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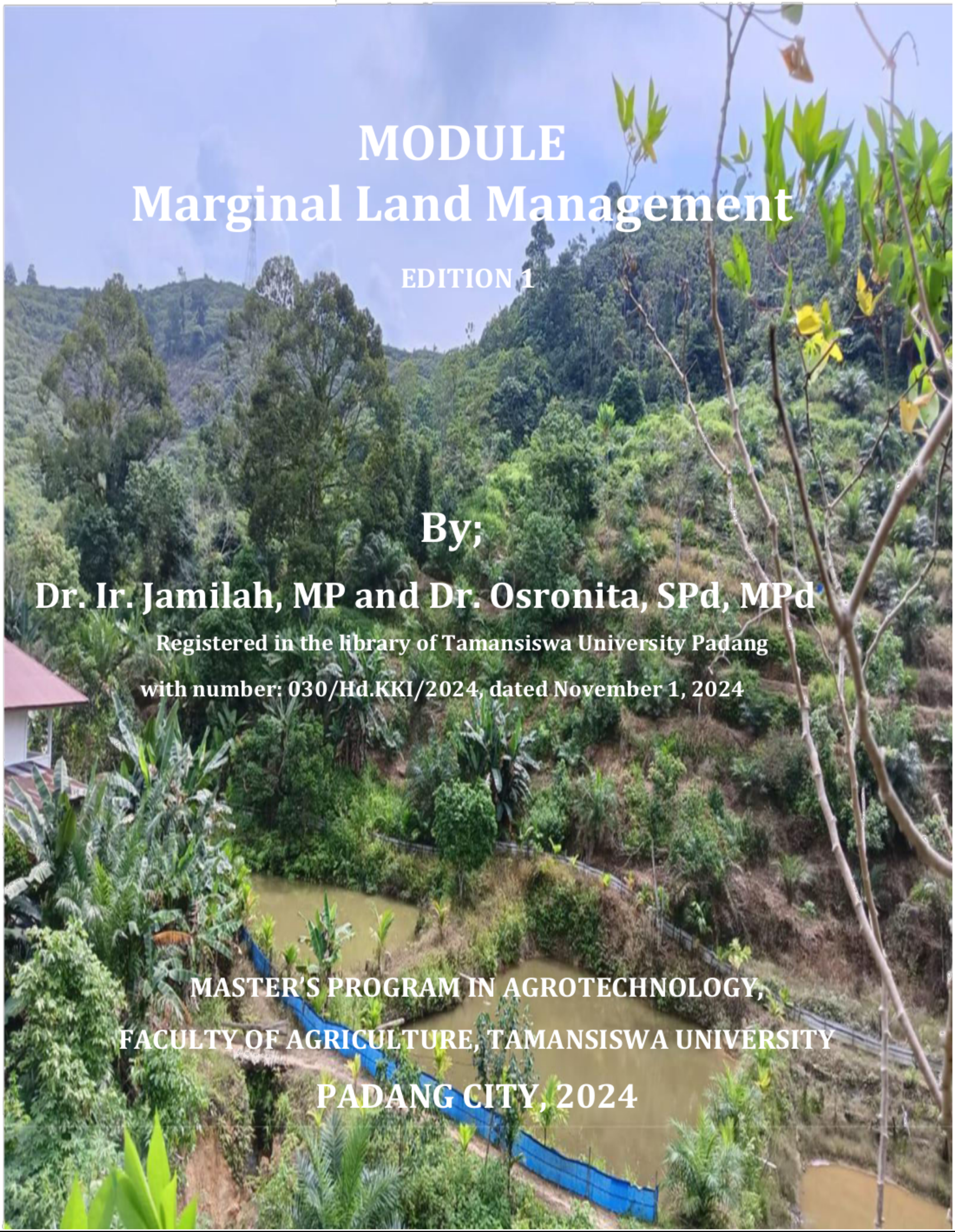

MODULE
Marginal Land Management

EDITION 1

By;

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MASTER'S PROGRAM IN AGROTECHNOLOGY,

FACULTY OF AGRICULTURE, TAMANSISWA UNIVERSITY

PADANG CITY, 2024

FOREWORD

We express our gratitude to the presence of God Almighty for His blessings and grace so that this book, entitled **Marginal Land Management**, can be compiled and completed. This book is presented as an effort to provide a deep and practical understanding of marginal land management, especially in areas that have natural challenges in terms of fertility, soil structure, and water availability.

Marginal land management is an important aspect of modern agriculture, especially in facing increasing food needs and the challenges of land conversion. This book is expected to be a useful reference for students, students, and practitioners in the fields of agriculture, forestry, and the environment. In it, we attempt to present the basic concepts of marginal land management, methods for increasing marginal land productivity, and best practices in land rehabilitation and soil conservation efforts.

The compilation of this book cannot be separated from the help, support, and valuable input from various parties. Therefore, we would like to thank the experts, practitioners, and academics who have shared their knowledge, experience, and references so that this book can be compiled properly. We also express our appreciation to colleagues and students who have contributed to the learning trials and provided constructive input.

We realize that there are still shortcomings in the preparation of this book, both in terms of material and presentation. Therefore, we are open to suggestions and constructive criticism for improvement in the next edition. Hopefully this book can provide benefits and become a useful source of knowledge in managing marginal land for the sustainability of agriculture in the future.

Finally, hopefully this book can support readers in improving their understanding and skills in the field of marginal land management, so that real contributions to sustainable agricultural development can be realized. Hopefully this foreword helps in compiling the books or study materials you need.

Padang, November 2024

Jamilah

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I. INTRODUCTION

Marginal Land Management course, one of the courses in the Agrotechnology Masters Program, which discusses and explains to students the importance of understanding marginal land and proper management techniques. This course has a load of 3 credits which is equipped with practical activities that can be done in the laboratory and in the field.

This course is presented for Masters students with the condition that they have passed the Basic Soil Science and Soil Fertility courses in S1. If students do not come from a linear S1, then the student is required to take the matriculation course in Soil Science and Soil Fertility.

