for harvest, while they also maintain the crops they planted in year-2 to year-4. They also benefit from the livestocks.

Source: Field observations by authors (2017)

Comparison between conventional and *daleh* swidden agriculture:

Table 4. Comparison between conventional swidden and *daleh* swidden systems of agriculture:

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Crops	Conventional swidden Year						*Daleh* swidden system Year					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
Rice	GMP	GMP	GMP	GMP	GMP		GMP	GMP	GMP	GMP	GMP	GMP
Rubber	GM	A	A	A	AP-		GM	GM	GM	GM	GMP	GMP
Cacao	GM	A	A	A	AP-		GM	GM	GM	GM	GM	GMP
Banana	GM	P-	P-	P-	P-		GM	MP	MP	MP	MP	MP
Chicken	GMP	0	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Pig	0	0	0	0	0		GM	GMP	GMP	GMP	GMP	GMP
Vegetables	GMP	GMP	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Manure	0	0	0	0	0		P	P	P	P	P	P

Legends:

G	=	Grow/ raise livestocks and/or poultry
M	=	Maintain the crops
A	=	Abandoned/not properly maintained
P	=	Production or harvest, good production or manure
P-	=	Production but less
F	=	Fail, no production because the crops are abandoned
O	=	No agricultural activity/no raising of livestock

Table 4 summarises the comparison between conventional and *daleh* agriculture in terms of the various activities involved and products harvested. It is evident from the table that both systems have the same activities such as growing (G), maintaining (M) and harvesting products (P) such as rice, corn, cucumber and other vegetables.

The differences are observed from second year onwards, the notable ones are: i) The crops grown in previous years, excluding rice, are maintained in *daleh* system because the subsequent years plots are close to the first year's plot. However, they are abandoned or neglected in conventional swidden agriculture due to the distance between first year's plot and subsequent years plots. ii) In conventional swidden agriculture, farmers do not build cages or facilities to raise chicken/poultry or pig and other livestocks because they live at the swidden site only for about 6 months to a year. After harvesting rice, they move to another swidden plot located far away from the first one. But in *daleh*, livestock is maintained as they live in the same location throughout the swidden cycle.

As mentioned above, the *daleh* swidden is a multi-product agricultural system as it involves mutual symbiosis between different elements such as rice, crops, livestocks and fish. In this system, products or bye products of one element supports or sustains the other elements and this enhances the overall productivity of the whole system. For example, the waste products resulting from rice cultivation is utilized to feed poultry and pig, while the manure of poultry and pig is used as organic fertilizer for crops. The central element of *daleh* system is the farmer and his/her family who control and maintain all elements, and at the same time, get multiple benefits from

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rice, other crops and livestocks. Figure 5 shows the multifarious interactions among the different elements of a *daleh* swidden agriculture system.

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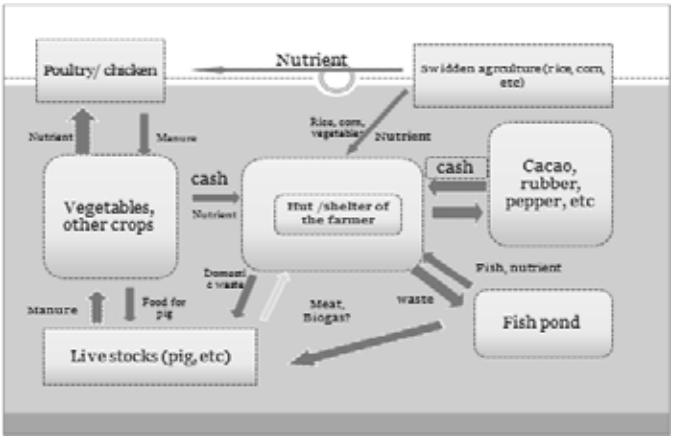

Figure 5. Interactions between different elements in a *daleh* swidden agriculture system.

Threats to swidden agriculture:

The basic principle of shifting cultivation or swidden agriculture is the availability of sufficient time gap for the fallowed lands to regain their natural fertility, between successive swidden cycles. The usual duration of of one cycle varies from 5 to 10 years, depending on the fertility of the land/soil and other considerations of the farmers. This implies that that a farmer should have at least 5 plots of swidden land to maintain this cycle by allowing enough time to the soil to become fertile after one swidden cultivation. .

However, the expansion of oil palm plantation has decreased the availability of suitable land for swidden agriculture. The narrower the extent of land available for swidden, shorter the swidden cycle becomes. Shortening of swidden cycle to less than 5 years, in turn, decreases land productivity because of insufficient nutrients in soil. This is one of the major threats to the continued practice of swidden agriculture, particularly at the study area. There are also other threats and constraints to swidden agriculture in general which are summarized in Table 5..

Table 5. Constraints and threats to swidden agriculture in the study area:

No	Constraints/ threats	Remarks
1	Expansion of oil palm plantations and Industrial Tree-Planted Forests (*HTI*) that caused the conversion of agricultural lands to commercial plantations	Some of the fertile land zones such *Tana' berahan, Tana' Kaso dan and Tana' Mawa'* have been converted to oil palm plantations and man-made tree forests (*HTI*).
2	The of land into smaller plots so that it is more difficult to practice *daleh* swidden agriculture.	A cluster of *daleh* system needs at least 4 to 6 hectares of land for its effective practice and a sufficient land fallow.
3	The decreasing interest of young generation towards farm work because of reasons such as hard manual labor involved, low income which is insufficient to fulfill their daily needs of subsistence and monetary requirment, uncertain market for agricultural products, etc.	Panalo (2016) found that average output of one hectare of swidden agriculture is Rp. 8.6 million. It means that the average income for one month is Rp. 1.1 million
4	Technological innovations in the area of swidden agriculture is lacking when compared to wet rice cultivation. Therefore, all stages of swidden activities are done manually which is also a reason for its low productivity..	The spread out of location of the swidden field also blamed for field officer reluctant to develop their agricultural activities.
5	There is no schemes of financial support to develop swidden agriculture compared to wetland rice which gets financial support for development	Financial support provided to wetland rice where as wetland rice not really acceptable for farmers.
6	The emerging negative perception about swidden farmers who clear land using fire which is also blamed as a cause for forest fire.	There is a West Kutai District Regulation (*Peraturan Daerah = PERDA*) regarding prohibiting the use of fire for land clearing. In this case, government did not consider the wisdom and culture of swidden agriculture.

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Conclusion:

The introduction and expansion of oil palm plantations, logging and industrial planted forests (*HTI*) in the village territory ignored and did not recognize the traditional wisdom of forest and land management. These activities were granted concession by Provincial and District Government and Customary Institution not strong enough against the concession. Swidden agriculture still plays an important role in the economic life of the community because more than 90% of the households still actively practicing swidden agriculture every year, despite of its disadvantages. The pressures and threats to the continued existence of conventional swidden agriculture has necessitated an innovative alternative swidden method which can improve land productivity and generate better income to farmers. The *daleh* swidden agriculture which is an integrated swidden farming combining the traditional swidden agriculture with livestocks and other crops in one plot, has the potential to become such an alternative because it improves land productivity, increases returns to farmers, and more importantly, it is culturally acceptable to the community. Unfortunately, District Government is not providing any financial assistance and agri-technological support to this system and facilitators to organize the farmers practicing this more productive swidden agriculture.

In order to protect the agriculturally potential land for the purpose of swidden, the government should recognize the local wisdoms on forest and land management and should consider providing financial and facilitation support for the practice and improvisation of both conventional and *daleh* systems. Besides the economic benefits of swidden agriculture, the *Bahau* community also of the opinion that the *daleh* swidden agriculture may also become an "agricultural tourism object" in the future, particularly at its two most important stages of planting and harvesting. .

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ACKNOWLEDGMENTS

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Assessment of *Daleh* swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia

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Abstract. Swidden agriculture is still an important livelihood for millions of people in the tropics. In Kalimantan Island of Indonesia, swidden agriculture is currently facing many external pressures such as massive expansion of oil palm plantations, concession for industrial plantations, and non-availability of financial and political support from the government. The above external pressures which ignore local wisdoms in forest and land management have reduced the land available for swidden agriculture. The external pressures, in turn, have shortened the cycle of swidden agriculture and decreased the productivity of swidden agriculture. The objectives of the present study is to assess socio-cultural and economic aspects of the innovative *daleh* agriculture as an alternative to conventional swidden agriculture under these conditions. The study was conducted in an indigenous *Bahau Dayak* community of East Kalimantan, Indonesia. Twenty swiddeners and 6 other key informants were interviewed for data collection. Research findings confirm that the expansion of oil palm plantations has ignored the wisdoms in forest and land management, in general, and caused pressure on swidden agriculture, in particular. Under such pressures, *daleh* swidden agriculture may be effectively practiced because it can increase land productivity and is also culturally acceptable. Further, financial and facilitation support from district government is needed to improve the practice of swidden agriculture in the study area.

Keywords: *Daleh* swidden agriculture, *Dayak people*, Kalimantan

INTRODUCTION

Swidden agriculture or shifting cultivation, locally called *ladang*, is one of the traditional practices of forest and land management by people in the tropics and is suitable to social typology in which there is a high interdependence between people and the environment Dove, 1993; Colfer *et al*., 1997 and Inoue, 2000). Furthermore, Sardjono (1990) maintains that traditional forms of swidden agriculture reflect an optimum interrelation between the strategy to serve human needs and efforts to maintain ecological balance in tropical regions. These practices can be further improved through agroforestry technologies to adapt to local socio-economic dynamics and environmental changes. Conceptually, swidden agriculture has a close relation with social forestry. Sardjono (2007), Pasaribu (2007), and Inoue and Kawai (2013) define social forestry as any conditions and efforts which intimately involve local people in forestry activities to ensure economic, ecological and social benefits, and simultaneously sustain the resources.

Dove (1988) and Inoue (1999) point out that the term 'shifting cultivation' is often taken to mean that the people are themselves 'shifting' or semi nomadic, even though most of them live in relatively permanent settlements. In fact, people use fire and fallow their field after harvest. The field, once set on fire, is called 'swidden'. So, 'swidden agriculture' is preferable to commonly used term 'shifting cultivation'.

Swidden agriculture is estimated to support 300-500 million people worldwide, covering about 30% of exploitable land for agricultural activities. In Asia Pacific, swidden covers an area of 73 million hectares and, in Indonesia, it involves 35 million hectares of land and about 2.2 million cultivators (Mubyarto , 1991).

Several scholars have studied swidden agriculture as practiced by the *Kenyah Dayak* people of East Kalimantan (Colfer *et al*., 1997; Jessup, 1992; Sindju, 2003). Inoue and Lahjie (1990) tried to develop models for the sustainability of *Kenyah* agricultural systems, including *ladang*. Sindju (2003), in a comparative study of *ladang* practiced by the *Kenyah* of West

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Kalimantan, Indonesia and the *Kenyah* of Sarawak, Malaysia, has qualitatively described the technological aspects of the practice.

Inoue (1999) categorized swidden agriculture in term of its sustainability as follows: (i) traditional swidden agriculture-sustainable swidden agriculture practiced by indigenous people, (ii) transitional (quasi-traditional) swidden agriculture - practiced by indigenous people, originating from both recurrent and pioneer types, but not so sustainable because of short fallow period, and (iii) non-traditional swidden agriculture - unsustainable slash and burn agriculture, often with cash crops, usually practiced by new comers to village.

Though Swidden continue to play an important role in rural areas as indicated by the fact that around 65% of Mahakam Ulu people are still practicing swidden (BPS Mahakam Ulu, 2016), the income from swidden agriculture was as low as Rp. 5-8 million (USD 385 – 615) for one hectare (Pannalo, 2015; Wijayanti, 2016). Besides the low economic returns, conventional swidden agriculture is also under external pressures, such as expansion of oil palm cultivation, coal mining and industrial forests *(Hutan Tanaman Industri = HTI)* which reduce the extent of potential land available for swidden agriculture.. Under these conditions, an innovative alternative to traditional swidden agriculture is desirable which is economically more productive and culturally more acceptable to local community.

The *Dayak* people have practiced swidden agriculture from many generations for subsistence and the indigenous *Bahau Dayak* have recently developed the practice of *daleh* swidden agriculture. Imang (2004) described that *daleh* is a concept initiated by the local *Bahau Dayak* in Matalibaq as the response to the disadvantages of conventional swidden and is culturally and economically more acceptable to people. In the present study, we have assessed the potential of this recently emerged practice of *daleh* agriculture as an alternative to the conventional swidden agriculture.

The specific objectives of the study are (i) to assess the traditional practices of land management under external and internal pressures on forest and land, (ii) to explore and compare the practices of conventional and *daleh* swidden agriculture and the associated problems, (iii) to assess socio-cultural and economic aspects of *daleh* swidden agriculture responsible for its successful implementation and culturall acceptance by the swiddeners, particularly the *Dayak* people.

