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Study of Local Knowledge on the Practices of Swidden Agriculture to Increase Productivity and Sustainable Land: Case Study on the Kenyah and Bahau Dayak in East Kalimantan, Indonesia

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Abstract:

East Kalimantan is facing the massive increase of population in the near future due to the relocation of Indonesian Capital Jakarta Java to East Kalimantan Province. One of the prospective ways to increase the productivity of rice is to improve the agricultural ways of the Indigenous people through implementation of local knowledge so that they could gain benefits from the relocation of Indonesian Capital.

The aims of this study were (1) to examine the knowledge and local wisdom of the 'umabileng' farming system and the 'daleh' system of the Bahau and Dayak Kenyah ethnic groups, (2) to integrate local wisdom and knowledge of the Dayak Kenyah and Bahau ethnic farming systems and science into a more productive and sustainable agricultural concept.

Research sites were two villages of indigenous Dayak people in Mahakam Ulu Regency and East Kalimantan Indonesia from March to July 2022. A descriptive qualitative approach was used for data analysis.

Research result showed that during the practice of this ways of farming, they have implemented traditional knowledge and wisdoms at every stage, i.e. how to look for fertile land, how to fell big trees to get optimum biomass, the best day to planting, traditional pest control, and the last stage of harvesting including the treatment to have good quality rice for seed (benih/beneq) in the following year.

However, the farmer still lacks in some stages of farming which need intervention and integration of agricultural science. For example, farmers still need to be assisted by the treatment of seeds by soaking rice seeds in a salt solution in order to obtain good quality seeds. Another example of how to increase soil fertility was by fertilizing organically, such as liquid organic fertilizer (POC = pupuk organik cair). In order for the daleh and umabileng systems to work, it is necessary to have field agricultural extension that will organize and motivate farmers so that this system can work well.

Keywords: Daleh, uma bileng, dayak kenyah, dayak bahau, swidden agriculture

1. Introduction

The Indonesian government, especially East Kalimantan Province, continues to increase rice production and productivity, both in lowland rice and upland rice (in Indonesia widely called *ladang*), of field rice to improve food security, especially rice. However, behind efforts to increase rice production, the food agriculture sub-sector, especially rice, faces challenges, namely the increasingly narrow food area due to the conversion of food agricultural land into non-agricultural land. According to BPS Kaltim (2019), it shows that East Kalimantan can only meet 288,353 tons or 85% of rice needs, so 41,000 tons still need to be supplied from other island such as Java and Sulawesi.

Upon the designation in the East Kalimantan Province as the location of the new State Capital of Indonesia (IKN = State Capital) with the enactment of the IKN Law, the demand for rice will continue to increase due to a very fast population growth.

To anticipate the need for rice which will continue to increase, the Mahakam Ulu Regency Government has also, since 2019, taken a policy to increase rice production through increasing agricultural land productivity, especially upland rice to meet regional rice needs, or at least reducing the supply of rice from outside with difficult access, especially access in the dry season because it cannot be passed by ships.

Compared to other Regencies, Mahakam Ulu Regency has a relatively large area of land for the development of food agriculture, especially upland rice. The problem is that the productivity of the fields is still low at around 1.2-1.7 tons/ha because the farming system is still traditional, local knowledge and local wisdom cannot be fully implemented due to various obstacles in the field (Wijayanti, 2015 and Imang, 2018).

Shifting cultivation, also called Swidden Agriculture or Swidden, is one of the traditional practices of forest and land management by communities in the tropics, and is considered compatible with a social typology in which there is a high interdependence between humans and the environment (Inoue, 2000; Dove, 1993; Colfer *et al*, 1997). Dove (1998) also found that the indigenous people of West Kalimantan Province practiced shifting cultivation based on their local knowledge and wisdoms.

In line with this statement, Sardjono (1990) stated that shifting cultivation reflects the close relationship between the strategy of meeting human needs and efforts to maintain ecological balance in the tropics.

Conceptually and practically, cultivation has a close relationship with social forestry. Sardjono (2007) and Pasaribu (2007) define social forestry as a condition and effort that involves local people in forestry activities to ensure socio-economic and ecological benefits while simultaneously maintaining available natural resources. In this case, there is some local wisdom/knowledge in managing land, especially in the Swidden farming system.