Learning about marginal land management is very important because marginal land often becomes a solution to meet food needs, especially when fertile land is increasingly limited due to land conversion, urbanization, and land degradation. Here are some reasons why marginal land management is very important:

1. Increasing Food Production, Marginal land has the potential to be utilized to increase food production, especially for developing countries with growing populations. With the right technology and management, these lands can produce food crops or feed crops.

2. Reducing Pressure on Fertile Land, Fertile land is often under pressure from intensive agriculture that causes soil degradation. By utilizing marginal land wisely, we can reduce dependence on fertile land and prevent its degradation.

3. Increasing Farmers' Income, Marginal land management can help farmers who have limited access to fertile land to remain productive. This can increase farmers' income and improve the economic welfare of rural communities.

4. Environmental Quality Improvement, Marginal land is often damaged or infertile. By implementing good management practices, such as the use of organic fertilizers, biochar, or cover crops, we can improve soil quality and increase its fertility gradually. This can also reduce erosion and improve the hydrological cycle.

5. Food and Environmental Security, By utilizing marginal land, we can strengthen food and environmental security, especially in the face of climate change. Sustainable management of marginal land can increase the capacity of land to store carbon and maintain biodiversity.

6. Innovation in Agricultural Technology, Challenges on marginal land often trigger the development of new technologies, such as crop varieties that are resistant to extreme conditions, efficient irrigation, and organic fertilizers or biofertilizers that can improve soil quality.

Overall, learning about marginal land management is an important investment for the sustainability of agriculture in the future. Next is presented in Table 1 Semester learning plan related to the Marginal Land Management course.

Table 1. Semester learning plan related to the Marginal Land Management course

SUBJECT	CODE	URLI- learn Eyes Studying	Credit Weight	Semester	Date compilation
MANAGEMENT MARGINAL LAND	PSA11304		3	1	February 2 2024
AUTHORIZATION	RPS development/coordinator Teaching friends			Head of Study Program	
	Dr. Ir. Jamilah, MP Dr. Osronita			 Dr. Ir. Jamilah, MP	
Learning outcomes (CP) Graduates of Study Program	1.Attitude Realm a. Have faith in God Almighty and be able to show a religious attitude b. Uphold humanitarian values in carrying out duties based on religion, morals and ethics. c. Contribute to improving the quality of life in society, the nation and the state, and the progress of civilization based on Pancasila. d. Act as a proud citizen who loves his country, has nationalism and a sense of responsibility towards the country and nation. e. Respect the diversity of cultures, views, religions and beliefs, as well as the original opinions or findings of others. f. Cooperate and have social sensitivity and concern for society and the environment. g. Obey the law and be disciplined in social and national life. h. Internalizing academic values, norms, and ethics; i. Demonstrate a responsible attitude towards work in his/her field of expertise independently; j. Internalizing the spirit of independence, struggle, and entrepreneurship. k. Prioritize aspirations, develop concern, and develop capabilities together with the principles of sharpening, caring, nurturing 1. l. Willing to learn throughout life.				
	2.General Skills a. Able to develop logical, critical, systematic and creative thinking in applying marginal land management concepts. b. Able to formulate ideas, thoughts and technical arguments responsibly and based on academic ethics,				

	and communicate it to the academic through media to community and the wider community. c. Able to make decisions in the context of finish marginal land problems based on a study of experimental information and data. d. Able to increase the learning capacity for managing marginal land independently. e. Able to document, store, secure, and rediscover marginal land data in order to ensure validity and prevent plagiarism. 3.Knowledge a. Able to develop concepts and principles of marginal land through research into innovative and tested works. b. Able to develop marginal land concepts to solve problems in society through scientific research by utilizing science and technology to produce innovative and tested works. c. Able to develop innovative, creative, and tested marginal land management research methods. d. Able to manage marginal land that supports the development of environmentally conscious industries in an environment of optimization, diversification, and conservation. e. Able to develop specific pedagogy to teach the concept of marginal land by considering the characteristics of the concept and appropriate pedagogy through an approach. *science spirituality*as an implementation*technological pedagogical content knowledge* (TPCK) at the undergraduate agricultural education level. 4.Special skills a. Able to solve problems in the fields of food, environment and health by managing marginal land with a science and technology approach. b. Able to contribute to compiling research ideas summarized in the form of a road map in the field of marginal land. c. Able to design research in the field of marginal land management to be applied in efforts to improve community welfare. d. Able to manage research in the field of marginal land. e. Able to produce marginal land management findings to be applied and worthy of publication at national and international levels. f. Have the ability to demonstrate work performance as a professional educator in the field of marginal land management at the master's level. g. Able to communicate orally and in writing effectively, empathetically and politely with students, fellow educators, education personnel, parents and the community. **8**

Achievements learning course (CP-MK)		1.Students are able to explain the processes of marginal land formation; 2.Students are able to explain the factors that cause marginal land to form; 3.Students are able to plan research related to marginal land management; 4.Students are able to relate the relationship between marginal land management and crop growth and yield; 5.Students are able to modify marginal land so that the growing environment becomes better and are able to improve plant metabolism processes.
Sub CP-MK (if any)		
Brief description of the eye studying		This course discusses Marginal Land Management. Marginal land problems, both from its pedological nature (characteristics) and its usefulness for farmers, conservation of marginal land physically, chemically and biologically, management of acidic soil, watershed management, management of peat soil, utilization of organic fertilizers (soil improvers) and studies on research results in marginal land management.
Library	Main	1. FAO. 2017. Sustainable farming systems for food and nutrition security Sustainable farming systems for food and nutrition security. Global Forum on Food Security and Nutrition 2. Eric Lichtfouse, Mireille Navarrete, Philippe Debaeke, Souchere Véronique, Caroline Alberola. 2009. Sustainable Agriculture, Volume 1, Springer Science & Business Media 3.Concepts of agricultural marginal lands and their utilization: A review (Csikos, N. and Gergely Toth. 2023, Agriculture System Journal)
	Supporters	Journals and scientific publications on marginal land management include; 4. Journal presenting peatland management 5. Management of marginal land 6. Acid soil management 7. Management of swamp land 8. River Basin Management (DAS) 9. Marginal Lands: Concept, Assessment and Management 10. Crop diversification and saline water irrigation as potential strategies to save freshwater resources and reclamation of marginal soils—a review
Instructional Media		Software:
		MS Office, MS Teams, Zoom, Google classroom (GC), https:// smart.unitaspdg.ac.id/
Eye care team studying		Dr. Ir. Jamilah, MP., Prof. Dr. Isril Berd, SU
Prerequisite courses:		Basic Soil Science and Soil Fertility

