
ABDIMAS

Jurnal Pengabdian kepada Masyarakat
<https://journal.unnes.ac.id/nju/index.php/abdimas/>

Dissemination of the Agroecological Model of Alang-Alang Land Reclamation to Increase Land Productivity

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Abstract

Using reed land for agriculture and improving productivity is cheaper than clearing forests because clearing new forests negatively impacts environmental quality. Reed control technology combined with an agroecology approach is expected to ensure a sustainable eradication of reed populations followed by technical culture and food crop cultivation patterns throughout the year. This community service program can solve food production problems, land fertility, and other environmental impacts. Community service program solutions can classify reed land based on land quality, educate the community in using reed land reclamation techniques in ready-to-plant land blocks, evaluate the skills of farmers/communities based on crop production in reed reclamation blocks, and involve the community in naming superior and environmentally friendly agricultural varieties in the la block program solutions can classify reed land based on land quality, and educate the community in using reed land reclamation techniques in ready-to-plant land blocks, evaluate farmer/community skills based on crop production in reed reclamation blocks, and involve the community in naming superior and environmentally friendly agricultural varieties in reed reclamation blocks.

Keywords: dissemination, environmentally friendly, land productivity, reeds

INTRODUCTION

Farmer Group Partners in Two Hamlets in Wayame Village, namely Kranjang Hamlet, Wayame Village, Ambon City, have so far not made massive use of reed land. Agricultural intensification activities are still on limited land which continues to experience a decline in soil fertility levels due to intensive crop rotation. The area of alang-alang land in Mitra Hamlet is quite large, but the farming community does not yet understand the technology of alang-alang reclamation as an alternative land use for the extensification of agricultural farming businesses, especially in supplying optimal agricultural and livestock products.

The main problems with alang-alang land include; (1) the rate of land conversion which has negative impacts on the physical, chemical and biological properties of the soil, and (2) limited agricultural land resources in meeting food needs at the village level, and (3) the anomalous phenomenon of climate change, giving rise to agricultural productivity. become limited. This problem is further exacerbated by farmers' habit of clearing land using a slash and burn system, thereby damaging the soil ecology, especially in the plant root zone. To overcome soil damage due to farmers' bad habits of clearing land, the development of alang-alang land reclamation models that can improve and increase soil productivity is aimed at developing. To build a sustainable agriculture on reed land. So it is necessary to carry out research to determine suitable land reclamation models, appropriate planting patterns, and commodities that have superior value.

Building sustainable agriculture according to Sinukaban (1991, 1994) is to implement an agricultural system that integrates conservation techniques aimed at increasing farmers' income and is environmentally friendly. The solution offered is the development of alang-alang land reclamation models and planting patterns based on agroecological zoning so as to improve soil

properties, adapt planting patterns that are preventive against soil erosion and environmentally friendly .

This PKM program was inspired by the technology application of the PKM Team from LPPM Pattimura University in 2018, which partnered with farmers/breeders in Keranjang Hamlet in using cocoa pod shell waste as a mixture of free-range chicken feed for free-range chicken farming businesses. Other technological applications such as making feed, making herbal medicines, hatching methods, and methods for collecting free-range chicken feces to make solid organic fertilizer really support the production process. The three programs carried out by the PKM Team are presented in Figure 1, then became the rationale for expanding the strategic program of the Mitra Village Service Program in 2019 by looking at Kranjang Hamlet as a center for agricultural and livestock production and the problem of limited productive land and soil fertility which supports the extensification program and intensification of superior agriculture and livestock in Maluku Province.