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MATERIALS AND METHODS

The present study was conducted in Matalibaq village, Long Hubung Sub-district, West Kutai District, East Kalimantan, Indonesia from July to August 2017. Data was gathered from indigenous *Bahau Dayak* community who lived here for over hundreds of years. The reasons behind choosing this village are: i) it has a long history of protecting and managing primary forest based on the cultural wisdom, ii) it has innovative local knowledge pertaining to the practice of more productive swidden agriculture, and iii) recently the village is facing the pressures of activities like oil palm plantation expansion, massive Industrial Forest expansion, and other types of forest and land degradation.

Figure 1. Map of the research site in Matalibaq village, Long Hubung Sub-district, West Kutai District, East Kalimantan, Indonesia

Data and information were collected through in-depth interviews with Customary Chief *(Kepala Adat)*, Village Chief *(Petinggi)*, former customary chief, five village elders and 20 swiddeners. Data and information collected pertains to the traditional wisdom and concept of managing forest and land, the concept and practices of conventional and *daleh* swidden system, their merits and demerits, threats and constraints and benefits involved.

RESULTS AND DISCUSSION

Traditional knowledge-based forest and land management:

Matalibaq village territory covers an area of 88,000 km^2 which was originally dominated by excellent primary forest. In order to protect the forest for sustainable local benefits, the available forest and land was allocated in 10 zones based on the availability of resources and socio-cultural considerations. The forest and land zonations are as follows: (1) *Tana' Umaq'*, land for settlement; (2) *Tana' Lumaq*, areas for swidden agriculture, perennial and annual crops; (3) *Tana' Lepu'un Luma'*, the former of swidden area that planted with fruits, in which the fruits are considered the proof of individual ownership; (4) *Tana' Bio'*, forested customary land in which the customary head implemented strict rules so that nobody can utilize the forest area for any purpose; (5) *Tana' Patai (kale')*, space for cemetery; (6) *Tana' Berahan* or *Belahan*, forested area for extraction of forest products such as timber for self consumption and for sale, hunting ground and fishing area; (7) *Tana' Mawa'* protected forest area for collecting high value forest products such as resin, rattan, honey, timber for housing and boat making, eagle wood (*gaharu*)and forest fruits; (8) *Tana' Ang/Hang*, the boundary area between adjacent villages wherein its utilization must be according to the agreement among bordering villages; (9) *Tana' Pukung*, a protected forest area which is abundant in forest fruits for wild animals' as food; (10) *Tana' Kaso*, primary forest specially allocated for hunting because it is habitat for many wild animals such as wild pigs, deers and monkeys. People are strictly prohibited from disturbing the area that is allocated for breeding of wild animals because wild animal hunting is also a way of life of the community.

Such traditional land zonations persisted until external influences such as establishment of a logging company in 1992

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and small-scale logging from 1999 to 2001 started affecting the village(Imang, et al, 2004. Such degradation activities

have damaged forests which are outside the agricultural zone *(tana' lumaq)*. The most massive forest and land degradation was caused by the land clearing for oil palm plantations taking place since 2014, covering around 6,000 hectares of land including primary forest area marked for hunting and fishing, without respecting the land zonation system followed traditionally by the villagers. Due to such destructive activities, some of the forest and land zones, such as those allocated for hunting and agricultural areas, have already been converted into oil palm plantations. Consequently, these activities have negatively impacted the practice of swidden agriculture. The most significant impact was a decrease in the land available for agriculture in general and swidden agriculture, in particular. This, in turn, shortened the cycle of conventional swidden agriculture. Under such a situation, the *Bahau Dayak* community of Matalibaq developed the concept of *daleh* swidden agriculture.

The practice of conventional swidden agriculture:

Even though the practice of swidden agriculture is almost similar across countries, the local term in each country is different, e.g. *tsheri* or *pangshingtsheri* in Bhutan, *milpa* or *tlacolol* in Guatemala, *Kaingin* in Philippines, *taungya* in Thailand , *si Nda Bot* in Cameroon and in Indonesia, it is popularly known as *ladang* ((Upadhyay, 1995; Imang *et al*. 2004). The local term for swidden agriculture in the research site of the present study is *lumaq*.

According to Imang (2001), the *Kenyah Dayak* people open new *ladang* through 9 stages. However, the *Bahau Dayak* people of Matalibaq village open their swidden agriculture commonly through 8 stages which are as follows: (1) slash the shrubs and small trees; (2) cut down the big trees, which is usually a male-task because its risky for female; (3) chop the fallen trunk for faster drying and proper burning; (4) burn the vegetation which not only clears the ground for planting, but also releases nutrients from the biomass to increase the soil fertility; (5) planting preparation by removing the twigs; (6) planting which is usually initiated by the Customary Chief *(Kepala Adat)* through a ritual ceremony to decide the most appropriate day for planting. Otherwise, the villagers believe that the harvest may not be good. This is an important stage of swidden in which the farmers gather and work together to plant one's swidden area in a labor exchange manner characterized by direct parity reciprocity; (7) weeding, (8) harvesting, like at planting stage, harvesting also a very enjoful stage because the famers will harvest together of 10 to 20 farmers and even more.

Swidden agriculture is still playing an important economic role in the study area. It is observed that more than 90% of the 156 households of the village are still practicing swidden agriculture. Each farmer has around 4-7 plots of land and the location of these plots are spread out with the distance between plots varying from 2 to 6 kilometers. The average size of the plots is 1.10 hectares and the mode of access to the plot or swidden field is either by foot/walk or by boat, and some farmers have recently started accessing the plots by motor bikes.

Productivity of swidden agriculture varies widely over years, depending on the weather, rainfall, pests and diseases. The average productivity per hectare in the study area in February 2017 was 1,475 kg. The farmers feel that productivity was a bit lower than that of previous year of 2015 because of prolonged drought. Further, this productivity is lower than the swidden productivity of 1700 kg obtained in Pampang village which is around 650 km away from Matalibaq (Panalo, 2015) and of Miau Baru village where it was 1,900 kg per hectare (Wijayanti, 2016).

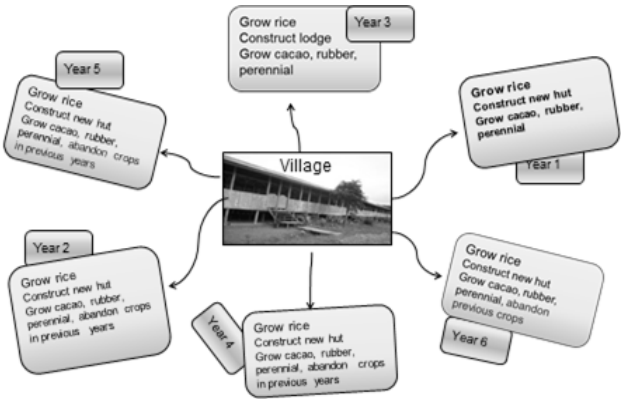

Figure 2. Utilization of land plots during different years in conventional swidden agriculture

The farmers start swidden cultivation by clearing land in a randomly chosen location or plot, depending on how long the plot of land has been previously fallowed. The swidden plot for year-2 is located in the opposite direction away from

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swidden plot of year1 and the plots for subsequent years are selected in different locations. Consequently, the crops grown in previous years are mostly abandoned after moving to a new location for land clearing, for next years swidden. Farmers stay temporarily for 6 to12 months in one location, before moving to another location.

The more land a farmer has, the longer the swidden cycle and fallow period. Each plot of land is cleared in a rotation every year. The rotation of swidden locations is a strategy to allow the soil to regain its fertility through accumulation of biomass. The farmers have learnt by experience that the longer the swidden cycle, more fertile the soil becomes. The biomass from leaves and decomposedtrees will be released to soil after it is burnt properly. This is in line with Weinstock and Sunito (1998) who mentioned that swidden agriculture is characterized by rotation of land rather than crops, or a rotational agriculture with a fallow period longer than the period of cultivation.

Farmers, through their experience, know that the rice planted in properly burnt area better growth compared to the rice planted in improperly burnt area. Properly burnt according to farmers is when leaves, twigs and small branches are completely burnt so that soil looks black. Therefore, during land clearing, farmers prefer felling trees towards inside of the swidden area instead of outside. This is also a strategy to prevent spreading of the fire to nearby forest areas during the burning of the swidden land.

Table 1. Practices of conventional swidden agriculture of a 6-year cycle in the study area.

Year	Activities	Harvested products
1	Open a swidden agriculture and grow rice, builda small hut/shelter, grow some vegetables and annual crops such as cacao, rubber or pepper.	Rice, corn, and vegetables.
2	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper. But, they abandon crops planted in year-1.	Rice, corn, vegetables.
3	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-2.	Rice, corn, vegetables.
4	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year -3.	Rice, corn, vegetables.
5	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	T. Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were abandoned
6	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were abandoned
7	Return to the plot of year-1, and start all steps of swidden from the beginning. The crops they planted in previous years not grow well because they abandoned.	Cacao, rubber or pepper not harvested because they were abandoned.

Source: Field observation by authors (2017)

Table 2. The disadvantages of conventional swidden agriculture as observed in the study area

No	Disadvantages
1	Swiddeners have to construct a new hut or shelter each time they open a new swidden which requires time and resources, both physical and financial.
2	Opening new swidden in another place results in increase of inputs because all of the previous years activities are repeated.
3	Cacao, rubber, pepper or other crops grown in the previous years are less productive or even not productive at all because of improper maintenance, crop damage by pests, diseases and weeds.
4	Swiddeners cannot raise livestock such as pig, poultry and others in swidden land (surrounding the hut) because they move to another place every year. The location of individual swidden is mostly away from neighbors' swidden, and most of the swiddeners will return home in the evening and return to swidden field in the next morning. Therefore, their livestocks and poultry may attacked by predators such as panther and weasel when farmer stay over night away from huts.
5	There is no availability of organic manures from livestocks for rice and crops, and farmers are left to depend only on the existing insufficient of natural soil fertility.
6	In some cases, the long abandoned former or ex-swidden areas of one farmer may be overlapping with the plots of other farmers or encroached by other farmers.

Source: Field observation by authors (2017)

The practices of *daleh* swidden agriculture:

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The cultural background of the *daleh* swidden is *gotong royong*, the cultural-spirit of 10 to 50 even more farmers working together in the swidden field of a farmer, usually in the stages of planting or harvesting. The labor exchange in *gotong royong* is characterized by direct parity reciprocity. Though the spirit of *daleh* can be practiced at any of the stages of swidden agriculture starting from slashing to harvesting, but the stages of planting and harvesting are the most suitable stages for *gotonng royong*.

The concept and steps of *daleh* swidden agriculture are as follows: (i) *Daleh* system consiss of adjacent agriculture fields belonging to at least 4 households that are bordering each other, forming a cluster so that they can help each other whenever needed (Figure 3). (ii) Each household or farmer of the cluster should have at least one hectare of land, so that it can be divided into 4 plots, each measuring 0.25 hectares or more. One plot is cleared every year during the swidden cycle of 4 years (Figure 4). (iii) The huts or shelters of the all the minimum 4 swidden group members are located in the centre of their swidden field in a proper location so that they can raise pig, o chicken or fishes surrounding their huts. When any swidden group member leaves the swidden field for overnight stay at village/home, other group members take care of his/her pigs or chickens and protect them from predators. Pigs and chickens have played a very important socio-cultural role in the life of *Bahau Dayak* people for hundreds of years. They offer pigs and chickens as sacrifices in every village ceremony. Manure of these livestock used as fertilizer for farming. On the other hand, domestic and agricultural wastes/bye products are used to feed them.

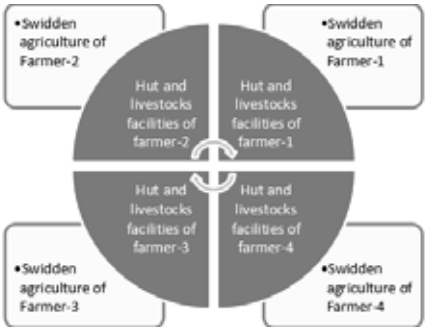

Figure 3. A cluster of *daleh* swidden agriculture consisting of four farmers.

Firstly, the farmer divided the land into some smaller plots. The number of plot depends on the size of land or depending on how large of land can be cleared by farmer, usually 4-6 plots In this part, we use a case of 6 plots, while in Table 3 below is a case of 4 plots. Secondly, farmer will clear one plot every year from year-1 to year-6 in the same way and also similar crops.

(9) In the first year, the swiddener cleared plot-1 and grew rice, corn, cucumber, vegetables at the same time. After six month, the rice could be ready to harvest. After the 0.25 ha of swidden already harvested, the swiddener can grow cacao, rubber, vegetables in former of the swidden field.

(10) In the second year, it is the turn for the second plot or plot-2 to clear for swidden in the same way and similar crops with the plot-1 in year-1. At the same time, the swiddener can maintain the crops he/she planted in the previous year so that the crops grow well.

(11) In the next year-3 and year-4, the swiddener also repeat the same ways as in the previous years until all of the 4 plots completed to clear for rice and for other crops. In year-4, the one-hectare of land is already planted with some annual and perennial crops, and ready to harvest.