II. MARGINAL LAND PROBLEMS

1.1 Causes, Management and Future Prospects in Food Supply in Indonesia

Marginal land in Indonesia has great potential to be developed to support food provision and agricultural sustainability, despite facing certain challenges. The following are the causes of marginal land formation, management strategies, and future prospects:

a. Causes of the Formation of Marginal Land in Indonesia

1 Natural Land Conditions: Marginal land is often formed naturally with characteristics such as acidic soil, poor in nutrients, and prone to erosion. The main example is the red-yellow podzolic soil that is spread across various regions in Indonesia.

2 Degradation Due to Human Activities: Intensive agricultural practices without proper management can cause erosion, nutrient loss, and increased soil salinity, making the land marginal.

3 Climate Change and Extreme Rainfall: Extreme climate variability can exacerbate land degradation and cause soil to undergo physical, chemical and biological deterioration more quickly.

4 Deforestation and Land Conversion: Deforestation or land conversion for housing and industry can damage the balance of the ecosystem and make the land unproductive.

b. Management of Marginal Land in Indonesia

1 Organic Fertilizer Application and Soil Amendment: The use of organic fertilizers such as compost, manure, and biochar helps improve soil structure and increase water absorption capacity and add nutrients.

2 Planting Cover Crops: Cover crops such as legumes can reduce erosion, add organic matter, and improve soil fertility on marginal land.

3 Using Lime to Treat Acid Soil: Application of lime (calcium carbonate) helps raise the pH of acidic soil, so that nutrients become more available to plants.

4 Implementation of Agroforestry System: Combining food crops with trees or perennials can help improve soil quality gradually, provide shade, and reduce erosion and nutrient loss. Irrigation and Drainage Engineering: For marginal

5 land that is too dry or too wet, good irrigation and drainage arrangements can help improve soil conditions and facilitate planting.

1.2 Future Prospects for Marginal Land in Indonesia

1 Potential to Reduce Pressure on Productive Land: With proper management, marginal land can be converted into additional areas for food production, thereby helping to reduce pressure on increasingly limited arable land.

2 Supporting the National Food Security Program: The government can utilize marginal land for crops that are more adaptive to suboptimal conditions, such as sorghum, cassava, and legumes, which are resistant to less fertile soil conditions.

3 Increased Use of Precision Farming Technologies: Technologies such as soil fertility mapping, use of drones for monitoring, and efficient fertilizer application can help increase the productivity of marginal land.

4 Policy Support for Marginal Land Development: Government policies and incentives that support research, extension, and technical assistance for farmers managing marginal land will increase the productive potential of this land.

5 Agroforestry Development as a Sustainability Solution: The use of agroforestry or silvopasture systems that combine food crops with hardwood trees has the potential to create sustainable ecosystems, increase productivity and soil quality, and provide long-term economic benefits.

Indonesia faces major challenges in providing stable and sustainable food, which are influenced by several main factors. Here are the causes of this problem, management strategies, and future prospects:

1.3 Causes of Food Supply Problems in Indonesia

1. Agricultural Land Degradation: Limited arable land is often degraded due to excessive use of synthetic fertilizers and pesticides, erosion, and less sustainable agricultural practices. This degradation reduces soil fertility and crop productivity (Figure 2.1).
2. Dependence on Certain Foodstuffs: Rice as the main staple food creates a high dependency on one type of commodity, which is vulnerable to climate change, pest attacks, and changes in market prices.
3. Climate Change: Increasingly unpredictable weather causes variability in planting and harvest seasons, resulting in a higher potential for crop failure.
4. Land conversion: Agricultural land that is converted into residential, industrial and infrastructure areas reduces the planting area and impacts food production.
5. Technology and Knowledge Limitations: Many farmers have not adopted modern technology or more efficient farming practices due to lack of access to training, tools, or financing.

1.4 Management and Strategies to Improve Food Supply

1. Implementation of Modern Agricultural Technology: Implementation of technologies such as precision farming systems, drones for land monitoring, and drip irrigation can increase agricultural efficiency and productivity.

2. Food Diversification: Reducing dependence on one type of commodity by developing other local foods such as cassava, corn, or sago to ensure better food security.

3. Land Restoration and Sustainable Agriculture: Increasing sustainable agricultural practices with crop rotation, use of organic fertilizers, and integrated pest management can reduce land degradation by growing oil palm or other commodities that are more profitable for farmers (Figure 2.2).

4. Development of New Food Barn Areas: The Indonesian government has initiated a program"food estate" in several provinces to create new agricultural areas outside Java which are expected to become new food production centers.

5. Utilization of Superior Plant Varieties: Development and planting of plant varieties that are more resistant to climate change, drought, and pest attacks can increase food security.

1.5 Future Prospects

1. Paradigm Shift from Agriculture to Sustainable Agriculture: A brighter future can be achieved with increasing support for organic and environmentally friendly agriculture. This will reduce dependence on synthetic fertilizers and pesticides, and maintain long-term soil fertility.

2. Investment in Agricultural Technology and Research: With increased support for research and technology development, it is hoped that more adaptive and efficient solutions to the challenges of climate change and land productivity can be obtained.

3. Strengthening Human Resources in Agriculture: Increasing the capacity of farmers through training, increasing technological literacy, and access to information will give them the ability to adapt to increasingly complex changes in food needs.

4. Strengthening the Local Economy Through Local Food: The potential for developing local food crops can be a solution to food security while strengthening the local economy and minimizing dependence on imports of certain food ingredients.

Through the implementation of targeted and sustainable strategies, Indonesia has a great opportunity to achieve better food security and meet national food needs independently.