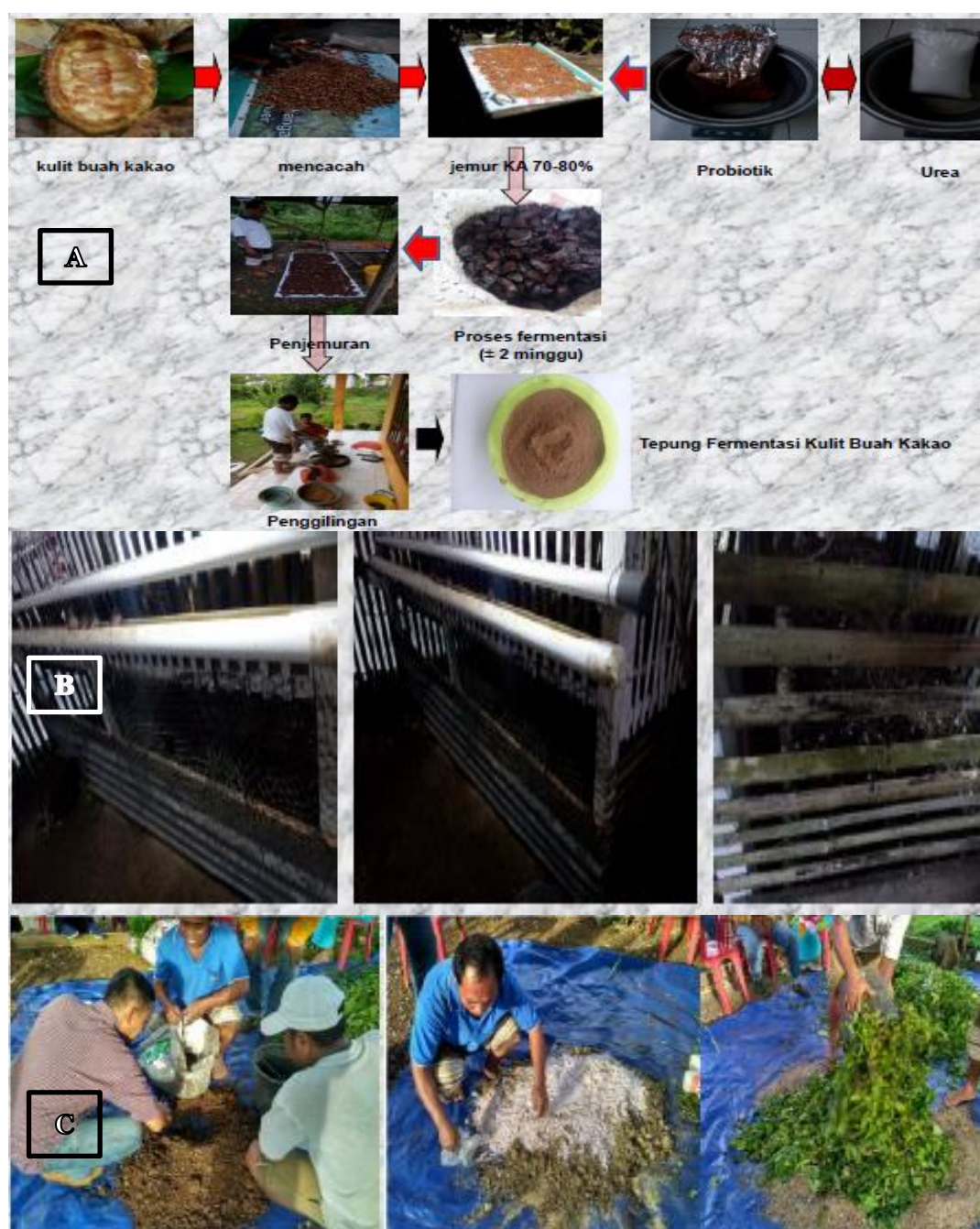


Figure 1. (A) Application of the use of cocoa pods for chicken feed; (B) Chicken manure as a source of compost material; and (C) Making compost from chicken manure

Land conversion is actually not a new phenomenon in human life. This phenomenon has been going on for a long time, and is considered to be a big problem when it results in environmental damage and touches on the issue of human survival. In line with population growth, land control and use becomes disturbed and begins to be considered problematic. This raises the complexity of problems due to explosive population growth, the discovery and use of technology, and the dynamics of development. Land which originally functioned as a medium for growing crops (agriculture), is slowly changing into multi-functional use (Adiningsih and Mulyadi, 1993). The specific change from agricultural use to non-agricultural use, known as *land conversion*, is increasing day by day. If the conversion of agricultural land is uncontrolled it can threaten food supply capacity, and in the long term it can even create a social disaster.