(12) In year-5, the swiddener can move to other nearby area to open new swidden while also maintaining the crops in the previous years and raising livestocks. Cacao and rubber or other crops are ready to harvest in year-5 or year-6.

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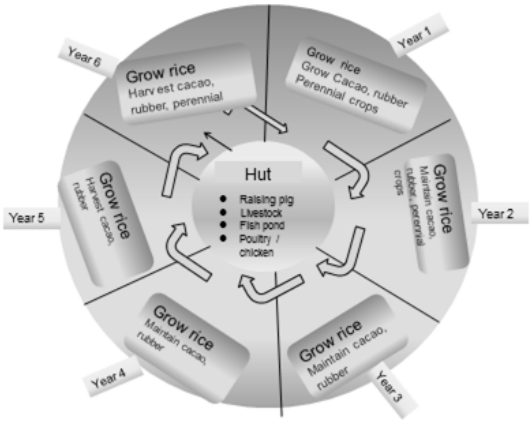

Figure 4. Details of utilization of one hectare land in *daleh* swidden agriculture practice

Figure 4 shows the details of how a farmer allocates his/her land during *daleh* swidden agriculture. The hut or shelter is built only once in the first year. They also build other facilities like cages to raise livestocks either in year1 or year 2. These huts and cages built once lasts for more than 5 years because of which farmers save time, labor, and economic and material resources otherwise spent every year for these works. Further details such as the pattern of plot clearing, crops grown, animals raised and products harvested in the practice of *daleh* swidden agriculture are shown in table 3.

Table 3. Practices of *daleh* swidden system in 4 plots of land;

Year	***Daleh* Swidden agriculture practices**	**Harvested Products**
1	Plot-1 is cleared for swidden to grow rice, corn, and vegetables at the same time. Swiddener also build a proper hut/shelter . While waiting for the harvest of rice, swiddener prepares cage for pig and poultry. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field Just after the rice is harvested.	rice, corn, cucumber, vegetables, chicken.
2	Plot-2 is cleared to grow rice, cucumber, corn, vegetables at the same time. No need to build a new hut/shelter. Swiddener continues to raise pig and poultry or fish pond. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field.	rice, corn, cucumber, vegetables, chicken, pig, fishes. Parallely, they can also maintain crops planted in previous years, and raise livestockssuch as chicken or pig.
3	Plot-3 is cleared for swidden to grow rice, corn and vegetables at the same time. Swiddener also build a proper hut/shelter in the year-1. While waiting the rice to harvest, swiddener prepares cage for pig and poultry. After rice harvesting the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field after rice is harvested..	Harvest rice, corn, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and raise livestocks such as chicken..
4	Plot-4 is cleared for swidden and after rice harvesting, swiddener grow cacao, rubber or pepper or other annual and perennial crops. In parallel, the swiddener also maintain crops they planted in plo-1 to 3.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and keep to raise livestocks
5	Open new swidden outside the previous area and repeat the same activities. Farmers also benefit from the pig and poultry, they can use waste to feed the livestocks, and conversely the livestocks provide manure/fertilizers for crops. This is an integrated farm that also acceptable to socio-cultural of the swiddeners.	Cacao and rubber they planted in year-1 plot-1 ready to for harvest, while they also maintain the crops they planted in year-2 to year-4. They also benefit from the livestocks.

Source: Field observations by authors (2017)

Economic comparison between conventional and *daleh* swidden agriculture:

Table 4. Economic comparison between conventional swidden and *daleh* swidden systems of agriculture:

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Crops	Conventional swidden Year						*Daleh* swidden system Year					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
Rice	GMP	GMP	GMP	GMP	GMP		GMP	GMP	GMP	GMP	GMP	GMP
Rubber	GM	A	A	A	AP-		GM	GM	GM	GM	GMP	GMP
Cacao	GM	A	A	A	AP-		GM	GM	GM	GM	GM	GMP
Banana	GM	P-	P-	P-	P-		GM	MP	MP	MP	MP	MP
Chicken	GMP	0	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Pig	0	0	0	0	0		GM	GMP	GMP	GMP	GMP	GMP
Vegetables	GMP	GMP	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Manure	0	0	0	0	0		P	P	P	P	P	P

Legends:

G	=	Grow/ raise livestocks and/or poultry
M	=	Maintain the crops
A	=	Abandoned/not properly maintained
P	=	Production of crops, or manure of livestocks
P-	=	Production but less
F	=	Fail, no production because the crops are abandoned
O	=	No agricultural activity/no raising of livestock

Table 4 summarises the economic comparison between conventional and *daleh* agriculture in terms of the various activities involved and products harvested. It is evident from the table that both systems have the same activities such as growing (G), maintaining (M) and harvesting products (P) such as rice, corn, and vegetables.

The differences are observed from second year onwards, the notable ones are: i) The crops grown in previous years, excluding rice, are maintained in *daleh* system because the subsequent years plots are close to the first year's plot. However, they are abandoned or neglected in conventional swidden agriculture due to the distance between first year's plot and subsequent years plots. ii) In conventional swidden agriculture, farmers do not build cages or facilities to raise chicken/poultry or pig and other livestocks because they live at the swidden site only for about 6 months to a year. After harvesting rice, they move to another swidden plot located far away from the first one. But in *daleh*, livestock is maintained as they live in the same location throughout the swidden cycle.

As mentioned above, the *daleh* swidden is a multi-product agricultural system as it involves mutual symbiosis between different elements such as rice, crops (cacao, rubber, pepper), livestocks and fish. In this system, products or bye products of one element supports or sustains the other elements and this enhances the overall productivity of the whole system. For example, the waste products resulting from rice cultivation is utilized to feed poultry and pig, while the manure of poultry and pig is used as organic fertilizer for crops. The central element of *daleh* system is the farmer and his/her family who control and maintain all elements, and at the same time, get multiple benefits from rice, other crops and livestocks. Figure 5 shows the multifarious interactions among the different elements of a *daleh* swidden agriculture system.

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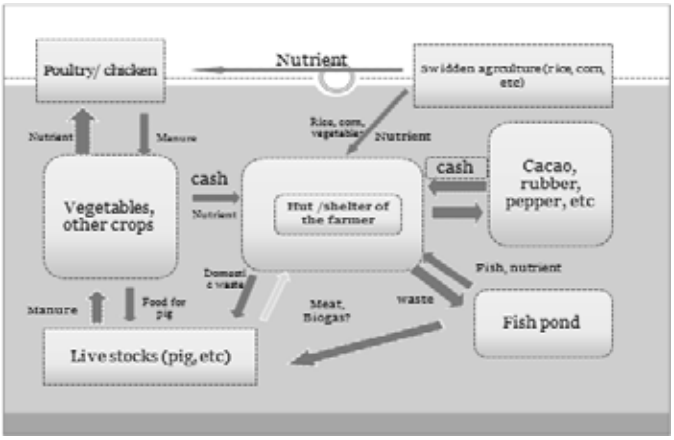

Figure 5. Interactions between different elements in a *daleh* swidden agriculture system.

Threats to swidden agriculture:

The basic principle of shifting cultivation or swidden agriculture is the availability of sufficient time gap for the fallowed lands to regain their natural fertility, between successive swidden cycles. The usual duration of of one cycle varies from 5 to 10 years, depending on the fertility of the land/soil and other considerations of the farmers. This implies that that a farmer should have at least 5 plots of swidden land to maintain this cycle by allowing enough time to the soil to become fertile after one swidden cultivation. .

However, the expansion of oil palm plantation has decreased the availability of suitable land for swidden agriculture. The narrower the extent of land available for swidden, shorter the swidden cycle becomes. Shortening of swidden cycle to less than 5 years, in turn, decreases land productivity because of insufficient nutrients in soil. This is one of the major threats to the continued practice of swidden agriculture, particularly at the study area. There are also other threats and constraints to swidden agriculture in general which are summarized in Table 5..

Table 5. Constraints and threats to swidden agriculture in the study area:

No	Constraints/ threats	Remarks
1	Expansion of oil palm plantations and Industrial Forests (*HTI*) that caused the conversion of agricultural lands to commercial plantations	Some of the fertile land zones such *Tana' berahan, Tana' Kaso dan and Tana' Mawa'* have been converted to oil palm plantations and man-made tree forests (*HTI*).
2	The division of land into smaller plots so that it is more difficult to practice *daleh* swidden agriculture.	A cluster of *daleh* system needs at least 4 to 6 hectares of land for its effective practice and a sufficient land fallow.
3	The decreasing interest of young generation towards farm work because of reasons such as hard manual labor involved, low income which is insufficient to fulfill their daily needs of subsistence and monetary requirment, uncertain market for agricultural products, etc.	Panalo (2016) found that average output of one hectare of swidden agriculture is Rp. 8.6 million. It means that the average income for one month is Rp. 1.1 million
4	Technological innovations in the area of swidden agriculture is lacking when compared to wet rice cultivation. Therefore, all stages of swidden activities are done manually which is also a reason for its low productivity..	The remote location of the swidden agriculture also a constraint for agricultural officer to develop agricultural activities.
5	There is no schemes of financial support to develop swidden agriculture compared to wetland rice which gets financial support for development	Financial support provided to wetland rice where as farmers more prefer to swidden agriculture.
6	The emerging negative perception about swidden farmers who clear land using fire which is also blamed as a cause for forest fire.	There is a West Kutai District Regulation (*Peraturan Daerah = PERDA*) regarding prohibiting the use of fire for land clearing. In this case, government did not consider the wisdom and culture of swidden agriculture.

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Conclusion:

The introduction and expansion of oil palm plantations, logging and industrial planted forests (*HTI*) in the village territory ignored and did not recognize the traditional wisdom of forest and land management. These activities were granted concession by Provincial and District Government and Customary Institution not strong enough to protect their lands that taken over by concession such as oil palm or industrial forest . Swidden agriculture still plays an important role in the economic life of the community because more than 90% of the households still actively practicing swidden agriculture every year, despite of its disadvantages. The pressures and threats to the continued existence of conventional swidden agriculture has necessitated an innovative alternative swidden method which can improve land productivity and generate better income to farmers. The *daleh* swidden agriculture which is an integrated swidden farming combining the traditional swidden agriculture with livestocks and other crops in one plot, has the potential to become such an alternative because it improves land productivity, increases returns to farmers, and more importantly, it is culturally acceptable to the community. Unfortunately, District Government is not providing any financial assistance and agri-technological support neither to organize farmers in practicing more productive swidden agriculture.

In order to protect the agriculturally potential land for the purpose of swidden, the government should recognize the local wisdoms on forest and land management and should consider providing financial and facilitation support for the practice and improvisation of both conventional and *daleh* systems. Besides the economic benefits of swidden agriculture, the *Bahau* community also of the opinion that the *daleh* swidden agriculture may also become an "agricultural tourism object" in the future, particularly at its two most important stages of planting and harvesting. .

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ACKNOWLEDGMENTS

The authors gratefully acknowledge the financial support from Islamic Development Bank/IDB through University of Mulawarman that enabled them to undertake this research. Special thanks and acknowledgments are due to the Village Chief (*Petinggi*), Customary Chief (*Kepala Adat*) and the people of Matalibaq village who voluntarily shared their valuable experiences and expectations during the field observations. We also appreciate perspective comments and constructive critiques from anonymous reviewers of this manuscript.

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Assessment of *Daleh* swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia

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Abstract. *Imang N, Rujehan, Duakaju NN. 2018. Assessment of* Daleh *swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia. Biodiversitas 19: xxxx.* Swidden agriculture is still an important livelihood for millions of people in the tropics. In Kalimantan Island of Indonesia, swidden agriculture is currently facing many external pressures such as massive expansion of oil palm plantations, concession for industrial plantations, and non-availability of financial and political support from the government. The above external pressures which ignore local wisdoms in forest and land management have reduced the land available for swidden agriculture. The external pressures, in turn, have shortened the cycle of swidden agriculture and decreased the productivity of swidden agriculture. The objectives of the present study is to assess socio-cultural and economic aspects of the innovative *daleh* agriculture as an alternative to conventional swidden agriculture under these conditions. The study was conducted in an indigenous *Bahau Dayak* community of East Kalimantan, Indonesia. Twenty swiddeners and 6 other key informants were interviewed for data collection. Research findings confirm that the expansion of oil palm plantations has ignored the wisdoms in forest and land management, in general, and caused pressure on swidden agriculture, in particular. Under such pressures, *daleh* swidden agriculture may be effectively practiced because it can increase land productivity and is also culturally acceptable. Further, financial and facilitation support from district government is needed to improve the practice of swidden agriculture in the study area.

Keywords: *Daleh* swidden agriculture, *Dayak people*, Kalimantan

INTRODUCTION

Swidden agriculture or shifting cultivation, locally called *ladang*, is one of the traditional practices of forest and land management by people in the tropics and is suitable to social typology in which there is a high interdependence between people and the environment (Dove 1993; Colfer et al. 1997; Inoue 2000). Furthermore, Sardjono (1990) maintains that traditional forms of swidden agriculture reflect an optimum interrelation between the strategy to serve human needs and efforts to maintain ecological balance in tropical regions. These practices can be further improved through agroforestry technologies to adapt to local socio-economic dynamics and environmental changes. Conceptually, swidden agriculture has a close relation with social forestry. Pasaribu (2007), Sardjono (2007), and Inoue and Kawai (2013) define social forestry as any conditions and efforts which intimately involve local people in forestry activities

to ensure economic, ecological and social benefits, and simultaneously sustain the resources.