The aims of this study were (1) to examine the knowledge and local wisdom of the '*umabileng*' farming system and the '*daleh*' system of the Bahau and Dayak Kenyah ethnic groups, (2) to integrate local wisdom and knowledge of the Dayak Kenyah and Bahau ethnic farming systems and science into a more productive and sustainable agricultural concept.

2. Methodology

2.1. Research Sites

The study was conducted for 6 months from March to October 2022. The research sites were 2 (two) villages in Mahakam Ulu Regency, namely- Data Bilang Ulu Village inhabited by Dayak Kenyah ethnicity and Matalibaq Village inhabited by Bahau ethnicity. These two ethnics were chosen because they are the two largest ethnic groups of 47,500 residents of Mahakam Ulu, the farming system is the main livelihood of about 75% of the community, and both of ethnic groups have local knowledge and wisdom in farming the so called '*umabileng*' system and the '*daleh*' systems.

2.2. Data Collection

Data were collected in 3 ways: (1) Focus Group Discussion (FGD) with customary leaders, community leaders, cultivation system practitioners, (2) In-depth interviews with key persons which aim to explore deeper into several topics or variables that have not been covered in the FGD, (3) direct observation in the field for visual observation and documenting the objects mentioned in the FGD and in-depth interviews.

The data and information includes local knowledge on how to determine physical and non-physical factors of fertile land/soil for farming, how to determine the cultivation cycle or fall period (fallow period) and what are the vegetation indicators, how to allocate land and land rotation in the system '*daleh*' of the Bahau ethnicity and the '*umabileng*' system of the Kenyah ethnicity, knowledge of seed treatment and determining the best day to start planting (*menugal*).

2.3. Data Analysis

The data analysis used is descriptive qualitative, which is a method of examining the status of a subject, a set of conditions, a system of thought or events that produce an accurate illustration, making a systematic description, figure out the relationship between the aspects to study (Khasanah, 2021).

3. Results and Discussion

The ethnic Dayak Bahau and Kenyah have local knowledge practices in making Swidden farming. This local knowledge starts from the stage of looking for suitable and fertile land for farming until the last stage, namely harvesting. However, to further increase land production and productivity, this knowledge and local wisdom needs to be combined with modern knowledge/science. This implementation of local knowledge is also known in local dialect as *umabileng* and *daleh*.

The implementation of local knowledge in the practice of *umabileng* and *daleh* cultivation as well as the integration of the necessary ecological sciences from looking for suitable land or fertile soil to the stage of harvesting is described below.

3.1. The Practices of Swidden Agriculture by the Kenyah Dan Bahau Dayak

Most of the farming practices of the Dayak Bahau and Kenyah are still carried out traditionally, with the characteristics of ecological adaptation to the physical conditions of the land and the local natural environment. Cultivation practices are carried out as an annual cycle of food agriculture activities in which certain local wisdoms are contained both in terms of physical, environmental, social and cultural aspects.

The stages of farming in the Dayak Bahau and Kenyah ethnic groups are a series of works in which earlier stage can benefit or impact the next stage. That is, the quality of work at earlier stage will determine success at the next stage until

the last stage, namely harvesting or productivity. For example, the results of proper felling (*nevang/nepeng*) and chopping (*mepat/metog*) activities will greatly determine the good quality of the results of field burning (*nutung*). Furthermore, the results of properly burning of fields will also have a good impact on soil fertility through biomass nutrition, and have an impact on reducing weeds that grow in cultivated land.

The following is local wisdom in every stage of farming, from determining soil fertility to the harvesting stage.

3.2. Looking for Fertile Land (Local Dialect: Pita Ba'i)

The Kenyah and Bahau Swiddeners (local dialect: *peladang*) have some indicators for a land that will be cleared for the next farming, for example 'plant indicators'. Plant indicators that indicate soil fertility (vegetation indicator) are indicators of certain plants that grow naturally and can be used as an indicator of whether the soil is fertile on certain lands or not. For example, among cultivators of the Dayak Kenyah ethnic group, including those in the Data Village of Bilang Ulu, plant indicators, which indicate that the soil is fertile, for example, are (in local dialects: *taap, batoq, tepo, udupenganen, uweiseringan, uteqmaq, benuaq, tekajeng, kidau, tepo, nyanding, nyadung, udupenganen*).