One of the impacts of land conversion is the increasing area of reed land. The area of reed land in Indonesia reaches 8.5 million ha or around 4.47% of Indonesia's territory. Alang-alang land is increasing in area along with population growth, where the increase in population demands the availability of agricultural and residential land, so that the fallow time for land becomes increasingly shorter. The shorter the fallow, the more the cleared land tends to become overgrown with weeds. Alang-alang land is marginal land, because without high input, it only produces low production and is not profitable or detrimental to farmers, so the land is often abandoned (Purnomosidhi et al, 1998).

Judging from its area, alang-alang land is potential land for development in agricultural land extensification programs (Zaini and Lamid, 1992). In utilizing reed land for seasonal crop farming, constraints such as poor physical, chemical and biological soil properties must be taken into consideration. This problem is exacerbated by farmers' habit of clearing land by burning and throwing organic material outside the land, which causes poor soil properties such as: bulk density (1.22 g cm^{-3}), aeration (9.65% by volume), C-organic (1.67 %), CEC (3.3 cmol kg^{-1}) and total microorganisms $3.96 \times 10^6 \text{ spk g}^{-1}$. Low soil fertility results in low land productivity (Sudharto et al., 1992).

Burning has caused a decrease in the organic matter content of the soil which in turn reduces the biomass of soil microorganisms in the top layer. To overcome soil damage due to the bad habits of farmers clearing reed land, a reed land reclamation model is needed that can repair and increase land productivity (Mulyani, A., 2005). For sustainable agricultural development on reed land in Wayame Village, Teluk Ambon District, it is necessary to develop an agroecological model of land reclamation to increase land productivity.

Based on the description above, this paper aims to disseminate the development model agroecological zonation of alang-alang land reclamation in Wayame Village (Kranjang Hamlet) through educating on models of alang-alang land reclamation based on land quality, and identifying models of alang-alang reclamation and classification of their use on productive agricultural land based on farmer groups.

METHODS

The PKM program in Wayame Village will build a base for activities to develop agroecological zoning for reed reclamation in three models. Land clearing techniques that have been practiced by partner village communities are relevant to Figure 2.