Dove (1988) and Inoue (1999) point out that the term 'shifting cultivation' is often taken to mean that the people are themselves 'shifting' or semi nomadic, even though most of them live in relatively permanent settlements. In fact, people use fire and fallow their field after harvest. The field, once set on fire, is called 'swidden'. So, 'swidden agriculture' is preferable to commonly used term 'shifting cultivation'.

Swidden agriculture is estimated to support 300-500 million people worldwide, covering about 30% of exploitable land for agricultural activities. In Asia Pacific, swidden covers an area of 73 million hectares and, in Indonesia, it involves 35 million hectares of land and about 2.2 million cultivators (Mubyarto 1991).

Several scholars have studied swidden agriculture as practiced by the *Kenyah Dayak* people of East Kalimantan (Jessup 1992; Colfer et al. 1997; Sindju 2003). Inoue and Lahjie (1990) tried to develop models for the sustainability of *Kenyah* agricultural systems, including *ladang*. Sindju (2003), in a comparative study of *ladang* practiced by the *Kenyah* of West Kalimantan, Indonesia and the *Kenyah* of Sarawak, Malaysia, has qualitatively described the technological aspects of the practice.

Inoue (1999) categorized swidden agriculture in term of its sustainability as follows: (i) traditional swidden agriculture-sustainable swidden agriculture practiced by indigenous people, (ii) transitional (quasi-traditional) swidden agriculture-practiced by indigenous people, originating from both recurrent and pioneer types, but not so sustainable because of short fallow period, and (iii) non-traditional swidden agriculture-unsustainable slash and burn agriculture, often with cash crops, usually practiced by new comers to village.

Though Swidden continue to play an important role in rural areas as indicated by the fact that around 65% of Mahakam Ulu people are still practicing swidden (BPS Mahakam Ulu 2016), the income from swidden agriculture was as low as Rp. 5-8 million (USD 385 – 615) for one hectare (Pannalo 2015; Wijayanti 2016). Besides the low economic returns, conventional swidden agriculture is also under external pressures, such as expansion of oil palm cultivation, coal mining and industrial forests *(Hutan Tanaman Industri = HTI)* which reduce the extent of potential land available for swidden agriculture. Under these conditions, an innovative alternative to traditional swidden agriculture is desirable which is economically more productive and culturally more acceptable to local community.

The *Dayak* people have practiced swidden agriculture from many generations for subsistence and the indigenous *Bahau Dayak* have recently developed the practice of *daleh* swidden agriculture. Imang et al. (2004a) described that *daleh* is a concept initiated by the local *Bahau Dayak* in Matalibaq as the response to the disadvantages of conventional swidden and is culturally and economically more acceptable to people. In the present study, we have assessed the potential of this recently emerged practice o

daleh agriculture as an alternative to the conventional swidden agriculture. The specific objectives of the study are (i) to assess the traditional practices of land management under external and internal pressures on forest and land, (ii) to explore andcompare the practices of conventional and *daleh* swidden agriculture and the associated problems, (iii) to assess socio-cultural and economic aspects of *daleh* swidden agriculture responsible for its successful implementation and cultural acceptence by the swiddeners, particularly the *Dayak* people.

MATERIALS AND METHODS

The present study was conducted in Matalibaq village, Long Hubung Sub-district, West Kutai District, East Kalimantan, Indonesia from July to August 2017. Data was gathered from indigenous *Bahau Dayak* community who lived here for over hundreds of years. The reasons behind choosing this village are: i) it has a long history of protecting and managing primary forest based on the cultural wisdom, ii) it has innovative local knowledge pertaining to the practice of more productive swidden agriculture, and iii) recently the village is facing the pressures of activities like oil palm plantation expansion, massive Industrial Forest expansion, and other types of forest and land degradation.

Data and information were collected through in-depth interviews with Customary Chief *(Kepala Adat)*, Village Chief *(Petinggi)*, former customary chief, five village elders and 20 swiddeners. Data and information collected pertains to the traditional wisdom and concept of managing forest and land, the concept and practices of conventional and *daleh* swidden system, their merits and demerits, threats and constraints and benefits involved.

RESULTS AND DISCUSSION

Traditional knowledge-based forest and land management

Matalibaq village territory covers an area of 88,000 km^2 which was originally dominated by excellent primary forest. In order to protect the forest for sustainable local benefits, the available forest and land was allocated in 10 zones based on the availability of resources and socio-cultural considerations. The forest and land zonations are as follows: (i) *Tana' Umaq'*, land for settlement; (ii) *Tana' Lumaq*, areas for swidden agriculture, perennial and annual crops; (iii) *Tana' Lepu'un Luma'*, the former swidden area that planted with fruits, in which the fruits are considered the proof of individual ownership; (iv) *Tana' Bio'*, forested customary land in which the customary head implemented strict rules so that nobody can utilize the forest area for any purpose; (v) *Tana' Patai (kale')*, space for cemetery; (vi) *Tana' Berahan* or *Belahan*, forested area for extraction of forest products such as timber for self consumption and for sale, hunting ground and fishing area; (vii) *Tana' Mawa'*

protected forest area for collecting high value forest products such as resin, rattan, honey, timber for housing and boat making, eagle wood (*gaharu)*and forest fruits; (viii) *Tana' Ang/Hang*, the boundary area between adjacent villages wherein its utilization must be according to the agreement among bordering villages; (ix) *Tana' Pukung*, a protected forest area which is abundant in forest fruits for wild animals' as food; (x) *Tana' Kaso*, primary forest specially allocated for hunting because it is habitat for many wild animals such as wild pigs, deers and monkeys. People are strictly prohibited from disturbing the area that is allocated for breeding of wild animals because wild animal hunting is also a way of life of the community.

Such traditional land zonations persisted until external influences such as establishment of a logging company in 1992 and small-scale logging from 1999 to 2001 started affecting the village (Imang et al. 2004a). Such degradation activities have damaged forests outside the agricultural zone *(tana' lumaq).* The most massive forest and land degradation was caused by the land clearing for oil palm plantations taking place since 2014, covering around 6,000 hectares of land including primary forest area marked for hunting and fishing, without respecting the land zonation system followed traditionally by the villagers. Due to such destructive activities, some of the forest and land zones, such as those allocated for hunting and agricultural areas, have already been converted into oil palm plantations. Consequently, these activities have negatively impacted the practice of swidden agriculture. The most significant impact was a decrease in the land available for agriculture in general and swidden agriculture, in particular. This, in turn, shortened the cycle of conventional swidden agriculture. Under such a situation, the *Bahau Dayak* community of Matalibaq developed the concept of *daleh* swidden agriculture.

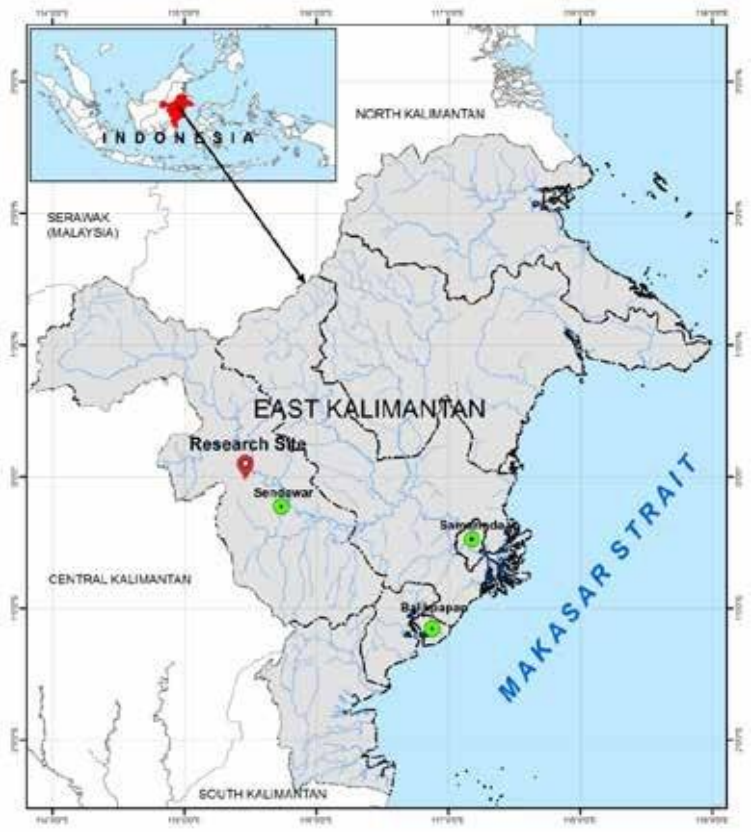

Figure 1. Map of the research site in Matalibaq village, West Kutai District, East Kalimantan, Indonesia

The practice of conventional swidden agriculture

Even though the practice of swidden agriculture is almost similar across countries, the local term in each country is different, e.g., *tsheri* or *pangshingtsheri* in Bhutan, *milpa* or *tlacolol* in Guatemala, *Kaingin* in Philippines, *taungya* in Thailand, *si Nda Bot* in Cameroon and in Indonesia, it is popularly known as *ladang* (Upadhyay 1995; Imang et al. 2004a). The local term for swidden agriculture in the research site of the present study is *lumaq*.

According to Imang (2004), the *Kenyah Dayak* people open new *ladang* through 9 stages. However, the *Bahau Dayak* people of Matalibaq village open their swidden agriculture commonly through 8 stages which are as follows: (i) slash the shrubs and small trees; (ii) cut down the big trees, which is usually a male-task because its risky for female; (iii) chop the fallen trunk for faster drying and proper burning; (iv) burn the vegetation which not only clears the ground for planting, but also releases nutrients from the biomass to increase the soil fertility; (v) planting preparation by removing the twigs; (vi) planting which is usually initiated by the Customary Chief *(Kepala Adat)* through a ritual ceremony to decide the most appropriate day for planting. Otherwise, the villagers believe that the harvests may not be good. This is an important stage of swidden in which the farmers gather and work together to plant one's swidden area in a labor exchange manner characterized by direct parity reciprocity; (vii) weeding, (8) harvesting, like at planting stage, harvesting also a very joyful stage because the farmers will harvest together of 10 to 20 farmers and even more.

Swidden agriculture is still playing an important economic role in the study area. It is observed that more than 90% of the 156 households of the village are still practicing swidden agriculture. Each farmer has around 4-7 plots of land and the location of these plots are spread out with the distance between plots varying from 2 to 6 kilometers. The average size of the plots is 1.10 hectares and the mode of access to the plot or swidden field is either by foot/walk or by boat, and some farmers have recently started accessing the plots by motor bikes.

Productivity of swidden agriculture varies widely over years, depending on the weather, rainfall, pests and diseases. The average productivity per hectare in the study area in February 2017 was 1,475 kg. The farmers feel that productivity was a bit lower than that of previous year of 2015 because of prolonged drought. Further, this productivity is lower than the swidden productivity of 1700 kg obtained in Pampang village which is around 650 km away from Matalibaq (Panalo 2015) and of Miau Baru village where it was 1,900 kg per hectare (Wijayanti 2016).

The farmers start swidden cultivation by clearing land in a randomly chosen location or plot, depending on how long the plot of land has been previously fallowed. The swidden plot for year-2 is located in the opposite direction away from swidden plot of year1 and the plots for subsequent years are selected in different locations. Consequently, the crops grown in previous years are mostly abandoned after moving to a new location for land clearing, for next years swidden. Farmers stay temporarily for 6 to12 months in one location, before moving to another location.

The more land a farmer has, the longer the swidden cycle and fallow period. Each plot of land is cleared in a rotation every year. The rotation of swidden locations is a strategy to allow the soil to regain its fertility through accumulation of biomass. The farmers have learnt by experience that the longer the swidden cycle, more fertile the soil becomes. The biomass from leaves and decomposed trees will be released to soil after it is burnt properly. This is in line with Weinstock and Sunito (1998) who mentioned that swidden agriculture is characterized by rotation of land rather than crops, or a rotational agriculture with a fallow period longer than the period of cultivation.

Farmers, through their experience, know that the rice planted in properly burnt area better growth compared to the rice planted in improperly burnt area. Properly burnt according to farmers is when leaves, twigs and small branches are completely burnt so that soil looks black. Therefore, during land clearing, farmers prefer felling trees towards inside of the swidden area instead of outside. This is also a strategy to prevent spreading of the fire to nearby forest areas during the burning of the swidden land.