Figure 2.1 Condition of marginal land that has not been planted with corn and that has been planted with corn

Figure 2.2 Marginal land developed for oil palm plantations

III. SOIL ORDER

Soil order is the highest level of classification in the soil taxonomy system, used to group soils based on their major characteristics and formation processes. In soil classification systems, most notably the popular USDA Soil Taxonomy, soils are grouped into 12 orders, each reflecting the types of soils that form in a particular environment and have distinctive properties. These orders serve as the basis for further classifications down to the suborder, major group, subgroup, family, and soil series levels.

12 Soil Orders in USDA Soil Taxonomy, presented in Figure 3.1

1. Entisols:sol (soil), ent = recent (new), Newly formed soil with minimal profile development, usually found in areas experiencing continuous erosion or deposition. Generally poor in nutrients and often used for pasture.
2. Inceptisol/Cambisols (Cambisol) (Bw),Soil with a more advanced profile development level than Entisol but still minimal. This soil is found in various environments and has better fertility potential.
3. Andisol:Soil formed from volcanic ash. This soil is fertile because it contains easily decomposed minerals and is rich in phosphorus.
4. Gelisol: (sol=soil, gelid=very cold, tundra climate, reindeer, rendieer) farmers grow crops, carrots and other vegetables when the temperature is 0-100C, and this can last for 3 months. Soil found in cold or polar regions, which contains permafrost layers in its soil profile. This type of soil has a frozen nature that inhibits the decomposition of organic matter.
5. Histosol: Organic soil that is very rich in organic matter, such as peat or swamp land. This type of soil contains high amounts of organic matter that does not decompose well due to the wet environmental conditions.
6. Aridisols:arid (dry), sol = land – desert. Soil found in dry or desert areas, with very low organic matter content and accumulation of salts or carbonates. Evaporation (evaporation) > precipitation (rain) = high salt on the soil surface (constraint), lack of water, if water is sufficient the soil is fertile
7. Vertisol: Soil with high clay content that cracks when dry and expands when wet. This soil is difficult to manage because of its easily deformed nature.
8. Mollisol:(mollis means soft) Fertile soil that is often used for agriculture. It has a thick, dark, organic-rich surface layer, and is good at storing moisture.
9. Alfisol: Fertile soil with a clear leaching horizon, found in temperate and wet tropical climates, widely used for agriculture and plantations.
10. Ultisol: from the word ultimus (continued/perfect) there is a characteristic Bt (accumulation of Illuviation, especially fine clay (argillic) = hard clay, roots cannot penetrate, plants do not grow. Older soil with a high level of leaching, usually poor in nutrients, but can still be used for agriculture with the addition of fertilizer. Many are found in tropical and subtropical areas.
11. Spodosol:from the word spodos (wood ash) Soil that is poor in nutrients, has a lower layer rich in aluminum and iron. Often found in cold or sandy climates, such as boreal forests.
12. Oxysol: Highly decomposed and nutrient-poor soil, but structurally stable. Found mostly in tropical areas, such as tropical rainforests.

Figure 3.1. There are 12 Land Orders in the World

Several soil orders among the 12 world soil orders are often categorized as Marginal Land due to physical, chemical, or biological limitations that make it difficult to cultivate for productive agriculture without intensive management. These soils generally have low nutrient content, less supportive physical properties, or are in extreme environments. The following are soil orders that are generally classified as marginal land:

1 Entisols; Characteristics: Newly formed soils with very minimal soil profile development. Typically found in areas subject to erosion or deposition, such as riverbanks or steep slopes. Limitations: Low in nutrients and less stable in structure, making these soils difficult to support crops without intensive management. Marginality: Entisols are often considered marginal because they require significant addition of nutrients and organic matter to be used for agriculture.
2 Aridisols; Characteristics: Formed in areas with arid or desert climates, these soils generally contain accumulations of salts or carbonates, but are low in organic matter and moisture. Limitations: Water shortage is a major factor limiting productivity. These soils are difficult to cultivate for agriculture without adequate irrigation. Marginality: Aridisols are often unproductive for agriculture in their natural state and are usually considered marginal unless water management is improved (Figure 3.2).
3 Gelisols-Characteristics: Formed in polar or cold climates with permafrost, these soils contain ice in their soil profiles. Limitations: Extremely low temperatures and the presence of permafrost make these soils unsuitable for conventional agriculture and limit the vegetation that can grow. Marginality: Gelisols are often considered marginal because of the extreme climate and frozen soil structure that limits agriculture.

4 Oxisols; Characteristics: Formed in tropical and subtropical regions, Oxisols have a high degree of weathering and low nutrient content. These soils are structurally stable but rich in iron and aluminum. Limitations: Poor in essential nutrients such as phosphorus, requiring high inputs to be used productively. Marginality: Considered marginal due to their low nutrient content and high input requirements for intensive farming.

5 Spodosols; Characteristics: These soils have lower horizons rich in aluminum and iron, and are found in cooler or sandy climates. Limitations: They are naturally nutrient poor and often acidic, making it difficult to support productive crops. Marginality: They are often considered marginal due to their low fertility and limited chemical properties that are challenging for agriculture.

6 Ultisols;Characteristics: These soils have a high degree of leaching and are usually poor in nutrients, although they may have a clay horizon. Limitations: They are low in nutrients and high in acidity, requiring liming and fertilization to increase productivity. Marginality: Ultisols are often considered marginal in some places, especially in the tropics and subtropics, although they can be used with good management (Figure 3.3).

Soil orders that are classified as marginal land include; Entisols, Aridisols, Gelisols, Oxisols, Spodosols, and Ultisols. These soils have natural limitations that require intensive management and inputs in order to be used productively in agriculture or other uses.

Figure 3.2 Surface Aridisol and complete with profile photo (source:www.uidaho.edu)

Figure 3.3. Characteristics of Ultisol, on the left, the E horizon (experiencing eluviation) and the Bt horizon (Argillic) contain high levels of fine clay, quite thick on agricultural land.

