Study of Biomass Management Systems for Agricultural Lands without Fuel and Friendly Environment in West Kalimantan

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Abstract. Almost every year in the dry season in West Kalimantan and other regions in Indonesia there are forest and land fires. The prolonged impact of El Nino has resulted in hundreds of thousands of hectares of land being burnt. Human health, destruction of plant and animal genetic resources, and huge economic losses. Therefore, it is necessary to open and manage land without burning and environmentally friendly. These methods include the biomangement system, namely the management of land resources by utilizing biodecomposers and human resource management by engineering institutions. Management of land resources by making a pile of grooves and decomposing biomass. This method in clearing and processing without burning the land but by arranging the trunks, branches and leaves of the remaining felling trees (biomass) into the trenches and then the biomass is decay using decomposers. The land can then be processed and ready to be planted with agricultural commodities such as rice, corn, soybeans, vegetables, and others. Human resource management by engineering institutions such as farmer groups or farmer group combinations, fire care communities and fire prepared communities play an active role in land clearing and land management without burning biomass. The results of the study showed that clearing paddy fields without burning biomass produced 5.7 tons of dry milled unhulled rice ha$^{-1}$ and 5.8 t ha$^{-1}$ of dry shelled corn.

1. Introduction
Smoke disasters in several regions in Indonesia such as West Kalimantan almost every year occur in the long dry season (El Nino). Several provinces on the islands of Sumatra and Kalimantan this year are quite alarming because of heavy smoke from forest and land fires. West Kalimantan Province was directly affected by thick smog due to forest and land fires. Thousands of hotspots were detected by satellites (HOTSPOT MODIS) in the West Kalimantan region. The Meteorology Climatology and Geophysics Agency (BMKG) of Pontianak Supadio, reported that there were 1,121 hotspots scattered in almost all regions [1].

The distribution of hotspots in West Kalimantan was the second largest after Central Kalimantan (Figure 1). These hotspots are scattered in all districts such as Sambas Regency 17 hotspots, Mempawah District 1 hotspot, Sanggau District there are 15 hotspots, Ketapang District 578 hotspots,
Sintang District 81 hotspots, Kapuas Hulu Regency 10 hotspots, Bengkayang Regency 1 hotspot, Landak District 3 hotspots, Sekadau District 5 hotspots, North Kayong Regency 216 hotspots, Melawi District 29 hotspots, Kubu Raya District 160 hotspots, Pontianak City 1 hotspot, and Singkawang City 4 hotspots (Figure 2).

Figure 1: Number of hotspots per province

Source: BMKG Supadio Pontianak Trust rate 51 - 100% Update: September 17, 2019

Figure 2: Map of hotspot distribution in West Kalimantan

Source: BMKG Supadio Pontianak, September 15, 2019
The prolonged impact of El Nino has caused hundreds of thousands of hectares of land to be burned, resulting in thick smoke that impacts on human health problems such as acute respiratory infections. Another impact due to forest and land fires is the destruction of genetic resources both plants and animals in the forest area on fire. Aside from that, thick smoke has limited visibility, causing daily community activities to be disrupted, including land, water and air transportation activities, which cause huge economic losses.

Rainwater potential in October to November in several regions in Indonesia is still low, including in West Kalimantan, so there is still the potential for forest and land fires. Therefore, to prevent forest fires from becoming more widespread, it is necessary to use land-burning and environmentally friendly methods or methods for clearing and managing land.

Land clearing and processing without burning land can be done with bio-management methods, namely managing land biophysical resources and managing human resources. Land resource management is carried out by clearing and clearing land by not burning but is carried out by utilizing biological agents in the form of decomposers that utilize decomposing bacteria to destroy biomass litter residue from felling trees and shrubs. The remaining biomass of the felling is stacked in predetermined grooves and then destroyed using decomposer bacteria, so that the decomposition results in compost that can be used as biofertilizer and environmentally friendly.