In addition, several species indicators, that indicate a fertile land, in the Dayak Kenyah dialect and Latin name, are *mpung* (*Blumea balsamifera*), *ulem* (NI), *siit* (NI), *balang* (*Lindera polyantha*), *lebem* (*Musa acuminata*), *sawan* (NI), *Karun* (NI), *lebem* (NI), *bine* (*Maccarangatrichocarpa*), *belebu* (NI), *sawan* (NI), *noh* (NI), *udupenganen* (NI), *titeq* (*Zingiberaceae*), *Benuaq* (*Maccaranga triloba*), *karun*, *pela* (NI), *sanampidek* (NI), *kayusanam* (NI), *aka kelese* (*Spatholobus*). Note: NI = Latin name not identified.

Meanwhile, plant indicators for soils that are considered less fertile, such as those found in dry/arid soils (*tanaqmegang*) are mainly: *katan balut*. If they find this plant indicator in a plot of land, the farmers usually look for another fertile land. Another indicator found in another type of soil which is also considered less fertile is that of *Tanaq Aga*, which is slightly white in color and slightly sandy. Plant indicators in this soil type are *kayu tat*, *dulin*, *keletang*, and *tekalet*.

No	Type of Vegetation (In Local Dialect)	Age (Year)	Description
A	Ethnic of Bahau		
1	Be'e/Be'eeq	<1	The vegetation consists of shrubs that grow just after the rice is harvested.
2	Kaharah	1-2	The vegetation is in the form of shrubs that grow immediately after rice is harvested, with mixed vegetation of small trees.
3	Sepitang Uk	2-3	The vegetation is shrub, with mixed vegetation of small trees and medium-sized trees.
4	Sepitang Ayaq	3-5	Dominated by fast growing species, a mixture of small trees and medium-sized trees.
5	Tu'aan Uk	6-10	Dominated by fast growing species with a mixture of large, medium and large trees.
6	Tu'aan Ayaq	>11	Dominated by a mixture of medium-sized and large-sized trees, which are derived from a succession of cultivation vegetation and/or from a succession of natural vegetation.
B	Ethnic of Kenyah		
1	Bekan	<3	The vegetation is in the form of shrubs that grow immediately after the rice is harvested.
2	Jekau Bu'et/Jekau Dumit	4-6	Dominated by fast growing species.
3	Jekau Dadoq	>7	The height of the tree is about 17 m with an average diameter of 20 cm. If it is opened into a field, the weeds that grow are greatly reduced because many of the seeds have died (Imang, 2020)
4	Mpak	Primary forest	Dominated by large and high trees with a dense canopy

Table 1: Types of Vegetation by the Bahau and Kenyah Dayak
Source: Field Survey 2020 and Imang and Devung (2019)

3.3. Slashing (Midik)

If the topography of the land is sloping, the slashing process usually starts from the bottom of the slope or the lower part of the field near the river (*mendaaq/cenbena*). The purposes were that the slashed wood and shrubs are easily disposed of towards the bottom of the slope so that they do not disturb the farmers while working, and point towards the top or ridge of the mountain. In order for the drying process to be better, then at the slashing stage, all shrubs and trees at diameter <5 cm are usually cut down with the stump as low as possible, so that later it does not become a stepping stone for pests such as rats and sparrows.

3.4. Felling (Nepeng/Nevang)

Felling (in local dialects: *nevang / nepeng*) is the most difficult and risky stage of work if the field is originated from primary forest or old secondary forest (*sepitangayaq / jekaudadoq*). This is because the diameter of the tree is large and the wood is hard, so it requires the power of man to cut it down. Nowadays, almost all felling is done using chainsaws, either with their own chainsaw or by a hired chainsaw-man.

Some traditional myths carried out by cultivators during felling activities are: (1) the felling process also starts from the bottom part of the field or the part near the river or from the valley (*men idaaq/cenbena*). This is done because in general the wood is inclined downwards / towards the river so that the felling process is not disturbed by the wood that has been felled earlier, (2) the felling direction is attempted towards the slope direction by adjusting the lower notch (*takikbawah*) and the reverse notch (*takikbalas*) at the time of felling. The felled trees are endeavored not to overlap each other so that later they will not be used by birds and rats as stepping stones as rice-pests, (3) it is endeavored so that all parts of the field get wood that falls evenly so that later after being burned, the nutrient content of the biomass can be spread evenly, (4) the wooden stump (*tunggul/tu'et*) is trimmed as low as possible so that it will not be used as a foothold for rats or birds to attack rice after the rice bears fruit, (5) cutting or chopping of the branches of trees (*mepat /metoq*) should be carried out when the felled wood is still fresh. If chopping conducted after the branches have dried, the leaves will fall from the twigs so that the drying process does not run perfectly because the leaves will fall to the ground. Dried wood will also be harder so it is more difficult to chop.