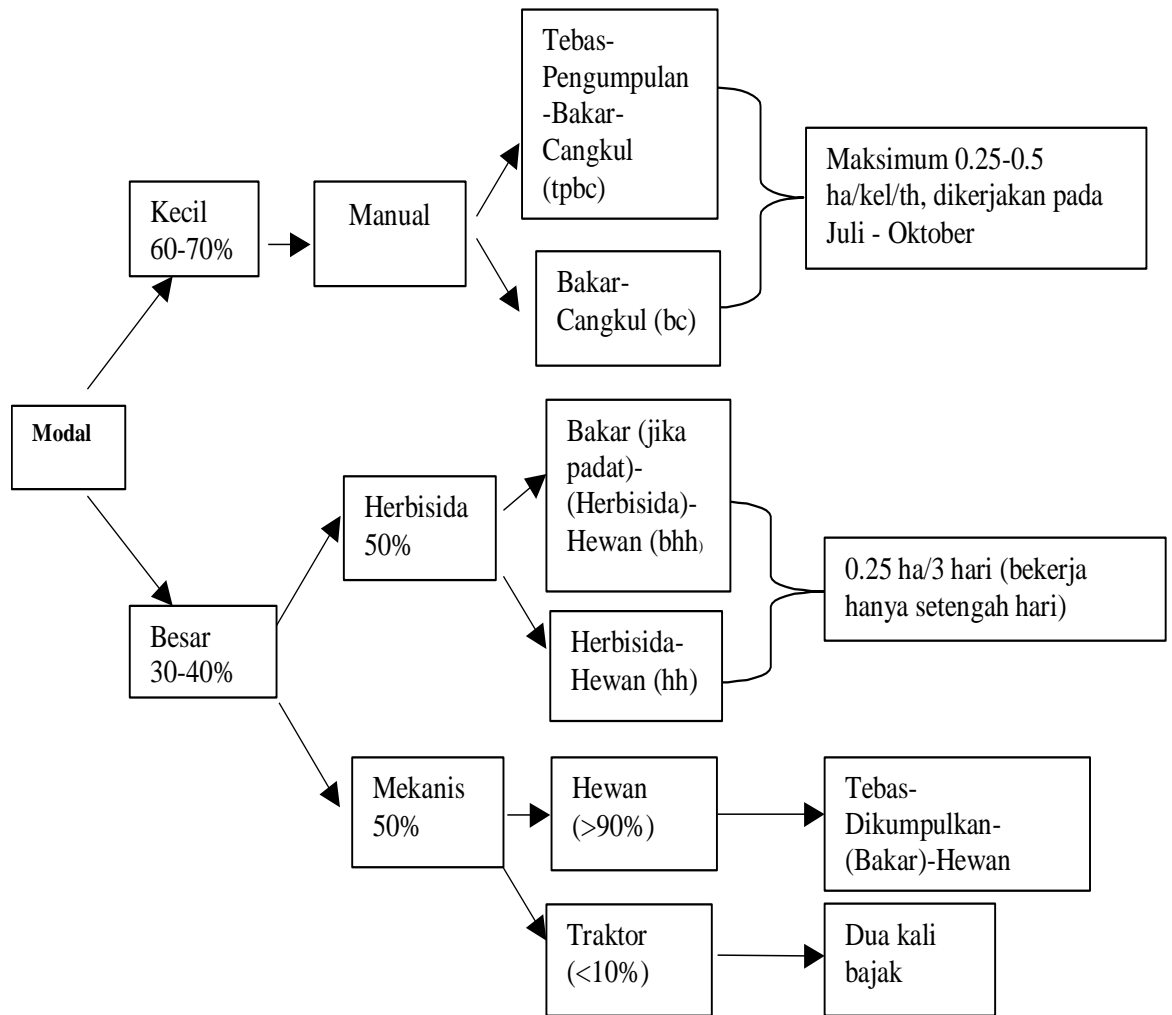


Figure 2 . How to clear reed land by farmers (Purnomosidhi and Rahayu, year)

This PKM program then combines land clearing practices by partner village communities in the flow of preparing a 1:50,000 scale agroecological zone (ZAE) map using descriptive methods based on *desk study* and survey activities. The principle of this method is based on the *landscape mapping approach*, namely delineating land units and interpreting aerial photos or satellite images. The preparation of the ZAE map is based on two main components, namely physiography or the shape of the region and land (Sulaeman and Mulyani, 2014).

Land resource characteristic parameters distinguish zoning into 7 main zones, namely: zone I, zone II, zone III, zone IV, zone V, zone VI, and zone VII. The division of main zones I, II, III, IV, is based on slope class with slope class divisions (%) respectively, namely: Slope > 40%; 16-40%; 8-15%; and < 8%. Zones V, VI, and VII are combined by soil type. The three main zones V, VI and VII have the same slope class, namely <8%. Specifically for zone VII, apart from soil type, it is also combined with drainage class, namely fast, rather fast and very fast classes (Rachim and Arifin, 2011).

Land block planting activities carried out in the field use a split plot design (RPT), where the *alang-alang* land reclamation method (R) is the main plot, and the planting pattern (P) is a sub plot with the following treatments:

Main plot (R): 4 ways of land reclamation, namely:	
R0	The reeds are burned and the land is processed conventionally (the soil is hoed and chopped once), a technique usually used by farmers.
R1	The reeds are cleared, cut to approximately 20 cm, used as mulch 10 tons/ha, plant residues used as mulch and the soil processed conventionally + P-natural flour 1 /ton/ha
R2	The reeds are cleared then the leaves and rhizomes of the reeds are composted and the soil is treated with conventional + lime CaCO ₃ 1 ton ha ⁻¹ + manure 10 tons/ha/year or 7.6 tons BKM/ha which is given 2.53