IV. VARIOUS TYPES OF MARGINAL LAND AND THEIR CHARACTERISTICS (PHYSICS, CHEMISTRY AND BIOLOGY).

Marginal soil is soil that has natural limitations in fertility, moisture, or structural stability, which make it less than optimal for agricultural production without intensive improvement or management. Marginal soil types have specific physical, chemical, and biological characteristics that affect their management. The following are some types of marginal soil and their main characteristics:

1. Sandy Soils, generally classified as Entisols

Physical Characteristics: This soil is dominated by coarse sand particles, which causes a loose and highly porous texture, allowing water and air to move easily in the soil. Chemical Characteristics: Generally has a low cation exchange capacity (CEC), making it less able to retain nutrients. Also poor in organic matter and mineral nutrients. Biological Characteristics: Low microorganism activity because the soil dries quickly. Organic matter decomposes quickly so that humus content is low. Limitations: Sandy soil is prone to drought because it quickly passes water and is poor in nutrients and organic matter.

2. Red Yellow Podsolic Soil (Ultisol)

Physical Characteristics: Usually has a less stable soil structure and tends to be hard or clayey in the lower horizon. Chemical Characteristics: Contains high levels of aluminum and is acidic (low pH). Nutrients such as phosphorus and calcium are often bound and unavailable to plants. Biological Characteristics: Microbial activity is often low due to high acidity and limited nutrient content, so decomposition of organic matter is slow. Limitations: High acidity and nutrient poverty inhibit plant growth, and high aluminum content can be toxic to plant roots.

3. Saline Soils

Physical Characteristics: Soil structure is often disturbed due to salt accumulation, causing the soil to tend to be compact and difficult to absorb water. Chemical Characteristics: High sodium and calcium salt content makes the soil saline, so the soil pH is often neutral to alkaline. These salts can damage the soil structure and inhibit water absorption by plants. Biological Characteristics: Soil microorganisms often experience stress due to high salt levels, which limits biological activity and decomposition processes. Limitations: High salt concentrations inhibit plant growth and cause toxicity, reducing the water absorption capacity of the roots.

4. Peat Soil (Histosol)

Physical Characteristics: Peat soil has a very porous structure, is light, and easily decomposed. The water content is very high and becomes very dry and flammable if it loses moisture. Peat conditions when the water content is high (Figure 4.1) and after drainage channels are made (Figure 4.2). Chemical Characteristics: Rich in organic matter but poor in key nutrients such as phosphorus, potassium, and micronutrients. This soil also has a low pH (very acidic). Biological Characteristics: Microorganism activity is often limited by acidic conditions and high water content, so that decomposition of organic matter is slowed down. Limitations: Peat soils are highly acidic, poor in mineral nutrients, and susceptible to subsidence when drained.

5. **Acid Soils (Acid Soils, including Ultisol and Oxisol)**

Physical Characteristics: Has a rather hard or clayey soil structure with a high level of weathering. Chemical Characteristics: Acidic with low pH, often high in aluminum and iron which can be toxic to plants. Low in phosphorus because it is bound to aluminum or iron. Biological Characteristics: Microorganism activity is limited by acidity, so the decomposition process of organic matter is slow and nutrient availability is reduced. Limitations: High acidity causes low nutrient availability and the possibility of aluminum toxicity in plants.

6. Vertisol soil

Physical Characteristics: Contains high clay content which causes the soil to expand and contract easily, resulting in large cracks when dry. Heavy texture and difficult to work. Chemical Characteristics: This soil is relatively fertile, but its physical limitations hinder water absorption and nutrient management. Biological Characteristics: Frequently cracked soil conditions can interfere with plant roots and microorganism habitats, and slow down the decomposition of organic matter. Limitations: Tendency to expand and contract makes soil cultivation difficult and causes stress to plants.

7. Laterite Soil

Physical Characteristics: The soil structure is hard, clayey, and often red due to the accumulation of iron oxide. This soil is often compact and difficult to work. Chemical Characteristics: Low nutrient content due to intensive washing, while iron and aluminum levels are high which can cause poisoning. Biological Characteristics: Low nutrient availability inhibits soil biological activity, and microorganisms are few because organic matter decomposes quickly. Limitations: Lateritization results in the soil becoming poor in nutrients, and its hard nature limits plant root growth.

Each type of marginal soil has specific and unique physical, chemical, and biological characteristics. Its management requires a special approach, such as the provision of organic matter, liming to reduce acidity, and the addition of specific nutrients. With proper management, marginal soil can be utilized productively to support sustainable agriculture.

Figure 4.1 Peat soil (Histosol)

Figure 4.2 Peat land that has had drainage channels opened

V. FACTUAL PHENOMENA FROM FARMERS REGARDING MARGINAL LAND CONDITIONS AND MANAGEMENT TECHNIQUES.

The factual phenomena of farmers in dealing with marginal land conditions show various challenges in managing less fertile land, as well as the creativity of farmers in finding solutions to maintain land productivity. Here are some common phenomena and management techniques faced by farmers in managing marginal land in Indonesia:

1. Excessive Use of Chemical Fertilizers; Phenomenon: In nutrient-poor soils such as Podsolic or acidic soils, farmers often rely excessively on chemical fertilizers (urea, TSP, KCl) to increase crop yields in a short time. However, this is not always effective, especially on marginal soils, and can worsen soil degradation in the long term. Impact: Excessive use of chemical fertilizers tends to increase soil acidity and reduce soil biological activity, worsening soil quality. Recommended Management Techniques: Combining chemical fertilizers with organic fertilizers, such as compost or manure, can help improve soil quality and improve soil structure in the long term.

2. Use of Organic Fertilizer and Compost; Phenomenon: Many farmers are beginning to realize the importance of organic matter to improve marginal soil. In sandy and acidic soils, farmers try to use manure, compost, or organic matter from plant residues to improve the organic matter content of the soil. Impact: The use of organic fertilizer increases the organic matter content, improves soil structure, increases water capacity, and increases the activity of soil microorganisms. Recommended Management Techniques: Regular use of compost and return of plant residues (mulch) can increase the humus content of the soil, so that marginal soil is better able to support plants.

3. Biochar Application; Phenomenon: In some areas, farmers have started using biochar (charcoal from organic materials such as rice husks or wood) to improve the soil. Biochar is used on soil that is easily drained of water such as sandy soil or soil that is poor in nutrients. Impact: Biochar helps store water and nutrients, and increases cation exchange capacity (CEC) so that the soil is more fertile in the long term. Recommended Management Techniques: Biochar should be mixed with organic fertilizer or compost and applied evenly for optimal results. Biochar can also improve sandy soil and reduce the rate of nutrient leaching.