The practices of *daleh* swidden agriculture

The cultural background of the *daleh* swidden is *gotong royong*, the cultural-spirit of 10 to 50 even more farmers working together in the swidden field of a farmer, usually in the stages of planting or harvesting. The labor exchange in *gotong royong* is characterized by direct parity reciprocity. Though the spirit of *daleh* can be practiced at any of the stages of swidden agriculture starting from slashing to harvesting, but the stages of planting and harvesting are the most suitable stages for *gotong royong*.

The concept and steps of *daleh* swidden agriculture are as follows: (i) *Daleh* system consiss of adjacent agriculture fields belonging to at least 4 households that are bordering each other, forming a cluster so that they can help each other whenever needed (Figure 3). (ii) Each household or farmer of the cluster should have at least one hectare of land, so that it can be divided into 4 plots, each measuring 0.25 hectares or more. One plot is cleared every year during the swidden cycle of 4 years (Figure 4). (iii) The huts or shelters of the all the minimum 4 swidden group members are located in the centre of their swidden field in a proper location so that they can raise pig, chicken or fishes surrounding their huts. When any swidden group member leaves the swidden field for overnight stay at village/home, other group members take care of his/her pigs or chickens and protect them from predators. Pigs and chickens have played a very important socio-cultural role in the life of *Bahau Dayak* people for hundreds of years. They offer pigs and chickens as sacrifices in every village ceremony. Manure of these livestock used as fertilizer for

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farming. On the other hand, domestic and agricultural wastes/bye products are used to feed them.

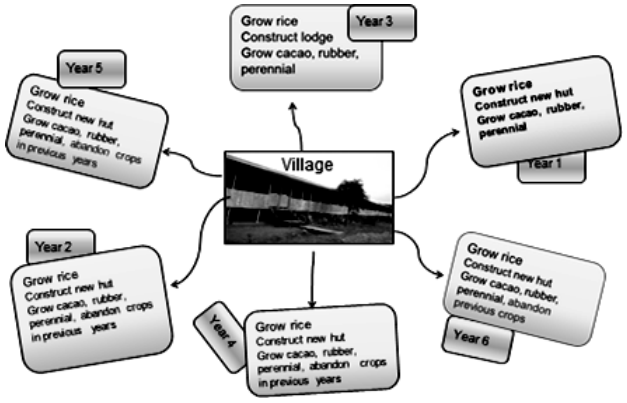

Figure 2. Utilization of land plots during different years in conventional swidden agriculture

Table 1. Practices of conventional swidden agriculture of a 6-year cycle in the study area.

Year	Activities	Harvested products
1	Open a swidden agriculture and grow rice, build a small hut/shelter, grow some vegetables and annual crops such as cacao, rubber or pepper.	Rice, corn, and vegetables.
2	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper. But, they abandon crops planted in year-1.	Rice, corn, vegetables.
3	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-2.	Rice, corn, vegetables.
4	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-3.	Rice, corn, vegetables.
5	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were abandoned
6	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were not maintained well.
7	Return to the plot of year-1, and start all steps of swidden from the beginning. The crops they planted in previous years not grow well because they abandoned.	Cacao, rubber or pepper not harvested because they were not maintained well.

Table 2. The disadvantages of conventional swidden agriculture as observed in the study area

Disadvantages
Swiddeners have to construct a new hut or shelter each time they open a new swidden which requires time and resources, both physical and financial.
Opening new swidden in another place results in increase of inputs because all of the previous years activities are repeated.
Cacao, rubber, pepper or other crops grown in the previous years are less productive or even not productive at all because of improper maintenance, crop damage by pests, diseases and weeds.
Swiddeners cannot raise livestock such as pig, poultry and others in swidden land (surrounding the hut) because they move to another place every year. The location of individual swidden is mostly away from neighbors' swidden, and most of the swiddeners will return home in the evening and return to swidden field in the next morning. Therefore, their livestocks and poultry may attacked by predators

such as panther and weasel when farmer stay over night away from huts.

There is no availability of organic manures from livestocks for rice and crops, and farmers are left to depend only on the existing insufficient of natural soil fertility.

In some cases, the long abandoned former or ex-swidden areas of one farmer may be overlapping with the plots of other farmers or encroached by other farmers.

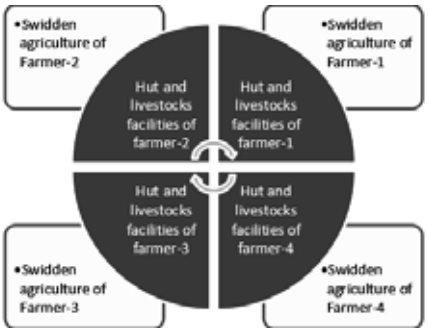

Figure 3. A cluster of *daleh* swidden agriculture consisting of four farmers

Firstly, the farmer divided the land into some smaller plots. The number of plot depends on the size of land or depending on how large of land can be cleared by farmer, usually 4-6 plots In this part, we use a case of 6 plots, while in Table 3 below is a case of 4 plots. Secondly, farmer will clear one plot every year from year-1 to year-6 in the same way and also similar crops. (i) In the first year, the swiddener cleared plot-1 and grew rice, corn, cucumber, vegetables at the same time. After six month, the rice could be ready to harvest. After the 0.25 ha of swidden already harvested, the swiddener can grow cacao, rubber, vegetables in former of the swidden field. (ii) In the second year, it is the turn for the second plot or plot-2 to clear for swidden in the same way and similar crops with the plot-1 in year-1. At the same time, the swiddener can maintain the crops he/she planted in the previous year so that the crops grow well. (iii) In the next year-3 and year-4, the swiddener also repeat the same ways as in the previous years until all of the 4 plots completed to clear for rice and for other crops. In year-4, the one-hectare of land is already planted with some annual and perennial crops, and ready to harvest. (iv) In year-5, the swiddener can move to other nearby area to open new swidden while also maintaining the crops in the previous years and raising livestocks. Cacao and rubber or other crops are ready to harvest in year-5 or year-6.

Figure 4 shows the details of how a farmer allocates his/her land during *daleh* swidden agriculture. The hut or shelter is built only once in the first year. They also build other facilities like cages to raise livestocks either in year 1 or year 2. These huts and cages built once lasts for more than 5 years because of which farmers save time, labor, and economic and material resources otherwise spent every year for these works. Further details such as the pattern of plot clearing, crops grown, animals raised and products harvested in the practice of *daleh* swidden agriculture are shown in Table 3.

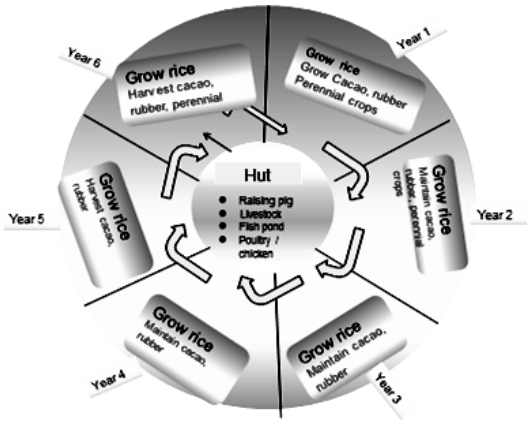

Figure 4. Details of utilization of one hectare land in *daleh* swidden agriculture practice

Table 3. Practices of *daleh* swidden system in 4 plots of land

Year	***Daleh* swidden agriculture practices**	**Harvested products**
1	Plot-1 is cleared for swidden to grow rice, corn, and vegetables at the same time. Swiddener also build a proper hut/shelter. While waiting for the harvest of rice, swiddener prepares cage for pig and poultry. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field Just after the rice is harvested.	Rice, corn, cucumber, vegetables, chicken.
2	Plot-2 is cleared to grow rice, cucumber, corn, vegetables at the same time. No need to build a new hut/shelter. Swiddener continues to raise pig and poultry or fish pond. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field.	Rice, corn, cucumber, vegetables, chicken, pig, fishes. Parallely, they can also maintain crops planted in previous years, and raise livestocks such as chicken or pig.
3	Plot-3 is cleared for swidden to grow rice, corn and vegetables at the same time. Swiddener also build a proper hut/shelter in the year-1. While waiting the rice to harvest, swiddener prepares cage for pig and poultry. After rice harvesting the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field after rice is harvested..	Harvest rice, corn, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and raise livestocks such as chicken..
4	Plot-4 is cleared for swidden and after rice harvesting, swiddener grow cacao, rubber or pepper or other annual and perennial crops. In parallel, the swiddener also maintain crops they planted in plo-1 to 3.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and keep to raise livestocks
5	Open new swidden outside the previous area and repeat the same activities. Farmers also benefit from the pig and poultry, they can use waste to feed the livestocks, and conversely the livestocks provide manure/fertilizers for crops. This is an integrated farm that also acceptable to socio-cultural of the swiddeners.	Cacao and rubber they planted in year-1 plot-1 ready to for harvest, while they also maintain the crops they planted in year-2 to year-4. They also benefit from the livestocks.

Economic comparison between conventional and *daleh* swidden agriculture

Table 4 summarizes the economic comparison between conventional and *daleh* agriculture in terms of the various activities involved and products harvested. It is evident from the table that both systems have the same activities such as growing (G), maintaining (M) and harvesting products (P) such as rice, corn, and vegetables.

The differences are observed from second year onwards, the notable ones are: i) The crops grown in previous years, excluding rice, are maintained in *daleh* system because the subsequent years plots are close to the first year's plot. However, they are abandoned or neglected in conventional swidden agriculture due to the distance between first year's plot and subsequent years plots. ii) In conventional swidden agriculture, farmers do not build cages or facilities to raise chicken/poultry or pig and other livestocks because they live at the swidden site only for about 6 months to a year. After harvesting rice, they move to another swidden plot located far away from the first one. But in *daleh*, livestock is maintained as they live in the same location throughout the swidden cycle.

As mentioned above, the *daleh* swidden is a multi-product agricultural system as it involves mutual symbiosis between different elements such as rice, crops (cacao, rubber, pepper), livestocks and fish. In this system, products or bye products of one element supports or sustains the other elements and this enhances the overall productivity of the whole system. For example, the waste products resulting from rice cultivation is utilized to feed poultry and pig, while the manure of poultry and pig is used as organic fertilizer for crops. The central element of *daleh* system is the farmer and his/her family who control and maintain all elements, and at the same time, get multiple benefits from rice, other crops and livestocks. Figure 5 shows the multifarious interactions among the different elements of a *daleh* swidden agriculture system.

Table 4. Economic comparison between conventional swidden and *daleh* swidden systems of agriculture:

Crops	**Conventional swidden**					***Daleh* swidden system**					
	Year					**Year**					
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**6**
Rice	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP
Rubber	GM	A	A	A	AP-	GM	GM	GM	GM	GMP	GMP
Cacao	GM	A	A	A	AP-	GM	GM	GM	GM	GM	GMP
Banana	GM	P-	P-	P-	P-	GM	MP	MP	MP	MP	MP
Chicken	GMP	0	0	0	0	GMP	GMP	GMP	GMP	GMP	GMP
Pig	0	0	0	0	0	GM	GMP	GMP	GMP	GMP	GMP

Vegetables	GMP	GMP	0	0	0		GMP	GMP	GMP	GMP	GMP	GMP
Manure	0	0	0	0	0		P	P	P	P	P	P

Note: G: Grow/ raise livestocks and/or poultry, M: Maintain the crops, A: Abandoned/not properly maintained, P: Production of crops, or manure of livestocks, P-: Production but less, F: Fail, no production because the crops are abandoned, O: No agricultural activity/no raising of livestock

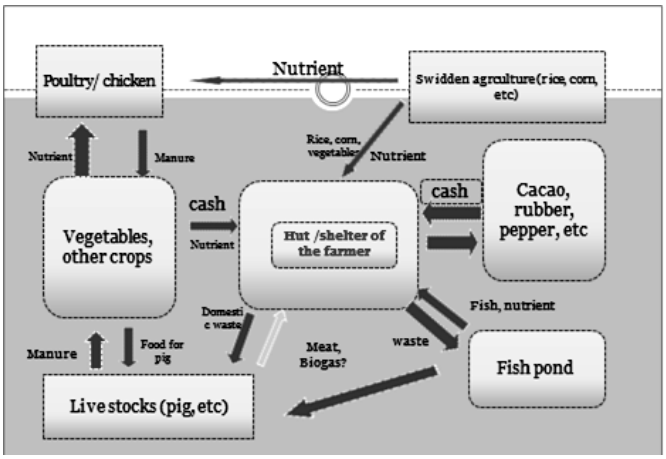

Figure 5. Interactions between different elements in a *daleh* swidden agriculture system

Threats to swidden agriculture:

The basic principle of shifting cultivation or swidden agriculture is the availability of sufficient time gap for the fallowed lands to regain their natural fertility, between successive swidden cycles. The usual duration of one cycle varies from 5 to 10 years, depending on the fertility of the land/soil and other considerations of the farmers. This implies that a farmer should have at least 5 plots of swidden land to maintain this cycle by allowing enough time to the soil to become fertile after one swidden cultivation.