	tons BKM/ha/ every year every planting season and add reed compost (7 tons/ha) to MT2 and plant residues are used as mulch and a mixture of cow feed, then the cow dung is returned to plot R2.
R3	The reeds are sprayed with systemic herbicide Round up then the reeds are laid down + the remaining crop harvest is used as mulch, the soil is cultivated minimally according to the rows of plants
	Subplots (P): 4 planting patterns, namely:
P1	The planting patterns usually used by local farmers as a comparison are long beans, beans →, →chili, →celery
P2	alternative planting patterns (I) Eggplant →, beans →, long beans, →corn ;
P3	Alternative planting patterns (II) crop rotation Sekata →Mustard greens →Hiaju mustard greens →Tomatoes →Chilies ; Mustard →Chili →Tomato →Kale ; Pakcoy →Cabbage →Tomato →Chayote; and Tomato →Mustard →Pakcoy →Chilli →Sekata →
P4	Alternative planting pattern (III) rotation of peanuts + long beans/- soybeans + corn - green beans. This alternative planting pattern uses plants that are suitable for the biophysical conditions of the local area and have economic value and have a high price on the market. The + sign means intercropping; sign - planted sequentially. To support and increase farmers' income, apart from food crops, farmers also planted 80 citrus plants, 120 rubber plants, and king grass. Three local cows are kept for fattening; cow feed is taken from king grass strips and part of the plant residues from plot R2; cow dung is returned to the R2 plot, which amounts to around 7.6 tons of BKM /ha/year.

RESULTS AND DISCUSSION

The Community Service Program (PKM) in Kranjang Hamlet, Wayame Village was carried out using a field observation approach (purpose sampling technique) for 60 farmers involved in the Subur Farmer Group. Various Businesses One and Two. The characteristics of respondents based on age are dominated by productive age 21-50 years at 70%, where women and men have relatively full contributions in agricultural activities. Characteristics of farmers based on and level of education is dominated by high school education at 60%, and occupation is dominated by 81.7%, dominated by farmers/farm laborers, and income is dominated by 70%, ranging from IDR 3,000,000 to IDR. 5,000,000 per month, and the number of family dependents is 75%, ranging from 3-5 people, with a length of time involved in agriculture ranging from 21-45 years, 60%. Finally, 53% of farmers' groups were quite active.

Land processing for agricultural activities in the farmer's view is that agricultural land in Kranjang Hamlet is relatively fertile. The profile of agricultural land based on physical, biological and chemical soil properties is relatively good, especially in mountainous areas. However, agricultural land near community settlements experiences agricultural intensification and extensification periodically. Land that is continuously planted will experience conditions that are relatively poor in nutrients and even experience a massive decline in fertility. Farming groups are very aware of land conditions like this. Therefore, reed reclamation techniques are also a conscious concern for farmers before land clearing and also crop rotation systems in accordance with soil fertility conditions.

The PKM program organized by the Environmental Science Study Program, Department of Forestry, Faculty of Agriculture, Pattimura University, began its activities by conducting field observations to identify how much reed reclamation technology has been adopted by the Subur and Aneka Usaha farmer groups in increasing land productivity and agricultural products on land. agriculture that has been cultivated through agricultural intensification and extensification. Furthermore, the results of field observations then become targets and solutions to problems related to the effectiveness of adopting reed reclamation technology to increase land fertility and agricultural productivity in Kranjang Hamlet through an outreach approach and demonstration of reed reclamation technology and an economical and environmentally friendly crop rotation system.

Reed reclamation techniques in Kranjang Hamlet

The area of farming land in Kranjang Hamlet, Wayame Village varies in three categories, namely Small (less than 1 hectare) at 30%, Medium (2-5 hectares) at 51.7% and Large (more than 5 hectares) at 18.3% , with business capital dominated by Medium (IDR 5,500,000 to IDR 10,000,000 per harvest) at 61.7%, followed by large capital (more than IDR 10,000,000 per harvest) at 21.7% and small capital (less than IDR 5,000,000 per harvest) of 16.7%. Farmers in Kranjang Hamlet also adopted three types of reed reclamation techniques, namely conventional

(18.3%), herbicides (50.0%) and mechanical using tractors (31.7%) .