4. Liming Practice; Phenomenon: Farmers in acidic soils, such as Ultisol or Podsolic, often use lime (dolomite) to reduce soil acidity. Liming has become a common technique in managing acidic soils, especially in rice fields or plantations. Impact: Liming helps raise soil pH, reduces aluminum toxicity, and increases the availability of elements

nutrients, so that plant productivity increases. Recommended Management Techniques: Lime application should be done in the right amount according to soil needs and conditions, and repeated every few years to keep the soil pH stable.

5. Mixed Farming System (Agroforestry); Phenomenon: On marginal land, some farmers adopt an agroforestry system, which combines food crops with woody trees or perennial plants to reduce erosion and improve soil quality (Figure 5.1). Impact: Trees play a role in adding organic matter through leaf litter and improving soil structure. In addition, this system can increase farmers' income with by-products such as wood or fruit. Recommended Management Techniques: Planting legumes as ground cover between agroforestry trees can help enrich soil nitrogen and maintain moisture.

6. Development of Simple Irrigation and Drip Irrigation Techniques; Phenomenon: In dry land or marginal land with low water retention such as sandy soil and Aridisols, farmers often make simple irrigation channels or use drip irrigation to maintain soil moisture (Figure 5.2). Impact: Simple irrigation helps maintain adequate water supply and increases water availability for plants. Drip irrigation is also efficient and reduces water wastage. Recommended Management Techniques: Utilizing water-saving irrigation technologies, such as drip irrigation or simple sprinklers, can help maintain soil moisture in dry marginal land.

7. Cover Crops and Mulch; Phenomenon: Some farmers on sloping or erosion-prone land use mulch or cover crops to reduce topsoil loss. Impact: Mulch and cover crops help reduce erosion rates, retain soil moisture, and add organic matter. Suggested Management Techniques: Crops such as legumes or grasses can be used as ground covers to protect against erosion and add nitrogen to the soil.

8. Use of Stress-Resistant Crops; Phenomenon: In extreme marginal lands such as saline or dry lands, farmers select crop varieties that are resistant to these conditions, such as saline-tolerant rice or drought-tolerant maize. Impact: Stress-tolerant crops can survive better on marginal lands and produce decent yields, even when soil conditions are not ideal. Recommended Management Techniques: Planting local varieties or varieties that have been selected for resistance to marginal conditions can be a sustainable long-term strategy.

Farmers on marginal land demonstrate various adaptations to maintain productivity despite limited land. The use of organic fertilizers, liming, water-saving irrigation systems, agroforestry, and selection of stress-resistant varieties are some of the techniques often applied. Support from the government, extension workers, and research institutions can help farmers expand their knowledge. them about effective management techniques on marginal lands and strengthening food security.

Figure 5.1 Agroforestry model

Figure 5.2 Simple Drip Irrigation Model on Agricultural Land

VI. ACCURACY OF CONSERVATION TECHNIQUES IN PHYSICS, CHEMISTRY AND BIOLOGY OF SOIL MARGINAL

Soil conservation on marginal land requires a special approach that takes into account the physical, chemical, and biological aspects of the soil. The following are appropriate conservation techniques based on these three aspects to increase productivity and maintain the fertility of marginal land:

1 Physical Conservation;

Physical engineering aims to improve the structure and physical properties of soil, as well as preventing erosion and soil degradation on marginal land. These techniques include:

a. Terracing: Terracing is effective for sloping land with high erosion risk, such as highland or sandy soil. Terracing reduces the speed of surface water flow and prevents erosion (Figure 6.1).
b. Making Bunds and Water Channels: Bunds or contours are used on soils with low water retention, such as sandy soils. Water channels or contour irrigation can direct water flow throughout the land area so that soil moisture is maintained.
c. Use of Mulch: Organic or inorganic mulch on the soil surface reduces water evaporation, retains moisture, and reduces the risk of erosion due to rainwater runoff (Figure 6.2).
d. Cover Crop Planting: Cover crops such as legumes or grasses can protect the soil from erosion and improve soil aggregates. This technique is suitable for easily eroded soils or marginal soils that are poor in nutrients.
e. Installation of Erosion Barriers: In areas with a high risk of erosion, such as sloping land, erosion barriers such as fences or sandbags can be installed to hold back the flow of sediment.

2 Chemical Conservation

a. Chemical techniques aim to improve nutrient balance, reduce toxicity, and increase nutrient availability in marginal soils. These techniques include:
b. Lime Application: In acidic soils, such as Ultisols or Podsolic soils, liming is effective in raising soil pH and reducing aluminum toxicity. Liming increases the availability of nutrients such as phosphorus and optimizes plant growth.
c. Application of Organic and Inorganic Fertilizers: Adding organic fertilizers (manure or compost) and balanced inorganic fertilizers can increase nutrients in marginal soil. The use of compost also increases the organic matter content, which increases the CEC of the soil and increases fertility.
d. Use of Biochar: Biochar functions to increase the water storage capacity and CEC of sandy or acidic soil. Biochar also absorbs nutrients so they are available for plants longer, especially in soils that are easily leached such as sandy soil or acid soil.
e. Addition of Gypsum to Saline Soil: In saline soil, application of gypsum ($CaSO_4$) can replace excess sodium ions with calcium, thereby reducing the impact of sodium toxicity and improving soil structure.
f. Local Resource Management: The use of local resources such as green manure or biofertilizer can increase soil nutrients gradually and sustainably.