However, the expansion of oil palm plantation has decreased the availability of suitable land for swidden agriculture. The narrower the extent of land available for swidden, shorter the swidden cycle becomes. Shortening of swidden cycle to less than 5 years, in turn, decreases land productivity because of insufficient nutrients in soil. This is one of the major threats to the continued practice of swidden agriculture, particularly at the study area. There are also other threats and constraints to swidden agriculture in general which are summarized in Table 5.

Conclusion

The introduction and expansion of oil palm plantations, logging and industrial planted forests (*HTI*) in the village territory ignored and did not recognize the traditional wisdom of forest and land management. These activities were granted concession by Provincial and District Government and Customary Institutions are not strong enough to protect their lands that are taken over by concession such as oil palm or industrial forest. Swidden agriculture still plays an important role in the economic life of the community because more than 90% of the households still actively practicing swidden agriculture every year, despite of its disadvantages. The pressures and threats to the continued existence of conventional swidden agriculture has necessitated an innovative alternative swidden method which can improve land productivity and generate better income to farmers. The *daleh* swidden agriculture, which is an integrated swidden farming combining the traditional swidden agriculture with livestocks and other crops in one plot, has the potential to become such an alternative because it improves land productivity, increases returns to farmers, and more importantly, it is culturally acceptable to the community. Unfortunately, District Government is not providing any financial assistance and agri-technological support to organize farmers for practicing more productive swidden agriculture.

In order to protect the agriculturally potential land for the purpose of swidden, the government should recognize the local wisdoms on forest and land management and should consider providing financial and facilitation support for the practice and improvisation of both conventional and *daleh* systems. Besides the economic benefits of swidden agriculture, the *Bahau* community also of the opinion that the *daleh* swidden agriculture may also become an

"agricultural tourism object" in the future, particularly at its two most important stages of planting and harvesting.

Table 5. Constraints and threats to swidden agriculture in the study area

No	Constraints/ threats	Remarks
1	Expansion of oil palm plantations and Industrial Forests (*HTI*) that caused the conversion of agricultural lands to commercial plantations	Some of the fertile land zones such *Tana' berahan, Tana' Kaso dan and Tana' Mawa'* have been converted to oil palm plantations and man-made tree forests (*HTI*).
2	The division of land into smaller plots so that it is more difficult to practice *daleh* swidden agriculture.	A cluster of *daleh* system needs at least 4 to 6 hectares of land for its effective practice and a sufficient land fallow.
3	The decreasing interest of young generation towards farm work because of reasons such as hard manual labor involved, low income which is insufficient to fulfill their daily needs of subsistence and monetary requirement, uncertain market for agricultural products, etc.	Panalo (2016) found that average output of one hectare of swidden agriculture is Rp. 8.6 million. It means that the average income for one month is Rp. 1.1 million
4	Technological innovations in the area of swidden agriculture is lacking when compared to wet rice cultivation. Therefore, all stages of swidden activities are done manually which is also a reason for its low productivity.	The remote location of the swidden agriculture also a constraint for agricultural officers to develop agricultural activities.
5	There is no schemes of financial support to develop swidden agriculture compared to wetland rice which gets financial support for development	Financial support provided to wetland rice where as farmers preference is towards swidden agriculture.
6	The emerging negative perception about swidden farmers who clear land using fire which is also blamed as a cause for forest fire.	There is a West Kutai District Regulation (Peraturan Daerah = PERDA) prohibiting the use of fire for land clearing. In this case, government did not consider the wisdom and culture of swidden agriculture.

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Assessment of *daleh* swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia

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Abstract. *Imang N, Rujehan, Duakaju NN. 2018. Assessment of* daleh *swidden agriculture as an innovative alternative to conventional swidden under conditions of external pressure on local forest management in Kalimantan, Indonesia. Biodiversitas 19: 840-848.* Swidden agriculture is still an important livelihood for millions of people in the tropics. In Kalimantan Island of Indonesia, swidden agriculture is currently facing many external pressures such as massive expansion of oil palm plantations, concession for industrial plantations, and non-availability of financial and political support from the government. The above external pressures which ignore local wisdom in forest and land management have reduced the land available for swidden agriculture. The external pressures, in turn, have shortened the cycle of swidden agriculture and decreased the productivity of swidden agriculture. The objectives of the present study are to assess socio-cultural and economic aspects of the innovative *daleh* agriculture as an alternative to conventional swidden agriculture under these conditions. The study was conducted in an indigenous *Bahau Dayak* community of East Kalimantan, Indonesia. Twenty swiddeners and 6 other key informants were interviewed for data collection. Research findings confirm that the expansion of oil palm plantations has ignored the wisdom in forest and land management, in general, and caused pressure on swidden agriculture, in particular. Under such pressures, *daleh* swidden agriculture may be effectively practiced because it can increase land productivity and is also culturally acceptable. Further, financial and facilitation support from district government is needed to improve the practice of swidden agriculture in the study area.

Keywords: *Daleh* swidden agriculture, Dayak people, Kalimantan

INTRODUCTION

Swidden agriculture or shifting cultivation, locally called *ladang*, is one of the traditional practices of forest and land management by people in the tropics and is suitable to social typology in which there is a high interdependence between people and the environment (Dove 1993; Colfer et al. 1997; Inoue 2000). Furthermore, Sardjono (1990) maintains that traditional forms of swidden agriculture reflect an optimum interrelation between the strategy to serve human needs and efforts to maintain ecological balance in tropical regions. These practices can be further improved through agroforestry technologies to adapt to local socio-economic dynamics and environmental changes. Conceptually, swidden agriculture has a close relationship with social forestry. Pasaribu (2007), Sardjono (2007), and Inoue and Kawai (2013) define social forestry as any conditions and efforts which intimately involve local people in forestry activities to ensure economic, ecological and social benefits, and simultaneously sustain the resources.

Dove (1988) and Inoue (1999) point out that the term ‘shifting cultivation' is often taken to mean that the people are themselves ‘shifting' or semi-nomadic, even though most of them live in relatively permanent settlements. In fact, people use fire and fallow their field after harvest. The field, once set on fire, is called ‘swidden’. So, ‘swidden agriculture’ is preferable to commonly used term ‘shifting cultivation’.

Swidden agriculture is estimated to support 300-500 million people worldwide, covering about 30% of exploitable land for agricultural activities. In the Asia Pacific, swidden covers an area of 73 million hectares and, in Indonesia, it involves 35 million hectares of land and about 2.2 million cultivators (Mubyarto 1991).

Several scholars have studied swidden agriculture as practiced by the *Kenyah Dayak* people of East Kalimantan (Jessup 1992; Colfer et al. 1997; Sindju 2003). Inoue and Lahjie (1990) tried to develop models for the sustainability of *Kenyah* agricultural systems, including *ladang*. Sindju (2003), in a comparative study of *ladang* practiced by the *Kenyah* of West Kalimantan, Indonesia and the *Kenyah* of Sarawak, Malaysia, has qualitatively described the technological aspects of the practice.

Inoue (1999) categorized swidden agriculture in term of its sustainability as follows: (i) traditional swidden agriculture-sustainable swidden agriculture practiced by indigenous people, (ii) transitional (quasi-traditional) swidden agriculture-practiced by indigenous people, originating from both recurrent and pioneer types, but not so sustainable because of short fallow period, and (iii) non-traditional swidden agriculture-unsustainable slash and

burn agriculture, often with cash crops, usually practiced by newcomers to village.

Though Swidden continue to play an important role in rural areas as indicated by the fact that around 65% of Mahakam Ulu people are still practicing swidden (BPS Mahakam Ulu 2016), the income from swidden agriculture was as low as Rp. 5-8 million (USD 385 – 615) for one hectare (Pannalo 2015; Wijayanti 2016). Besides the low economic returns, conventional swidden agriculture is also under external pressures, such as expansion of oil palm cultivation, coal mining and industrial forests *(Hutan Tanaman Industri = HTI)* which reduce the extent of potential land available for swidden agriculture. Under these conditions, an innovative alternative to traditional swidden agriculture is desirable which is economically more productive and culturally more acceptable to local community.

The *Dayak* people have practiced swidden agriculture from many generations for subsistence and the indigenous *Bahau Dayak* have recently developed the practice of *daleh* swidden agriculture. Imang et al. (2004a) described that *daleh* is a concept initiated by the local *Bahau Dayak* in Matalibaq as the response to the disadvantages of conventional swidden and is culturally and economically more acceptable to people. In the present study, we have assessed the potential of this recently emerged practice of *daleh* agriculture as an alternative to the conventional swidden agriculture.

The specific objectives of the study are (i) to assess the traditional practices of land management under external and internal pressures on forest and land, (ii) to explore and compare the practices of conventional and *daleh* swidden agriculture and the associated problems, (iii) to assess socio-cultural and economic aspects of *daleh* swidden agriculture responsible for its successful implementation and cultural acceptance by the swiddeners, particularly the *Dayak* people.

MATERIALS AND METHODS

The present study was conducted in Matalibaq village, Long Hubung Sub-district, West Kutai District, East Kalimantan, Indonesia from July to August 2017. Data was gathered from indigenous *Bahau Dayak* community who lived here for over hundreds of years. The reasons behind choosing this village are: i) it has a long history of protecting and managing primary forest based on the cultural wisdom, ii) it has innovative local knowledge pertaining to the practice of more productive swidden agriculture, and iii) recently the village is facing the pressures of activities like oil palm plantation expansion, massive Industrial Forest expansion, and other types of forest and land degradation.

Data and information were collected through in-depth interviews with Customary Chief *(Kepala Adat)*, Village Chief *(Petinggi)*, former customary chief, five village elders and 20 swiddeners. Data and information collected pertain to the traditional wisdom and concept of managing forest and land, the concept and practices of conventional and *daleh* swidden system, their merits and demerits, threats and constraints and benefits involved.

RESULTS AND DISCUSSION

Traditional knowledge-based forest and land management

Matalibaq village territory covers an area of 88,000 km^2 which was originally dominated by excellent primary forest. In order to protect the forest for sustainable local benefits, the available forest and land were allocated in 10 zones based on the availability of resources and socio-cultural considerations. The forest and land zonations are as follows: (i) *Tana' Umaq'*, land for settlement; (ii) *Tana' Lumaq*, areas for swidden agriculture, perennial and annual crops; (iii) *Tana' Lepu'un Luma'*, the former swidden area that planted with fruits, in which the fruits are considered the proof of individual ownership; (iv) *Tana' Bio'*, forested customary land in which the customary head implemented strict rules so that nobody can utilize the forest area for any purpose; (v) *Tana' Patai (kale')*, space for cemetery; (vi) *Tana' Berahan* or *Belahan*, forested area for extraction of forest products such as timber for self consumption and for sale, hunting ground and fishing area; (vii) *Tana' Mawa'* protected forest area for collecting high value forest products such as resin, rattan, honey, timber for housing and boat making, eagle wood (*gaharu)*and forest fruits; (viii) *Tana' Ang/Hang*, the boundary area between adjacent villages wherein its utilization must be according to the agreement among bordering villages; (ix) *Tana' Pukung*, a protected forest area which is abundant in forest fruits for wild animals' as food; (x) *Tana' Kaso*, primary forest specially allocated for hunting because it is habitat for many wild animals such as wild pigs, deers and monkeys. People are strictly prohibited from disturbing the area that is allocated for breeding of wild animals because wild animal hunting is also a way of life of the community.

Such traditional land zonations persisted until external influences such as establishment of a logging company in 1992 and small-scale logging from 1999 to 2001 started affecting the village (Imang et al. 2004a). Such degradation activities have damaged forests outside the agricultural zone *(tana' lumaq).* The most massive forest and land degradation were caused by the land clearing for oil palm plantations taking place since 2014, covering around 6,000 hectares of land including primary forest area marked for hunting and fishing, without respecting the land zonation system followed traditionally by the villagers. Due to such destructive activities, some of the forest and land zones, such as those allocated for hunting and agricultural areas, have already been converted into oil palm plantations. Consequently, these activities have negatively impacted the practice of swidden agriculture. The most significant impact was a decrease in the land available for agriculture in general and swidden agriculture, in particular. This, in turn, shortened the cycle of conventional swidden agriculture. Under such a situation, the *Bahau Dayak* community of Matalibaq developed the concept of *daleh* swidden agriculture.