Conventional manual reed reclamation techniques , namely this system, tend to require a lower initial investment compared to mechanical farming techniques. Manual equipment such as hoes, sickles, and other hand tools are generally more affordable and allow farmers on a limited budget to start an agricultural business. Meanwhile, the disadvantage of adopting manual farming techniques is that productivity tends to be lower compared to mechanized farming techniques. Manual equipment generally cannot work as efficiently and quickly as modern agricultural machinery. According to farmers in Kranjang Hamlet, the disadvantages of using conventional reclamation techniques include: conventional manual techniques require a relatively long time and are energy-intensive, from clearing land to harvesting agricultural products, and there are also obstacles related to climate and weather, such as water shortages.

The herbicide reclamation technique of reeds has a weakness, namely that there are concerns about the side effects of using herbicides in the form of poison. The types of herbicide that are generally used in Kranjang Hamlet are *gramasson* , which was used at the beginning of clearing agricultural land, especially on fairly dense reeds, but was no longer used thereafter. The advantages of adopting the reed reclamation technique using herbicides include: helping to eradicate the reeds quickly, saving costs, time and energy compared to the manual system. However, farmers limit the use of herbicides to the plant maintenance phase by not using herbicides carelessly.

Mechanical reed reclamation techniques (tractor engines) have advantages namely, mechanical reed reclamation techniques often increase agricultural productivity. Modern machines can help and speed up the stages of productive farming processes such as planting, watering, irrigation and harvesting effectively and efficiently, producing greater results in a shorter time, especially in terms of cost and energy efficiency. The use of agricultural machines and equipment allows for faster and more efficient work compared to traditional, more manual methods. This saves farmers time and energy. The downside is operational costs and the cost of replacing equipment if it is damaged. Adoption of mechanical reed reclamation techniques may result in the loss of traditional skills required in agriculture. This can reduce farmers' knowledge and skills in conventional farming methods, which can harm sustainability and agriculture. Agricultural machinery and necessary equipment have high initial costs. Investing in these machines can be an obstacle for farmers with limited resources. However, adopting machines still requires manual equipment such as hoes, especially on land with rocky soil conditions.

Land clearing system and agricultural system in Kranjang Hamlet

The land clearing system according to respondent farmers in Kranjang Hamlet includes several models, namely (1) the manual Slash and Burn Hoe →Collection (TPBC) →system →; (2) Manual Bakar →Hoe (BC) system; (3) Herbicide system: Burn Animal →Herbicide →(BHH); (4) Herbicide system: →Animal Herbicide (HH), (5) Animal mechanical system: Slash and Animal →Burn →collection →, and (6) Mechanical system using Tractors.

, the land clearing system using the manual Slash and Burn Hoe Collection (TPBC) system **is →rarely →adopted →by** respondent farmers (53.3%), followed by 28.3% who always adopt it when clearing land and 18.3% who never adopt it. According to farmers, this manual land clearing system consumes more time and energy during the long land clearing process. Farmers who have limited resources still adopt this system because it adapts to family capabilities. This percentage illustrates that the farming capital owned by farmers in Kranjang Hamlet is still relatively limited so that adoption of this system is still relatively dominant among farmers.

Land clearing using the dominant **Bakar →Hoe (BC) manual system** is 46.7% never adopted, 31.7% always adopted and 21.7% rarely adopted. The land clearing system using the burn and hoe system is starting to be abandoned, followed by a more environmentally friendly and cost-effective land clearing system. The collection of grass cutting residue is used for compost, and farmers never use animal power.

Land clearing uses a herbicide system, **Animal Herbicide →Burn (BHH) →**never (38.3%), always (33.3%) and rarely (28.3%). Farmers' understanding of using a herbicide land clearing system with this system is that the process of using chemicals is faster and very beneficial for the plant growth process. The application of herbicides for dense reeds but does not use animal power, is never done using animals or herbicides because it is expensive and The

location is quite strategic and herbicides help facilitate the garden sanitation process.