3.5. Burning (Nutung)

For Dayak Bahau and Kenyah cultivators, who have practiced it for generations, burning fields is also not only a way of clearing land but has many other benefits for field farmers as follows: (1) cleaning/removing nuisance plants/wild weeds, fungi and insect pests unwanted and fungi and pests that exist in the soil because the heat from burning can kill the weed seeds/seeds, (2) the heat of combustion changes the structure of the soil and the burnt residue can loosen the soil so that it is easy to plant, (3) increase soil fertility, due to additional nutrients from burning ash, (4) reduce soil acidity because ash is alkaline so it can increase soil pH. Farmers learned that if the land is burnt perfectly with a lot of black ash, the rice will grow and bear good fruit. Acidity and aluminum poisoning are soil problems in the tropics, so increasing soil pH can solve them, (5) heat in the soil makes the nutrients stored in the soil increase for plant growth, (6) the burning process acts as a soil sterilizer and can lead to a reduction in the population of microbes, insects and plant-disturbing weeds, (7) increase the potential for exchangeable cations such as Ca and Mg which are required for soil fertility, (8) reduce the cost of tillage and the soil is less susceptible to erosion. Without burning, it will be very difficult for cultivators to move large logs or branches.

3.6. Land Preparation for Planting (Mekup)

Cleaning the un-burned (in Dayak dialect: *ngekup/mekup*) in the fields is done if the burning process is not running perfectly. If the field is completely burned, then the *mekup* process does not need to be done. The function of *mekup* is to prepare the land to facilitate the next stages of work, i.e. weeding, controlling weeds and harvesting related activities. If the burning process is not perfect and the coverage is not carried out properly, it will cause several problems as follows: (1) the messy branches and twigs will disturb cultivators in their activities, starting from the time of planting, clearing weeds (*navau/mabeu*) to harvest stage (*ngelunau/majeu*), (2) farmers also learned from earlier experience that if there are many twigs and stems, they will become a stepping stone for rats and birds to eat rice, hence resulting in a lot of damage to farmers, (3) if the burned process is not good, it can reduce the biomass that enters the soil in the form of ash because it is still in the form of hard wood that has not been decomposed.

3.7. Planting (Menugal)

For the farmers, especially the ethnic Dayak Bahau and Kenyah field farmers, *menugal* is a very enjoyable stage of farming and is eagerly awaited by almost all the villagers. This is because there are several fun activities and even beautiful memories for the farmers, among other things, because in this stage of *menugal*, farmers are usually in groups, because (1) the *menugal* period is an opportunity for the farmers to work together/cooperate (*mahap /paladau/senguyun*) which can increase the intimacy between residents, (2) while working, a more special menu of food and drink is always provided compared to other stages of work, (3) for the Bahau ethnic, the planting (*menugal*) activity is preceded by the *ngurang* ceremony, in which the day before planting they always prepare large amounts of food and drink which will be enjoyed together at the time of planting, (4) the seeds to be harvested are rice that is harvested in the afternoon when it is dry naturally, and only short dried in a place to dry the rice (in Kenyah dialect: *taing*). This prospective rice seed is not threshed, it is enough to store it in the form of a complete panicle (in Kenyah it is called: *ulo*). It is also intended to distinguish 'prospective seeds' from other rice that will be milled or consumed. This seed is stored in a separated sack to

avoid taking it wrong (in Kenyah it is called: *saruq*) when you want to grind rice, (5) for the Dayak Kenyah farmers, determining the date or the first day to start planting is simpler but also uses the sun's position as in the Bahau ethnic group. Dayak Kenyah farmers not only use the position of 'moon' (*bulan di atas/bulan di langit*) to begin planting, but also combine it with the date on the calendar, which is around August 17th, the Indonesian Independence Day. The first good day for planting is determined based on the sun's position or '*asat tau*' which is at the position of '*seleng Punan*' to the position of the sun '*petatip*'. The position of the sun '*lekoq sang*' is also good for planting, while the position of '*mujunupit*' is not good for planting because there will be a lot of bird pests (*upit*). This way has been used for generations since they lived in the area of origin of Apau Kayan near the border with Sarawak, Malaysia. When compared with the Bahau ethnic, in the Kenyah Dayak ethnic, social class in society or caste (*paren, kelayan, panyen*) has no effect in determining the first day to planting.