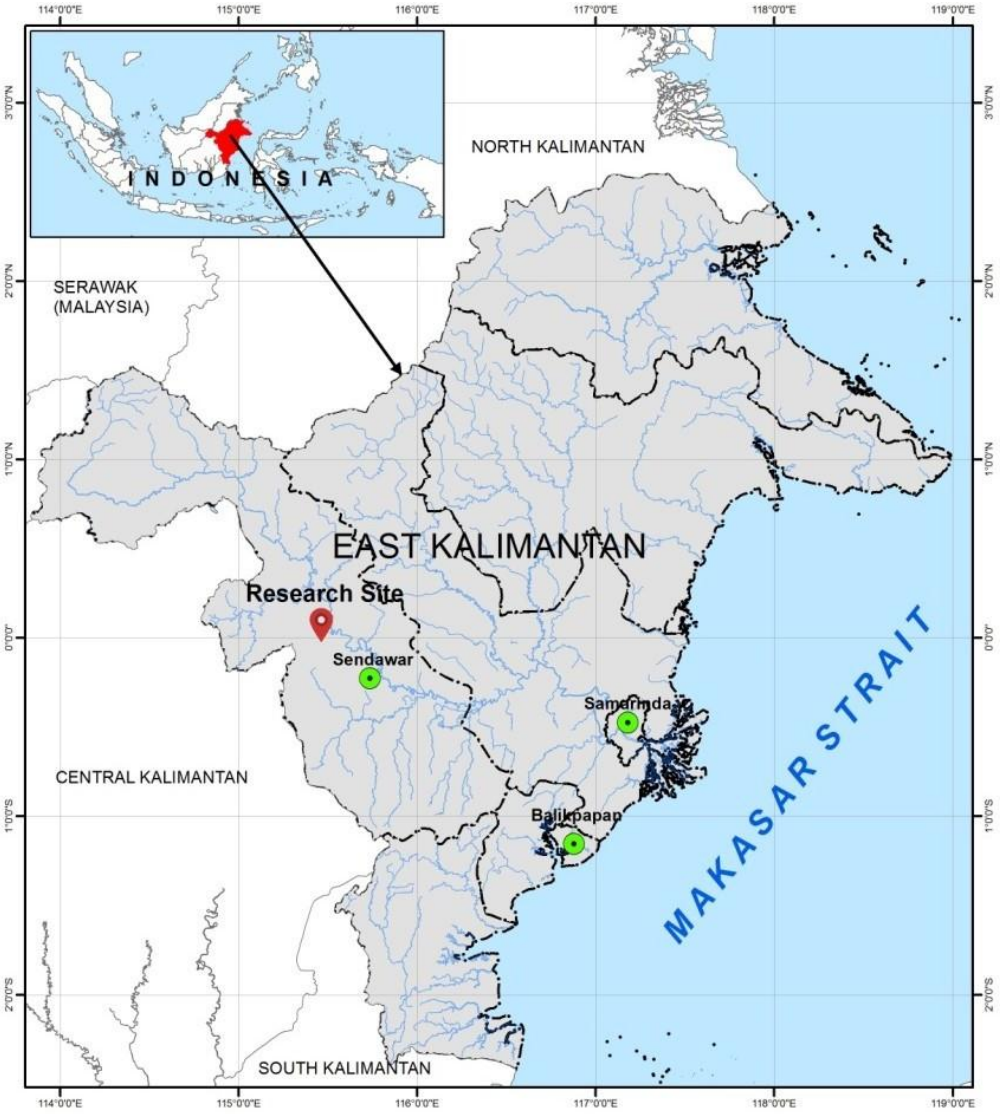

Figure 1. Map of the research site in Matalibaq village, West Kutai District, East Kalimantan, Indonesia

The practice of conventional swidden agriculture

Even though the practice of swidden agriculture is almost similar across countries, the local term in each country is different, e.g., *tsheri* or *pangshingtsheri* in Bhutan, *milpa* or *tlacolol* in Guatemala, *Kaingin* in Philippines, *taungya* in Thailand, *si Nda Bot* in Cameroon and in Indonesia, it is popularly known as *ladang* (Upadhyay 1995; Imang et al. 2004a). The local term for swidden agriculture in the research site of the present study is *lumaq*.

According to Imang (2004), the *Kenyah Dayak* people open new *ladang* through 9 stages. However, the *Bahau Dayak* people of Matalibaq village open their swidden agriculture commonly through 8 stages which are as follows: (i) slash the shrubs and small trees; (ii) cut down the big trees, which is usually a male-task because its risky for female; (iii) chop the fallen trunk for faster drying and proper burning; (iv) burn the vegetation which not only clears the ground for planting, but also releases nutrients from the biomass to increase the soil fertility; (v) planting preparation by removing the twigs; (vi) planting which is usually initiated by the Customary Chief *(Kepala Adat)* through a ritual ceremony to decide the most appropriate day for planting. Otherwise, the villagers believe that the harvests may not be good. This is an important stage of swidden in which the farmers gather and work together to plant one's swidden area in a labor exchange manner characterized by direct parity reciprocity; (vii) weeding, (viii) harvesting, like at planting stage, harvesting also a very joyful stage because the farmers will harvest together of 10 to 20 farmers and even more.

Swidden agriculture is still playing an important economic role in the study area. It is observed that more than 90% of the 156 households of the village are still practicing swidden agriculture. Each farmer has around 4-7 plots of land and the location of these plots are spread out with the distance between plots varying from 2 to 6 kilometers. The average size of the plots is 1.10 hectares

and the mode of access to the plot or swidden field is either by foot/walk or by boat, and some farmers have recently started accessing the plots by motorbikes.

Productivity of swidden agriculture varies widely over the years, depending on the weather, rainfall, pests, and diseases. The average productivity per hectare in the study area in February 2017 was 1,475 kg. The farmers feel that productivity was a bit lower than that of previous year of 2015 because of prolonged drought. Further, this productivity is lower than the swidden productivity of 1700 kg obtained in Pampang village which is around 650 km away from Matalibaq (Panalo 2015) and of Miau Baru village where it was 1,900 kg per hectare (Wijayanti 2016).

The farmers start swidden cultivation by clearing land in a randomly chosen location or plot, depending on how long the plot of land has been previously fallowed. The swidden plot for year-2 is located in the opposite direction away from swidden plot of year1 and the plots for subsequent years are selected in different locations. Consequently, the crops grown in previous years are mostly abandoned after moving to a new location for land clearing, for next years swidden. Farmers stay temporarily for 6 to12 months in one location, before moving to another location.

The more land a farmer has, the longer the swidden cycle and fallow period. Each plot of land is cleared in a rotation every year. The rotation of swidden locations is a strategy to allow the soil to regain its fertility through accumulation of biomass. The farmers have learnt by experience that the longer the swidden cycle, more fertile the soil becomes. The biomass from leaves and decomposed trees will be released to soil after it is burnt properly. This is in line with Weinstock and Sunito (1998) who mentioned that swidden agriculture is characterized by rotation of land rather than crops, or a rotational agriculture with a fallow period longer than the period of cultivation.

Farmers, through their experience, know that the rice planted in properly burnt area better growth compared to the rice planted in improperly burnt area. Properly burnt according to farmers is when leaves, twigs and small branches are completely burnt so that soil looks black. Therefore, during land clearing, farmers prefer felling trees towards inside of the swidden area instead of outside. This is also a strategy to prevent spreading of the fire to nearby forest areas during the burning of the swidden land.

The practices of *daleh* swidden agriculture

The cultural background of the *daleh* swidden is *gotong royong*, the cultural-spirit of 10 to 50 even more farmers working together in the swidden field of a farmer, usually in the stages of planting or harvesting. The labor exchange in *gotong royong* is characterized by direct parity reciprocity. Though the spirit of *daleh* can be practiced at any of the stages of swidden agriculture starting from slashing to harvesting, but the stages of planting and harvesting are the most suitable stages for *gotong-royong*.

The concept and steps of *daleh* swidden agriculture are as follows: (i) *Daleh* system consists of adjacent agriculture fields belonging to at least 4 households that are bordering each other, forming a cluster so that they can help each other whenever needed (Figure 3). (ii) Each household or farmer of the cluster should have at least one hectare of land, so that it can be divided into 4 plots, each measuring 0.25 hectares or more. One plot is cleared every year during the swidden cycle of 4 years (Figure 4). (iii) The huts or shelters of the all the minimum 4 swidden group members are located in the center of their swidden field in a proper location so that they can raise pig, chicken or fishes surrounding their huts. When any swidden group member leaves the swidden field for overnight stay at village/home, other group members take care of his/her pigs or chickens and protect them from predators. Pigs and chickens have played a very important socio-cultural role in the life of *Bahau Dayak* people for hundreds of years. They offer pigs and chickens as sacrifices in every village ceremony. Manure of this livestock used as fertilizer for farming. On the other hand, domestic and agricultural wastes/bye products are used to feed them.

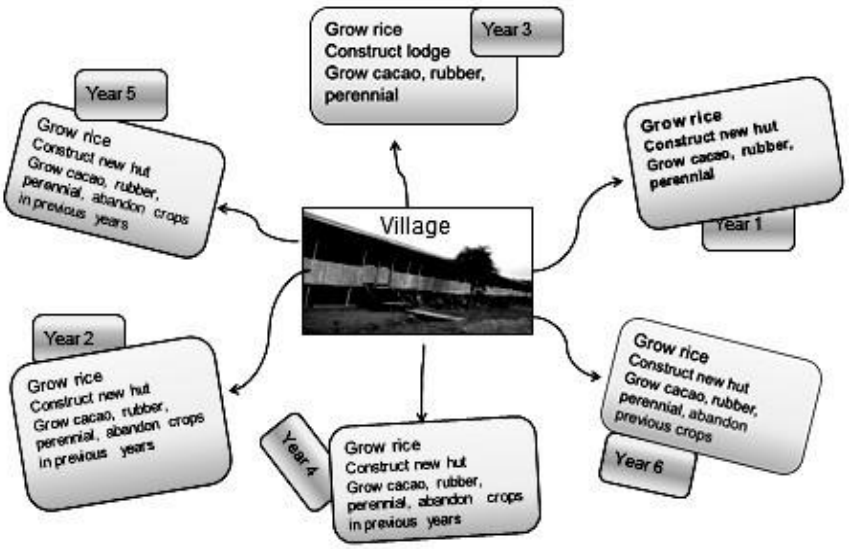

Figure 2. Utilization of land plots during different years in conventional swidden agriculture

Table 1. Practices of conventional swidden agriculture of a 6-year cycle in the study area.

Year	Activities	Harvested products
1	Open swidden agriculture and grow rice, build a small hut/shelter, grow some vegetables and annual crops such as cacao, rubber or pepper.	Rice, corn, and vegetables.
2	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, growing vegetables, cacao, rubber or pepper. But, they abandon crops planted in year-1.	Rice, corn, vegetables.
3	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-2.	Rice, corn, vegetables.
4	Open swidden agriculture in another place/plot, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper. But, they abandon the crops planted in year-3.	Rice, corn, vegetables.
5	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were abandoned
6	Open swidden agriculture in another place, develop new hut again and other supporting facilities, grow vegetables, cacao, rubber or pepper.	Harvest rice, corn, vegetables. Cacao, rubber or pepper not harvested because they were not maintained well.
7	Return to the plot of year-1, and start all steps of swidden from the beginning. The crops they planted in previous years not grow well because they abandoned.	Cacao, rubber or pepper not harvested because they were not maintained well.

Table 2. The disadvantages of conventional swidden agriculture as observed in the study area

Disadvantages
1. Swiddeners have to construct a new hut or shelter each time they open a new swidden which requires time and resources, both physical and financial.
2. Opening new swidden in another place results in increase of inputs because all of the previous years activities are repeated.
3. Cacao, rubber, pepper or other crops are grown in the previous years are less productive or even not productive at all because of improper maintenance, crop damage by pests, diseases and weeds.
4. Swiddeners cannot raise livestock such as pig, poultry, and others in swidden land (surrounding the hut) because they move to another place every year. The location of individual swidden is mostly away from neighbors' swidden, and most of the swiddeners will return home in the evening and return to swidden field in the next morning. Therefore, their livestock and poultry may be attacked by predators such as panther and weasel when farmer stays overnight away from huts.
5. There is no availability of organic manures from livestock for rice and crops, and farmers are left to depend only on the existing insufficient of natural soil fertility.
6. In some cases, the long-abandoned former or ex-swidden areas of one farmer may be overlapping with the plots of other farmers or encroached by other farmers.

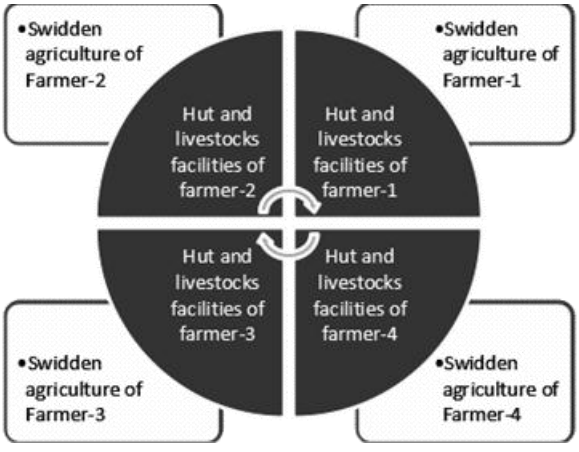

Figure 3. A cluster of *daleh* swidden agriculture consisting of four farmers

Firstly, the farmer divided the land into some smaller plots. The number of plot depends on the size of land or depending on how large of land can be cleared by farmer, usually 4-6 plots. In this part, we use a case of 6 plots, while in Table 3 below is a case of 4 plots. Secondly, farmer will clear one plot every year from year-1 to year-6 in the same way and also similar crops. (i) In the first year, the swiddener cleared plot-1 and grew rice, corn, cucumber, vegetables at the same time. After six months, the rice could be ready to harvest. After the 0.25 ha of swidden already harvested, the swiddener can grow cacao, rubber, vegetables in former of the swidden field. (ii) In the second year, it is the turn for the second plot or plot-2 to clear for swidden in the same way and similar crops with the plot-1 in year-1. At the same time, the swiddener can maintain the crops he/she planted in the previous year so that the crops grow well. (iii) In the next year-3 and year-4,

the swiddener also repeat the same ways as in the previous years until all of the 4 plots completed to clear for rice and other crops. In year-4, the one-hectare of land is already planted with some annual and perennial crops, and ready to harvest. (iv) In year-5, the swiddener can move to other nearby area to open new swidden while also maintaining the crops in the previous years and raising livestock. Cacao and rubber or other crops are ready to harvest in year-5 or year-6.