3. Biological Conservation

a. Biological conservation techniques utilize living organisms, both microorganisms and plants, to improve soil conditions and increase fertility. These techniques include:
b. Planting Cover Crops: Cover crops such as legumes (e.g. beans) can fix atmospheric nitrogen into the soil through symbiosis with Rhizobium bacteria. This helps to increase soil nitrogen content in marginal lands.
c. Application of Biofertilizers: Biofertilizers containing beneficial microorganisms, such as phosphate-solubilizing bacteria or mycorrhizal fungi, can increase nutrient availability and improve soil health. The use of mycorrhizae also increases phosphorus uptake, especially in phosphorus-deficient soils.
d. Agroforestry or Mixed Farming System: The combination of food crops with perennials or trees can add organic matter and protect the soil from erosion. Woody plants provide shade, prevent evaporation, and produce leaf litter that enriches the soil's organic matter.
e. Crop Rotation and Polyculture: Crop rotation with legumes or the use of polyculture systems (planting more than one type of crop in one area) can enrich the nutrient content of the soil and reduce pest pressure on marginal land.
f. Addition of Decomposing Microorganisms: Decomposing microorganisms, such as decomposing bacteria or decomposing fungi, accelerate the decomposition of organic matter and improve the nutrient content of marginal soil.

The accuracy of conservation techniques for marginal land is determined by a deep understanding of the physical, chemical, and biological properties of the managed land. Physical conservation techniques aim to reduce erosion and maintain soil moisture, chemical conservation techniques aim to improve nutrient balance and improve soil chemical properties, while biological techniques utilize the role of microorganisms and plants to improve soil fertility. The combination of these three approaches can help improve marginal land productivity sustainably.

Figure 6.1 Terracing Model, its functions and types

Figure 6.2 Providing Organic Mulch to Onion Plants

VII. MAPPING ACID SOILS, AND APPROPRIATE TECHNIQUES IN MANAGING ACID SOIL

Acid soils are commonly found in tropical areas, including Indonesia. Mapping of acid soils aims to identify areas with high acidity levels (low pH), which generally require special management techniques to increase their fertility and productivity. The following is a mapping of general conditions of acid soils in Indonesia and the right techniques to manage them:

1. Mapping of Acid Soil in Indonesia

a. Distribution Location: Sumatra and Kalimantan: Many acidic soils are found, especially Ultisol and Red Yellow Podsolic types. This land is generally found in lowland and sloping areas. Papua: Several areas in Papua have acidic soil with soil types such as Ultisol and Podsolic soil which are formed in areas with high rainfall. Java: Acidic soils are also found in several areas of Central Java and East Java, especially on land that has experienced agricultural intensification for a long time, which increases soil acidity.

b. General Characteristics of Acid Soil: Low pH: Acid soil has a pH between 4.0-5.5, which is not ideal for most crops. High Aluminum and Iron: These soils typically have high aluminum and iron contents, which can be toxic to plants. Nutrient Deficiencies: Deficiencies in phosphorus, potassium, and calcium are common in acid soils, as these nutrients are bound up or lost through leaching. Low to Moderate Organic Matter: Although organic matter is present, decomposition is slow due to the high acidity.

c. Need for Mapping: Measured Soil Analysis: Measurement of pH, aluminum content, and mineral composition in various areas to determine management priorities. Zoning Mapping: Using geographic data to create acid soil zoning maps based on acidity intensity and soil types requiring specific treatments.

2. Acid Soil Management Techniques

To effectively manage acid soils, several management techniques can be applied with the aim of reducing acidity, adding nutrients, and improving overall soil quality. These techniques include:

1. Lime Application; Description: Lime is the addition of lime materials such as dolomite or calcite to increase soil pH and reduce toxic aluminum levels. Application Method: Lime is applied according to the dosage based on the results of pH tests and soil needs. Ideally, lime is mixed evenly throughout the topsoil (Figure 7.1). Benefits: Increases soil pH, increases phosphorus availability, and reduces aluminum and iron toxicity.

2. Organic Matter Application; Description: Organic matter such as manure, compost, or green manure can be added to the soil to increase the cation exchange capacity (CEC) and bind nutrients. Application Method: Organic matter can be applied on the surface or mixed into the soil each growing season. Organic mulch can also be used

to retain moisture. Benefits: Increases soil fertility, increases organic carbon content, and reduces free aluminum levels in the soil.

3. Phosphate Fertilizer Application; Description: Acid soils are often deficient in phosphorus because it is bound to aluminum and iron. The use of phosphate fertilizers, such as rock phosphate or superphosphate, can increase the availability of phosphorus. Application Method: Phosphate applications are carried out periodically, ideally spread evenly over the land or in planting holes, to increase the effectiveness of its absorption by plants. Benefits; Increases the availability of phosphorus, which is essential for root growth and plant development.

4. Utilization of Cover Crops; Description: Cover crops, especially legumes such as beans, are useful for improving soil because of their ability to bind nitrogen from the air and add organic matter. Application Method: These plants are planted as intercrops or during the break between main crops. Can be left to grow or loosened into the soil as green manure. Benefits: Adds soil nitrogen, increases organic matter, and reduces erosion on sloping land.

5. Biochar Application; Description: Biochar is charcoal made from organic materials such as wood or rice husks and can be added to the soil to improve the physical and chemical properties of the soil (Figure 7.2). Application Method: Biochar is mixed with organic fertilizer or directly sprinkled on the land and stirred into the soil layer (Figure 7.3). Benefits: Increases nutrient absorption capacity, improves soil structure, and reduces soil acidity gradually.

6. Use of Biofertilizer; Description: Biofertilizer contains microorganisms that support nutrient absorption, such as phosphate-solubilizing bacteria and mycorrhizae, which can help improve acidic soils. Application Method: Biofertilizer is usually applied to seedlings or around plants to increase nutrient absorption. Benefits: Increases nutrient absorption, especially phosphorus, and improves biological interactions in the soil.

7. Drainage and Irrigation Management; Description: On poorly drained acid soils, good drainage management can help prevent acid buildup in the soil. Application Method: The creation of drainage channels or a simple irrigation system can help control moisture and maintain pH stability. Benefits: Reduces excess water that can trigger acidity, maintains soil aeration, and helps remove toxic elements such as aluminum.

8. Selection of Acid Tolerant Plant Varieties; Description: Planting plant varieties that are resistant to soil acidity, such as acid-tolerant rice or corn, can be a solution to optimize yields on acidic soils. Application Method: Selection of the right plant varieties is adjusted to the type of acidic soil and the needs of farmers. Benefits: Acid-tolerant plants are better able to adapt to soil conditions so they can increase yields on acidic soils.