Animal mechanical land clearing: Animal **Herbicides →(HH)** are rarely adopted 45%, followed by always 30.0% and never 25.0%. The view of farmers using herbicides and animals is that this system is quite good and beneficial for plants by using goat manure as drum fertilizer. The adoption of non-burning herbicides has been carried out since 8 years ago by farmers in reclaiming reeds before planting. Some farmers do not use animal power, but use domestic goat manure as natural compost

Land clearing uses a mechanical animal system: **Slash →collection →Burn The dominant →animal** is rarely adopted at 41.7%, followed by never at 31.7% and always at 26.7%. The adoption of reed reclamation techniques using this system has never been carried out using animals or herbicides because it is expensive and the location is quite strategic. The final land clearing system using tractors was dominated by always 60.0%, followed by never 35%, and rarely 5.0%. Some farmers use the Honda Still 3001 series tractor specifically for cultivating the land. The work volume using a tractor is greater. The advantage of land processing (alang reclamation) is using a mechanical system because the system works very quickly and the reeds are rare and even using reed mulch is quite effective in eradicating the reeds. The land clearing system using tractors in land processing can save time and energy compared to manual methods. Tractors can carry out larger tasks in a relatively shorter time, thereby speeding up the land processing process. Meanwhile, using a tractor and supporting equipment can be expensive in terms of purchasing, maintenance and repairs. High initial investment and operational costs can be an obstacle for farmers or land owners who cannot afford it. The advantages of tractors make it possible to cultivate land on a large scale. They can be used for plowing, weeding, and performing other tasks in a more time efficient manner on large areas of land. Improper or excessive use of a tractor can cause damage to the soil structure. Tractors that are too heavy or used in damp soil conditions can cause soil compaction and land degradation.

Agricultural land or crops obtain relatively good results. The physical properties of soil are the factors responsible for the transport of air, heat, water and dissolved materials in the soil. Soil physical properties vary in tropical soils. Some physical properties of soil can change with processing such as soil temperature, permeability, sensitivity to surface runoff, and erosion, the ability to bind water and supply water to plants. Continuous management of agricultural land in various cropping rotations can increase the bulk density of the soil, which is indicated by an increase in the bulk density value of the soil.

The land plowing system uses a tractor for farmer groups that have large arable areas, usually plowing the land twice for one land processing. The production of agricultural products obtained is relatively high, and the efficiency of time, energy and costs is relatively commensurate with the relatively high productivity. Farming groups use mechanical reed reclamation techniques by adopting land management rules that lead to environmentally friendly agriculture. The land burning system is starting to be avoided in farmer groups assisted by CSR Pertamina and supported by agricultural extension workers in Maluku Province. The fertilization system uses 2 tonnes of manure per ha plus dolomite lime at a concentration of 250 kg per hectare (Trikodekma). The fertilizer application system is very dependent on the condition of the land and plants. For example, fertilizing pak choy plants 20 days after planting, and generally fertilizing horticultural plants is done 2 weeks after planting depending on the type of plant. Reeds have potential as a botanical pesticide containing active compounds of alkaloids, flavonoids, steroids, terpenoids and tannins. The potential of reed infusion as a disease control agent in horticultural plants and its effect on plant growth.



Figure 3. Stages of reed reclamation and land clearing

Crop rotation system in Kranjang Hamlet

Many horticultural plants are cultivated in Kranjang Hamlet, Wayame Village, including: tomatoes, chilies, beans and other vegetables. Crop rotation is the practice of planting various types of plants in turns on one piece of land. Cropping rotation is a planting pattern that is carried out in turns in a certain time sequence. Farmers often apply rotation to prevent the development of pests and diseases, maintain and improve soil fertility (availability of nutrients and physical properties of the soil) and reduce land erosion, increase water and nutrient retention and reduce the need for chemical fertilizers through planting legumes, controlling weeds, improving soil structure.

The crop rotation system has developed in Kranjang Hamlet, Wayame Village, Ambon City, including five types of crop rotation based on the market prospects of superior horticultural crops that are in demand in the Ambon City market. The five types of horticultural crop rotation include: (1) **Long beans** , →beans, →chilies, →Celery ; (2) **Eggplant** →, beans →, long beans, →corn ; (3) **Sekata** →mustard greens →Hiaju mustard greens →Chili tomatoes →; (4) **Mustard greens** →, →tomatoes, →kale ; (5) **Pakchoy** →Cabbage →Tomato →Chayote ; and (6) **Mustard** →Tomato →Pakcoy →Chilli →Sekata →as presented in Table 6 .