Figure 4 shows the details of how a farmer allocates his/her land during *daleh* swidden agriculture. The hut or shelter is built only once in the first year. They also build other facilities like cages to raise livestock either in year 1 or year 2. These huts and cages built once last for more than 5 years because of which farmers save time, labor, and economic and material resources otherwise spent every year for these works. Further details such as the pattern of plot clearing, crops grown, animals raised and products harvested in the practice of *daleh* swidden agriculture are shown in Table 3.

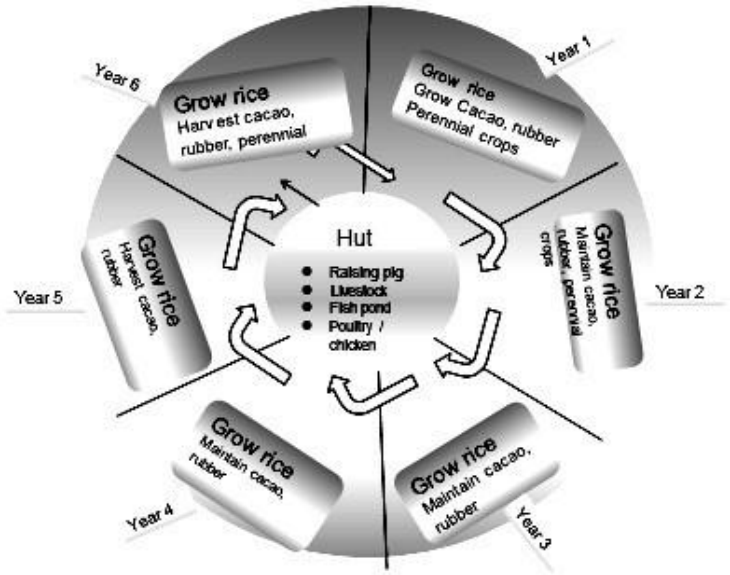

Figure 4. Details of utilization of one-hectare land in *daleh* swidden agriculture practice

Table 3. Practices of *daleh* swidden system in 4 plots of land

Year	***Daleh* swidden agriculture practices**	**Harvested products**
1	Plot-1 is cleared for swidden to grow rice, corn, and vegetables at the same time. Swiddener also builds a proper hut/shelter. While waiting for the harvest of rice, swiddener prepares cage for pig and poultry. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field Just after the rice is harvested.	Rice, corn, cucumber, vegetables, chicken.
2	Plot-2 is cleared to grow rice, cucumber, corn, vegetables at the same time. No need to build a new hut/shelter. Swiddener continues to raise pig and poultry or fish pond. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the former swidden field.	Rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel, they can also maintain crops planted in previous years, and raise livestock such as chicken or pig.
3	Plot-3 is cleared for swidden to grow rice, corn, and vegetables at the same time. Swiddener also builds a proper hut/shelter in the year-1. While waiting for the rice to harvest, swiddener prepares cage for pig and poultry. After rice harvesting, the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field after rice is harvested..	Harvest rice, corn, vegetables, chicken, pig, fishes. In parallel they can also maintain crops they planted in previous years, and raise livestock such as chicken.
4	Plot-4 is cleared for swidden and after rice harvesting, swiddener grow cacao, rubber or pepper or other annual and perennial crops. In parallel, the swiddener also maintain crops they planted in plot-1 to 3.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes. In parallel, they can also maintain crops they planted in previous years, and keep to raise livestock
5	Open new swidden outside the previous area and repeat the same activities. Farmers also benefit from the pig and poultry, they can use waste to feed the livestock, and conversely, the livestock provide manure/fertilizers for crops. This is an integrated farm that also acceptable to socio-cultural of the swiddeners.	Cacao and rubber they planted in year-1 plot-1 ready to for harvest, while they also maintain the crops they planted in year-2 to year-4. They also benefit from the livestock.

Economic comparison between conventional and *daleh* swidden agriculture

Table 4 summarizes the economic comparison between conventional and *daleh* agriculture in terms of the various activities involved and products harvested. It is evident from the table that both systems have the same activities such as growing (G), maintaining (M) and harvesting products (P) such as rice, corn, and vegetables.

The differences are observed from second year onwards, the notable ones are: (i) The crops grown in previous years, excluding rice, are maintained in *daleh* system because the subsequent years plots are close to the first year's plot. However, they are abandoned or neglected in conventional swidden agriculture due to the distance between first year's plot and subsequent years plots. (ii) In conventional swidden agriculture, farmers do not build cages or facilities to raise chicken/poultry or pig and other livestocks because they live at the swidden site only for about 6 months to a year. After harvesting rice, they move to another swidden plot located far away from the first one. But in *daleh*, livestock is maintained as they live in the same location throughout the swidden cycle.

As mentioned above, the *daleh* swidden is a multi-product agricultural system as it involves mutual symbiosis between different elements such as rice, crops (cacao, rubber, pepper), livestock and fish. In this system, products or bye products of one element supports or sustains the other elements and this enhances the overall productivity of the whole system. For example, the waste products resulting from rice cultivation is utilized to feed poultry and pig, while the manure of poultry and pig is used as organic fertilizer for crops. The central element of *daleh* system is the farmer and his/her family who control and maintain all elements, and at the same time, get multiple benefits from rice, other crops, and livestock. Figure 5 shows the multifarious interactions among the different elements of a *daleh* swidden agriculture system.

Table 4. Economic comparison between conventional swidden and *daleh* swidden systems of agriculture

Crops	Conventional swidden Year					*Daleh* swidden system Year					
	1	2	3	4	5	1	2	3	4	5	6
Rice	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP	GMP
Rubber	GM	A	A	A	AP-	GM	GM	GM	GM	GMP	GMP
Cacao	GM	A	A	A	AP-	GM	GM	GM	GM	GM	GMP
Banana	GM	P-	P-	P-	P-	GM	MP	MP	MP	MP	MP
Chicken	GMP	0	0	0	0	GMP	GMP	GMP	GMP	GMP	GMP
Pig	0	0	0	0	0	GM	GMP	GMP	GMP	GMP	GMP
Vegetables	GMP	GMP	0	0	0	GMP	GMP	GMP	GMP	GMP	GMP
Manure	0	0	0	0	0	P	P	P	P	P	P

Note: G: Grow/ raise livestock and/or poultry, M: Maintain the crops, A: Abandoned/not properly maintained, P: Production of crops, or manure of livestock, P-: Production but less, F: Fail, no production because the crops are abandoned, O: No agricultural activity/no raising of livestock

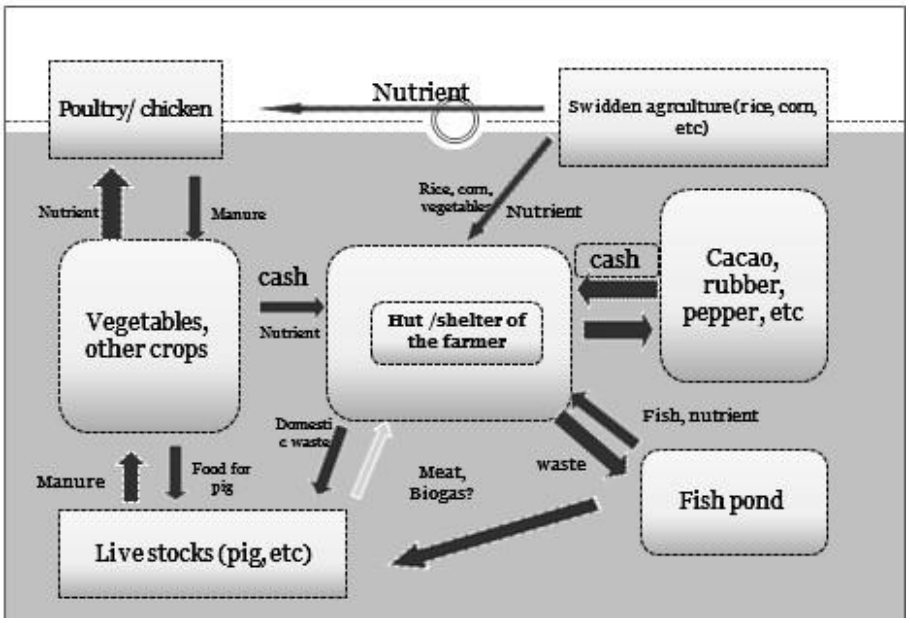

Figure 5. Interactions between different elements in a *daleh* swidden agriculture system

Table 5. Constraints and threats to swidden agriculture in the study area

No	Constraints/ threats	Remarks
1	Expansion of oil palm plantations and Industrial Forests (*HTI*) that caused the conversion of agricultural lands to commercial plantations	Some of the fertile land zones such *as Tana' berahan, Tana' Kaso dan and Tana' Mawa'* have been converted to oil palm plantations and man-made tree forests (*HTI*).
2	The division of land into smaller plots so that it is more difficult to practice *daleh* swidden agriculture.	A cluster of *daleh* system needs at least 4 to 6 hectares of land for its effective practice and a sufficient land fallow.
3	The decreasing interest of young generation towards farm work because of reasons such as hard manual labor involved, low income which is insufficient to fulfill their daily needs of subsistence and monetary requirement, uncertain market for agricultural products, etc.	Panalo (2016) found that average output of one hectare of swidden agriculture is Rp. 8.6 million. It means that the average income for one month is Rp. 1.1 million
4	Technological innovations in the area of swidden agriculture are lacking when compared to wet rice cultivation. Therefore, all stages of swidden activities are done manually which is also a reason for its low productivity.	The remote location of the swidden agriculture also a constraint for agricultural officers to develop agricultural activities.
5	There are no schemes of financial support to develop swidden agriculture compared to wetland rice which gets financial support for development	Financial support provided to wetland rice, whereas farmers preference is towards swidden agriculture.
6	The emerging negative perception about swidden farmers who clear land using fire which is also blamed as a cause for forest fire.	There is a West Kutai District Regulation (Peraturan Daerah = PERDA) prohibiting the use of fire for land clearing. In this case, government did not consider the wisdom and culture of swidden agriculture.

Threats to swidden agriculture

The basic principle of shifting cultivation or swidden agriculture is the availability of sufficient time gap for the fallowed lands to regain their natural fertility, between successive swidden cycles. The usual duration of one cycle varies from 5 to 10 years, depending on the fertility of the land/soil and other considerations of the farmers. This implies that a farmer should have at least 5 plots of swidden land to maintain this cycle by allowing enough time for the soil to become fertile after one swidden cultivation.

However, the expansion of oil palm plantation has decreased the availability of suitable land for swidden agriculture. The narrower the extent of land available for swidden, shorter the swidden cycle becomes. Shortening of swidden cycle to less than 5 years, in turn, decreases land productivity because of insufficient nutrients in soil. This is one of the major threats to the continued practice of swidden agriculture, particularly in the study area. There are also other threats and constraints to swidden agriculture in general which are summarized in Table 5.

Conclusion

The introduction and expansion of oil palm plantations, logging and industrial planted forests (*HTI*) in the village territory ignored and did not recognize the traditional wisdom of forest and land management. These activities were granted concession by Provincial and District Government and Customary Institutions are not strong enough to protect their lands that are taken over by concessions such as oil palm or industrial forest. Swidden agriculture still plays an important role in the economic life of the community because more than 90% of the households still actively practicing swidden agriculture every year, despite its disadvantages. The pressures and threats to the continued existence of conventional swidden agriculture have necessitated an innovative alternative swidden method which can improve land productivity and generate better income for farmers. The *daleh* swidden agriculture, which is integrated swidden farming combining the traditional swidden agriculture with livestock and other crops in one plot, has the potential to become such an alternative because it improves land productivity, increases return to farmers, and more importantly, it is culturally acceptable to the community. Unfortunately, District Government is not providing any financial assistance and agri-technological support to organize farmers for practicing more productive swidden agriculture.

In order to protect the agriculturally potential land for the purpose of swidden, the government should recognize the local wisdom on forest and land management and should consider providing financial and facilitation support for the practice and improvisation of both conventional and *daleh* systems. Besides the economic benefits of swidden agriculture, the *Bahau* community also of the opinion that the *daleh* swidden agriculture may also become an "agricultural tourism object" in the future, particularly at its two most important stages of planting and harvesting.

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