Land clearing and processing for agriculture can be done on upland or wetland, upland is land for agricultural cultivation that is not affected by the availability of water or water that is needed is limited depending on rain water or can also be called as rainfed land (upland), while land wet is agricultural land with almost all year water available. Understanding upland implies superior land which is the opposite of subordinate land (lowland) associated with drainage conditions [2]. Agreement on the definition of upland in a national seminar on the development of upland in Lampung: upland is a stretch of land that is utilized without flooding, either permanently or seasonally with water sources in the form of rain or irrigation water [3]. Definition given by Soil Survey Staffs (2017), upland is an expanse of land that has never been inundated or inundated for a period most of the year. This typology of land can be found from the lowlands (0-700 m asl) to the highlands (> 700m asl). From the above understanding, the types of land use included in the upland group include: rainfed land, dry fields, fields, mixed gardens, plantations, forests, bushes, grasslands, and alang-alang grasslands.

Wetlands are swamps, peatlands, and water areas, whether natural or artificial, are permanent or temporary, stagnant, static or flowing water that is fresh, brackish, or salty, including areas of marine in which at low tide no more than six meters [4]. Wetlands are areas that have permanent or seasonal saturated soils, which have shallow water layers. Meanwhile, there is another understanding of wetlands, namely land that falls into the category of land that is flooded or has a high-water content. Simply put, the definition of wetlands is where water meets land, such as mangrove areas, peatlands, swamps, rivers, lakes, deltas, floodplain areas, and rice fields. Land agroecosystems, both upland and wetlands, often occur fires during the long dry season.

Land clearing and processing for agriculture is the process of clearing land of trees, stumps, shrubs and other obstacles that are ready for agricultural business both for food crops, horticulture and plantations. Land clearing and cultivation without burning is meant the opening of upland and wetlands which is done by not burning from the remnants of felling (Biomass) but the biomass is decay with decomposer material through the process of decomposition of biomass material which is accelerated by using decomposer bacteria.

In the bio management system to improve soil fertility by providing ameliorant, namely by using biochar. Biochar can improve the chemical, physical, and biological properties of soils and contain complex functional groups, high affinity, and amorphous and durable in the soil [5] [6]. Biochar generally has alkaline pH, CEC, C-organic and high surface area [7] [8]. The absorption of water from biochar is high and resistant to the decomposition of microorganisms. These properties cause this material to have high nutrient retention thereby reducing nutrient leaching [9] [10]. Biochar in addition to high water retention, contains nutrients N, P, K, which can be absorbed by plants [11] [12].
Application of bio-fertilizer can utilize local resources that are quite a lot in the study location to be used as Micro Local Organisms (MOL) as liquid organic fertilizer. Addition of bio-ameliorant in the form of biological charcoal can improve physical, chemical and biological soil fertility [13]. Application of biochar oil palm shells with a dose of 2 t ha\(^{-1}\) can increase pH and reduce Al-dd of Ultisols in the Sungai Bahar Jambi. Subsequently reported by Omyani et. al., (2014) that the giving of 20 g of mycorrhizal fungi inoculum and 20 g of biochar per corn plant, as well as the addition of a 5% bio-stimulant solution from seaweed extracts can produce dried corn shells of 5.8 t ha\(^{-1}\). The purpose of this study is to find out how to clear and burn land without management through the application of environmentally friendly biomass management technologies for agricultural businesses.

2. Materials and Methods

2.1 Materials and Methods

This research was conducted on the stretch of land in dryland and wetland agroecosystems. Land clearing and processing is carried out on upland which is then planted with 5 ha of corn in Pawis Village, Jelimpo District, Landak District, West Kalimantan Province, Indonesia in 2018 and 2 ha in Mekar Baru Village, Monterado District, Bengkayang Regency, West Kalimantan Province, Indonesia in 2019. While wetlands land clearing and land management are carried out on 10 ha of peat tidal paddy fields which are then planted with rice in Sungai Daun Village, Selakau District, Sambas Regency in 2018.

The method of land clearing and land management uses several methods, namely manual and mechanical methods and a combination of manual and mechanical. The manual method uses tools such as saws, axes, machetes, hoes, plows, rakes and cultivators. While the mechanical way is using an excavator, tractor and chainsaw engine. Manual land clearing and land management is carried out on upland in the village of Pawis on young people’s palm oil plantations that are still young and have not yet produced using tools such as axes, machetes, hoes, and cultivators. While in Simpang Monterado Village land clearing and land management are carried out by mechanical means using excavators, tractors and chainsaws. Whereas land clearing and tillage in the wetlands are done manually using axes, machetes, hoes, and hand tractors in Sungai Daun Village.