Horticultural crop rotation system (1) **Long beans**, →beans, →chilies, →celery , according to 53.3% of farmers, are rarely adopted in their farming. This is because . Rotation system (2) **Eggplant** , →beans →, long beans, →corn 46.7% never adopted, 31.7% always adopted and 21.7% rarely adopted. Crop rotation system (3) **Mustard** →Sekata **Mustard greens** →Hiaju →Tomato →Chili shows that 38.3% of farmers never adopt it, followed by 33.3% always adopt it and 28.3% rarely adopt this system. The crop rotation system (4) **Mustard** →Chili →Tomato →Kangkung shows that 45% are rarely adopted, 30% are always adopted and 25% are never adopted. The crop rotation system (5) **Pakchoy** →Cabbage →Tomato →Chayote shows that 41.7% are rarely adopted, 31.7% are never adopted and 26.7% are always adopted. Crop rotation (6) **Tomato** →Mustard greens →Pakcoy →Chilli →Sekata →shows that 60% always adopt this crop rotation system, 35% never adopt it and 5.0% rarely adopt it .

The application of crop rotation has a role in several aspects, including: agronomy, economics and the environment. Proper crop rotation can increase soil organic matter, improve soil structure, reduce soil degradation, and can increase crop yields so that agricultural profits are greater in the long term. The benefits and advantages felt by farmers in planting with a rotation system are increasing soil fertility, making it easier to cultivate the land, reducing evil weeds, and reducing the risk of pest and disease attacks on plants. Crop rotation also prevents the accumulation of pathogens and pests that often attack one species. Crop rotation also improves the quality of soil structure and maintains fertility by alternating between deep-rooted plants and shallow-rooted plants. Crop rotation is part of polyculture.

CONCLUSION

Alang-alang land is land that has the potential to be developed, and has a low level of soil fertility, so efforts are needed that can support increasing land productivity. Alang-alang can grow on soil with various nutrients, moisture and pH, although sometimes weeds in the soil poor or marginal. Reeds dominate due to the lack of competition from other types of plants that cannot survive in shady soil. However, sedges do not tolerate shady environments due to carbon assimilation through the C4 photosynthesis pathway. Reeds have an allelopathic effect through the release of toxic substances mainly from rhizomes that delay germination and inhibit the growth of other plants. The dried product of willang reeds interacts with agricultural plants. This means that allelopathic activity influences the development of plants that compete with reeds.

The area expansion program can only utilize critical land. Meanwhile, the intensification program carries out good processing. One of the recommended soil treatments is intensive tillage and conservation tillage. Tillage is any mechanical manipulation of the soil to create good soil conditions for plant growth. The main purpose of tilling the soil is to prepare a place for seedlings to grow, create a good root area, bury plant debris and eradicate weeds. Minimum tillage is land cultivation that is carried out on a limited basis or as necessary without tilling the entire land area. Tilling the soil is an action that has the aim of eradicating weeds, inserting and

mixing plant residues into the soil and loosening the soil so that it is in the processing condition required by the roots and ultimately will increase air circulation, water infiltration, root growth and uptake of nutrients by the roots. Land cultivation as a whole, apart from being less efficient, will also cause land degradation so that the carrying capacity and productivity of the land decreases, which in the long term will cause the agricultural system to be unsustainable. The disadvantages caused by intensive soil in the long term are that it harms surface soil granulation, accelerates oxidation and the implementation of soil processing with heavy equipment tends to damage stable soil aggregates and accelerates the oxidation of organic matter in the soil. Excessive tillage can accelerate the decline in soil fertility and damage the soil.

ACKNOWLEDGEMENT

Thank you to the Leadership of the Faculty of Agriculture for providing the opportunity for the Environmental Science Study Program Team to manage the PNPB Funds of the Faculty of Agriculture to carry out PKM in Kranjang Hamlet, Wayame Village, Ambon City, Maluku Province until the publication of the PKM results.

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