3.8. The Control of Pests and Weed (*Mabeu/Maveu and Jagaquma*)

The traditional methods that have been used for decades and are recommended to control pests are as follows: (1) planting at the same time or the same week, which is actually a way to reduce losses due to pest attacks. If planting is not done at the same time, the pests will attack the rice alternately according to the age of the rice. In this case, the *ngurang* event for the Bahau ethnic group and *senguyunnugan* for the Dayak Kenyah ethnic group have also become part of the traditional way of reducing losses due to pest attacks, (2) as for monkey pests, traps are usually used (*tepap*); some use air rifles, or Timex poison. Fields that are located adjacent to the forest and are not adjacent to other fields are very vulnerable to monkey pests. For this reason, farmers are encouraged to open fields in one landscape so that they can take care of each other. If the monkey attack causes large damage, farmers usually have to stay in the fields to prevent monkeys from eating and damaging the rice. Monkeys usually attack rice in the morning and evening, (3) plant hopper (*Cicadellaviridis*) is one of the most destructive pests that is quite detrimental if there is pest explosion in a certain year. There are certain years when the plant hopper pests are very severe, but there are also certain years when the plant hopper pests are not so destructive. These plant hoppers can be controlled by burning materials with a sharp and spicy smell in the fields, such as *sembung* leaves (*uroq bung/ureu bung*), or some farmers burning rubber or old tires with a strong smell and smoke. The sharp smell of smoke will spread to the fields so as to reduce pest attacks, (4) for farmers in Matalibaq, *Hara Bambu Telivag* is used, namely *ataqlivah* (a kind of herb mixed inside a gong/crock) filled with a mixture of charcoal, eggs, kitchen ash, and water, which is then given a spell by the Customary Officer (*dayung*). The mixed water is put in bamboo, then shared among the farmers and then sprinkled on their respective fields. The *Dayung* that fulfills this requirement is usually *Dayung Doh* (Women's Customary Leader). The habit of using *ataqlivah/telang Liva* for pest control requirements is also carried out by all other Bahau ethnic groups in Mahakam Ulu Regency with various variations of mixtures of ingredients, (5) to reduce losses caused by weeds, farmers take two steps, first making farm (*ladang*) in old secondary forest where weeds are less, and clearing the land (*mekup*) by making bonfires evenly in the fields.

3.9. Harvesting and Seed Treatment

The quality of rice seeds plays a very important role in maintaining and even increasing rice productivity. Therefore, it is necessary to have special treatment for rice that will be used for seeds, namely as follows: (1) The signs of good panicles/grains of rice to be used as seeds are that the rice is already at the level of maturity which in the Dayak Kenyah language is called *ngelambangbatuk* of which the stalk of rice becomes yellow-brown but not broken; the rice grains look solid; there is no sign of disease or fungal attack on the rice, (2) Rice to be harvested for seed is done in two ways. First, selecting rice that meets the indicators mentioned above, and secondly determining a plot that has the best rice, then harvesting it for seed, (3) The rice is harvested on a sunny day around 1-3 o'clock, and the rice is not threshed (left intact with the panicles), and only briefly dried in the sun.

3.9.1. Uma Bileng Anddaleh

Literally, '*umabileng*' means green fields of rice. There is also another term that is commonly used, for example '*umatiga*'. The meaning of green in the Dayak Kenyah farming system also indicates that the rice is fertile and will bear good rice.

The '*umabileng*' farming system in the Kenyah Dayak is literally translated as 'environmentally and eco-friendly fertile fields'. This concept has existed since the days of the ancestors of farmers hundreds of years ago, but its implementation faces many obstacles because there is no one to organize field farmers in its implementation. In addition, another obstacle is that there is less government support due to the negative opinion that the cultivation system (*ladang*) damages forests and causes forest and land fires (Imang and Devung, 2019 and Panalo, 2015).