Land clearing and clearing at these locations using machetes is carried out for the removal of shrubs and weeds, whereas for trees and shrubs use excavators, saws and axes. Logging of an economical tree is chosen first which can be utilized by the trunk of the wood, then after that another felling of another tree. Demolition of the stump is done using an ax. The biomass of branches, leaves and weeds left over from the felling is stacked in the trenches that have been made before and then decomposed by spraying the biomass using decomposer material (Figure 3). The biomass accumulation process is not carried out biomass burning, but the biomass is decomposed with decomposer material in the channels that have been provided. The biomass decomposition process is periodically controlled from weeds and pest sources such as rats and oryctes and diseases such as Ganoderma and others. Land management is carried out using a tractor perfectly so that the land is ready for planting.

On the cleared paddy fields, it does not burn the remaining straw of the rice plant, but rice straw is collected at the edge of the paddy field which is then composted (Figure 4). Rice fields that have been cleaned of straw are then processed perfectly using a tractor so that the paddy fields are ready to be planted with rice. A week before the paddy fields are planted with rice, the mature rice straw compost is returned to the paddy field as organic fertilizer.
2.2. Method of Analysis

2.2.1. Before and after analysis

This study was an applied study at the level of demonstration technology readiness in the actual environment (demfarm). Therefore, the framework for the study of biomass management on land clearing and tillage without burning and environmentally friendly begins with the identification and characterization of the region. Before the study activities, an analysis of the existing conditions of drylands and wetlands was carried out and interviews with farmers in each of the locations specified above. Analysis of maize and rice farming was carried out on farmer's land which had cleared land by burning land in the previous year, while demfarm studies were carried out on the same land, but land clearing and land management were carried out without burning and utilizing biomass as ameliorant in the rice and corn farming system. The existing condition is compared with the condition of rice and
corn farming after the application of biomass management technology in land clearing and tillage without burning and environmentally friendly

2.2.2 Participatory rural appraisal (PRA)
Another analysis method used in this study is a participatory approach through Participatory Rural Appraisal. This participatory method characterizes the constraints, potential and opportunities for developing a biomass management system for land clearing and land management without burning for agricultural businesses in farmer groups or farmer groups (gapoktan). This method is carried out to accommodate local wisdom and integrate with the technology applied in order to maintain continuity in the development of a biomass management bio-management system on land clearing and tillage without burning.

Participatory methods are also carried out in the identification and characterization of the biophysical conditions of the study area and the socio-economic and institutional conditions of farmers, and farmers' preferences, especially methods without land burning and the type farming desired by farmers.

2.2.3. Initiation of farmer economic institutions
The method of initiation of farmer economic institutions, institutional Cooperatives or Village-Owned Enterprises (BUMDes) accelerated methods of institutional initiation to support sustainable farming. Institutional initiation by holding meetings of the management and members of the farmer groups and joint farmer groups (gapoktan) involving groups of Fire Concerned Communities, Fire Alert Communities and other relevant agencies.

2.2.4. Demonstration farming assessment
The demfarm study begins with soil sampling to determine the biophysical condition of the land carried out at a predetermined location to be analyzed in the laboratory to determine the technological package applied, especially the dose of inorganic or organic fertilizer and the amount of bio-ameliorant used. The technology package is applied as follows:

| No. | Technology components | Before treatment | After treatment |
|-----|-----------------------|------------------|----------------|
| 1.  | Land clearing         | Land burning     | System stack grooves on unburned |
| 2.  | Soil processing       | No dirt          | No dirt        |
| 3.  | Biomass treatment     | none             | Decomposer of corn biomass |
| 4.  | Corn varieties        | local            | The superior varieties of Sukmaraga |
| 5.  | Planting              | Normal (70 x 20 cm) | Jajar Legowo 2:1 (100-50) x 20 cm |
| 6.  | Seed treatment        | none             | Fungicide and Mycorrhiza |
| 7.  | Organic matter        | none             | Compost 5 t/ha |
| 8.  | Fertilization         | Urea 200 kg/ha, TSP 50 kg/ha and KCl 50 kg/ha | Application of Urea fertilizer 200 kg/ha, TSP 100 kg/ha and KCl 50 kg/ha. |
| 9.  | Ameliorant            | The remaining ash of land combustion | Lime 1 ton/ha |
| 10. | Control of a pest crop organism | Pesticides | Integrated and environmentally friendly pest control |

Table 1: The technology package of corn farming system is a growing gap in the land of Perkebunan palm oil without burning land in the village Pawis Jelimpo District Landak, West Kalimantan Province, Indonesia.
| No. | Technology components | Before treatment | After treatment |
|-----|-----------------------|------------------|-----------------|
| 1.  | Land clearing         | Land burning     | System stack grooves on unburned |
| 2.  | Soil processing       | None             | None            |
| 3.  | Biomass treatment     | None             | Decomposer of corn biomass |
| 4.  | Corn varieties        | Local varieties  | The superior varieties of Sukmaraga |
| 5.  | Planting              | Normal (70 cm x 20 cm) | Jajar Legowo/row 2:1 (100-50) cm x 20 cm |
| 6.  | Seed treatment        | None             | Fungicide and Mycorrhiza |
| 7.  | Organic matter        | None             | Compost 5 t ha⁻¹ |
| 8.  | Fertilization         | Urea 200 kg ha⁻¹, TSP 50 kg ha⁻¹, and KCl 50 kg ha⁻¹ | Application of Urea fertilizer 200 kg ha⁻¹, TSP 100 kg ha⁻¹ and KCl 50 kg ha⁻¹. |
| 9.  | Ameliorant            | The remaining ash of land combustion | land is not burned and Limed 1 ton ha⁻¹ |
| 10. | Control of a pest crop organism | Pesticides | Integrated and environmentally friendly pest control |

**Table 2:** Package technology of corn farming system in upland without land burning in the village of Mekar Baru, District Monterado, District Bengkayang, Province of West Kalimantan, Indonesia.

| No. | Technology components | Before treatment | After treatment |
|-----|-----------------------|------------------|-----------------|
| 1.  | Land clearing         | Land burning     | The system of unfired stack grooves |
| 2.  | Soil tillage          | None             | Perfectly tillage |
| 3.  | Biomass treatment     | None             | Decomposer Delivery |
| 4.  | Varieties             | Local Varieties  | Varieties of Lamuru |
| 5.  | Planting distance     | 50 cm x 20 cm    | 70 cm x 20 cm    |
| 6.  | Seed treatment        | None             | Fungicides |
| 7.  | Application of organic matter | None | Compost 5 t ha⁻¹ |
| 8.  | Fertilization         | Urea 200 kg ha⁻¹, TSP 50 kg ha⁻¹, and KCl 50 kg ha⁻¹ | Addition Fertilizer of N P K 450 kg ha⁻¹, Urea 150 kg ha⁻¹, and TSP50 kg ha⁻¹. |
| 9.  | Control of a pest - crop organism | Pesticides | Integrated and environmentally friendly pest control |

**Table 3:** Package of technology of rice farming system in the field of paddy land without burning the land in Sungai Daun Village, District Selakau, Sambas Regency, West Kalimantan Province, Indonesia.

2.2.5 **Data analysis**
The parameters observed were the results of the productivity of maize and rice per hectare on land in conditions before and after the treatment of technological applications without fuel and environmentally friendly.
3. Result and Discussion

3.1. Location of Pawis Hilir Village, Jelimpo District, Landak Regency, West Kalimantan Province, Indonesia

Field observations on crop types, productivity, farming constraints and opportunities for improvement that the three main crops cultivated by the community in the Pawis Hilir Village area were oil palm, rubber, cassava, corn and vegetables. However, the average production produced especially for corn plants was still low, only reaching 1.7 t ha\(^{-1}\). Communities in Pawis Hilir Village in their agricultural business there were still some community members doing land clearing by burning land. Survey results showed that farmers generally still did not utilize the technology recommended by the Field Agricultural Extension Officers or the relevant agency (Dinas). As in the cultivation of corn cultivation was not using superior varieties or still using local varieties or old varieties. Fertilization of corn plants had not paid attention to a balanced fertilization method and utilized local resources such as utilizing organic fertilizer from waste/biomass.

The results of the harvest calculation of corn farming activities as intercropping on oil palm plantations without burning the land with a technological package produced include the use of Sukmaraga varieties, balanced fertilization and addition of ameliorant in the form of 1 t ha\(^{-1}\) lime and 5 t ha\(^{-1}\) of compost can produce corn of 5.8 t ha\(^{-1}\) dry shelled which is planted monoculture and which is intercropped with oil palm plants produces corn of 4.15 t ha\(^{-1}\) (Figure 5).