Furthermore, Imang and Devung (2019) added that the obstacles in increasing rice production and changing cropping patterns of upland rice include local knowledge and wisdom that has not been fully adopted so that it is not effective in increasing land productivity. Pests are difficult to control because the farmers and land allocation for *ladang* are not well-organized, patterns of field clusters are not organized either, productivity is low because of damage by pests, rotation and combination of plantation and livestock commodities have not been carried out because there is no one to organize it, there is lack of technical support and production and marketing facilities from the Regency Government and also from University.

The background of the '*daleh*' system of cultivation is mutual cooperation in which 10-20 cultivators open fields together in one landscape. By clearing fields in one larger landscape, farmers can have mutual-help, especially at the stages of farming and harvesting, and not limited to other stages of work.

The concept and stages of the *daleh* system are as follows: (1) some 4-10 farmers, whose fields are adjacent to each other, will form a group with the aim of helping each other in future, (2) each cultivator clears about one ha or more of land so that the land is large enough to be divided into 4 parts/plots or more. Each plot will be opened into fields in turns from the 1st year to the 4th year. In addition to planting rice, each farmer also plants plantation crops on former newly harvested fields, (3) the hut of each farmer is built in the middle of the field or other suitable location so that it is possible to raise livestock such as chickens, pigs or fish, etc., (4) since each hut is close to each other, if one of the farmers does not stay in the hut, he is returning home (usually for Sunday worship), the hut and all his livestock will be guarded by other cultivators who are members of the group. Pigs or chickens play an important role for the Dayak community in every traditional ceremony. Imang (2004) suggested that *daleh* is an alternative way to improve land productivity and still maintain the sustainability of the forest. By doing this way of farming, the farmers are expected no longer to clear larger forested land every year which leads to deforestation.

The picture below shows one hectare of land divided into 4 plots which will, later, be cleared for *ladang* starting from plot-1 to plot-4 in rotation or cycle every year.

Plot-1	Plot-3
Plot-2	Plot-4

Year	The Practices of <i>Daleh</i> Swidden Agriculture	Products to Harvest
1	Year-1 open Plot-1 to grow rice, corn, and vegetables at the same time. Farmers will build a proper hut. While waiting for the harvest of rice, farmer prepares facilities to raise pig and chicken. After rice harvesting, the farmer grows rubber, cacao and/or other annual and perennial crops in the ex-field just after the rice is harvested.	Rice, corn, cucumber, vegetables, chicken.
2	Year-2, Plot-2 is cleared to grow rice, cucumber, corn, vegetables at the same time. In year, there is no need to build a new hut/shelter because farmer will use the old one. Farmer continues to raise pig, chicken and/or fish. 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, farmers can also maintain crops that already planted in year-1, and raise livestock such as chicken or pig.
3	Plot-3 is open to grow rice, corn and vegetables at the same time. After rice harvesting, the farmer grows rubber, cacao and or other annual and perennial crops in the former swidden field after it is harvested.	Harvest rice, corn, vegetables, chicken, pig, fishes. In parallel, farmers keep maintaining crops that already planted in year 1-2.
4	Year 4, Plot-4 is cleared to grow rice. Farmer grows cacao, rubber or pepper or other annual and perennial crops. In parallel, the farmer also maintains crops they already planted from year 1 to year 3.	Harvest rice, corn, cucumber, vegetables, chicken, pig, fishes.

Table 2: Matrix of the Practice of *Daleh* Swidden Agriculture System

Source: Field Observation (2022)

4. Conclusion and Recommendation

Uma bileng and *daleh* are two ways of Swidden agriculture or shifting cultivation (*ladang*) that have been practiced by the Kenyah and Bahau Dayak for generations. During the practice of this ways of farming, they have implemented traditional knowledge and wisdoms at every stage, i.e. how to look for fertile land, how to fell big trees to get optimum biomass, the best day to planting, traditional pest control, and the last stage of harvesting including the treatment to have good quality rice for seed (*benih/beneq*) in the following year.

However, the farmers still lack in some stages of farming which need intervention and integration of agricultural science. For example, farmers still need to be assisted by the treatment of seeds by soaking rice seeds in a salt solution in order to obtain good quality seeds. Another example is how to increase soil fertility by fertilizing organically, such as liquid organic fertilizer (POC = *pupuk organik cair*). In order for the *daleh* and *umabileng* systems to work, it is necessary to have field agricultural extension that will organize and motivate farmers so that this system can work well.

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