These results indicate that maize plants in land clearing without burning land and planted in monoculture can produce dry shelled corn of 5.8 t ha\(^{-1}\) and if planted as an intercrop in oil palm plantations can produce 4.15 t ha\(^{-1}\). In the existing condition of maize cultivated by farmers by burning land and not applying the cultivation of corn technology recommended in the monoculture method of producing only 1.8 t ha\(^{-1}\) dry shelled and intercropping with oil palm produces 1.28 t ha\(^{-1}\) shelled dry.

![Figure 5](image)

**Figure 5:** Average productivity of corn without land burning and by burning land (existing) in Pawis Hilir Village, Jelimpo District. Landak Regency. West Kalimantan. Indonesia.

3.2. Location of Mekar Baru Village, Monterado District, Benngkayang Regency, West Kalimantan Province, Indonesia

There were still people of Mekar Baru Village who were farming traditionally by burning land in cleaning and tilling their land for agricultural business. Based on field observations, the average production of corn plants was still low, reaching only 1.4 t ha\(^{-1}\), while the results of studies conducted without burning land for corn farming by applying a technology package like in Table 2 can produce corn of 3.6 t ha\(^{-1}\). There was an increase in corn yield of 2.2 t ha\(^{-1}\) (157%) (Figure 6).
Figure 6: Average productivity of corn without land burning and by burning land (existing) in Mekar Baru Village, Monterado District, Bengkayang Regency, West Kalimantan, Indonesia.

These results indicate that maize plants in land clearing without burning land and planted in monoculture can produce dry shelled corn of 5.8 t ha\(^{-1}\) and if planted as an intercrop in oil palm plantations can produce 4.15 t ha\(^{-1}\). In the existing condition of maize cultivated by farmers by burning land and not applying the cultivation of corn technology recommended in the monoculture method of producing only 1.8 t ha\(^{-1}\) dry shelled and intercropping with oil palm produces 1.28 t ha\(^{-1}\) shelled dry.

Figure 7: Flow stack method in land clearing without burning in Mekar Baru Village Monterado District, Bengkayang Regency, West Kalimantan, Indonesia.

3.2.1. Location of Sungai Daun Village, Selakau District, Sambas Regency, West Kalimantan Province. Indonesia

Farmers in the Selakau District rice farming activities are carried out in paddy fields with rice planting twice a year (IP 200) using local superior varieties six months old in the rainy season and superior varieties in the dry season. Problems that often arise in rice farming, corn and other agricultural commodities there are farmers who still burn land in the clearing of their land besides rice is also often poisoned with iron, pests and diseases such as rat pests, blasts and neck blasts. From farming activities in the traditional way, the rice produced is still very low, around 1.2 t ha\(^{-1}\). Therefore, we need a touch of rice cultivation technology that can increase land productivity and rice crop productivity without burning land. The results of the study of rice farming without land burning can produce rice of 5.7 t ha\(^{-1}\) (Figure 8).
3.3. Initiation and Institutional Strengthening

Institutional initiatives at the village level, such as farmer groups, fire care communities, fire alert communities and other institutions, are intended to continuously support the process of continuing land clearing without burning. If these institutions at the village level have not yet been formed, they need to be formed. However, if there are already institutions, these institutions need institutional strengthening by holding regular meetings to discuss and discuss problems, especially looking for solutions to prevent and overcome land and forest fires. Discussion of meetings from on-farm activities to off-farm activities, post-harvest handling to marketing the results are managed in groups (farmer groups or farmer groups).

Figure 8: Average results of rice p without land burning and by burning land (existing) in Sungai Daun Village, Selakau District Sambas Regency, West Kalimantan, Indonesia.

Figure 9: Management of rice straw biomass into compost in paddy fields
4. Conclusion

Land clearing and processing for agriculture did not have to be done by burning the land but can be done in a way that was not felled and environmentally friendly, namely by the method of stacking grooves and decomposition of biomass from crop residues such as rice germ and corn. This method was considered effective enough to avoid forest and land fires let alone supported by strong institutions, such as farmer groups and farmer groups (gapoktan), fire care society and fire alert society with the spirit of mutual cooperation in the effort to open and cultivate land for agricultural business.

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