Acid soil management techniques require an integrated approach, including physical interventions (such as drainage management), chemical (such as liming and application of phosphate fertilizers), and biological (such as the use of biofertilizers and cover crops). Through accurate mapping and the application of appropriate techniques, acid soils in Indonesia can be managed to produce more optimal and sustainable production.

Figure 7.1 Applying lime to acid soil

Figure 7.2. Making (A) and Application of Biochar on Cocoa Plantation Land (B)

VIII. MANAGEMENT OF SWAMP LAND AND APPROPRIATE TECHNIQUES IN MANAGING SWAMP LAND.

Swamplands are ecosystems that include wetlands such as tidal swamps and peat swamps, which have the potential to be used as agricultural land. However, swamps also have challenges, such as high water content, acidity, certain toxicities, and dependence on the natural water cycle. Proper management can increase the productivity of swamps sustainably. The following is an explanation of swamp management and the techniques that can be applied:

1. Characteristics of Swamp Land

a. High Acidity Level: Most swamp lands, especially peat lands, have a low pH (acidic) which causes nutrient limitations.

b. High Organic Matter Content: Swamps, especially peatlands, have a high organic matter content that undergoes slow decomposition. However, in acidic and water-saturated conditions, this decomposition does not provide nutrients that are readily available to plants.

c. High Groundwater Levels: Swampy areas are usually flooded or saturated with water for long periods of time, which can lead to a lack of oxygen in plant roots.

d. Toxic Content: Some swampy areas contain iron, manganese, or other compounds that, when flooded, can be toxic to plants.

2. Swamp Land Management Techniques

The following are the correct techniques for managing swamp land to achieve optimal productivity:

a. Regular Drainage Management; Description: Drainage functions to regulate the water content of the soil so that plants can grow well (Figure 8.1). A good drainage system is important to lower the water level in a controlled manner, so that drought does not occur in the dry season or flooding in the rainy season. Technique: Making primary, secondary, and tertiary drainage canals or channels to control water in swampy areas. The canals can be opened or closed according to the water needs of the land. Benefits: Controlling excess water, maintaining ideal soil moisture, and reducing toxin levels.

b. Liming to Reduce Acidity; Description: Swamp soil, especially peat soil, is generally acidic. Liming aims to increase soil pH, thereby reducing acidity and increasing nutrient availability. Technique: Periodic application of lime (dolomite or calcite) according to needs and measured soil acidity levels. Benefits: Increases soil pH, reduces aluminum and iron toxicity, and increases the availability of essential nutrients such as phosphorus.

c. Application of Organic Materials and Fertilizers; Description: Application of organic materials such as compost or manure can add nutrients needed by plants and increase the water retention capacity of the soil. Technique: Application of organic materials evenly on the land or mixed with the soil. Manure or compost can also be applied to increase the fertility of swamp soil. Benefits: Provides additional nutrients, increases cation exchange capacity (CEC), and improves soil structure.

d. Use of Phosphate Fertilizer; Description: Swampy soil tends to be poor in phosphorus because this element is easily bound by organic matter or soil minerals in acidic conditions. Technique: The use of phosphate fertilizer in the form of TSP (Triple Super Phosphate) or natural phosphate is carried out routinely with doses that suit plant needs. Benefits: Increases the availability of phosphorus which is very important for plant growth in swampy areas.

e. Application of Bed or Ridge Technique; Description: Beds or ridges help separate plants from standing water directly, providing a non-saturated growing area for plant roots (Figure 8.2). Technique: The soil is processed into beds or ridges 20-30 cm high to ensure that plants are not always submerged in water. Benefits: Prevents root rot, improves aeration, and prevents excessive waterlogging.

f. Utilization of Acidity and Waterlogging Tolerant Plants; Description: Selection of plant varieties that are tolerant to acidic soil conditions and waterlogging, such as several varieties of swamp rice or oil palm. Technique: Planting plants that are tolerant or adaptive to swampy land conditions, as well as plants that have acid-resistant roots. Benefits: Increase crop yields in swampy land conditions that are difficult to change.

g. Fire Management on Peatlands; Description: Peatlands are susceptible to fire when dry. Fire management aims to prevent illegal burning that can damage the swamp ecosystem. Technique: Maintain peatland moisture with good drainage management and avoid land clearing by burning. Benefits: Prevent the loss of organic matter in peatlands and reduce the risk of fire.

h. Utilization of Biofertilizer; Description: Biofertilizer contains microorganisms that can help plants in nutrient absorption or add certain nutrients to the soil. Technique: Application of biofertilizer containing phosphate-solubilizing microbes or nitrogen-fixing bacteria. Benefits: Increases plant nutrient absorption, reduces the need for chemical fertilizers, and improves the biological quality of the soil.

i. Planting Ground Cover Crops; Description: Ground cover crops help protect the soil from erosion and enrich the soil's nutrient content. organic. Technique: Planting cover crops such as legumes (e.g. beans) that are able to fix nitrogen and increase organic matter. Benefits: Adds soil nitrogen, protects soil from erosion, and increases soil organic matter.

Management of swamp land requires a combination of techniques to overcome specific challenges, such as acidity, excess water, and toxicity risks. Controlled drainage techniques, liming, use of organic and phosphate fertilizers, and selection of tolerant plants are effective methods to increase swamp productivity sustainably. With proper management, swamp land can be optimized as a high-value agricultural resource for food security in Indonesia.

Figure 8.1 Horticultural Cultivation on Swamp Land

Figure 8.2 Making Channels or Beds to Overcome Flooding

IX. APPROPRIATE MAPPING AND TECHNIQUES IN LAND MANAGEMENT FORMER MINE

Former mining land often has a tough challenge to return to its function as productive land. After mining activities end, the land tends to be degraded with problems such as poor soil, pollution, and high erosion. Therefore, mapping and implementing appropriate management techniques are very important to restore this land so that it can be productive and environmentally friendly again. The following is an explanation of mapping and management techniques for former mining land:

1. Post-Mining Land Mapping; Mapping is the first step to understand the characteristics and level of damage to post-mining land (Figure 9.1). This mapping includes the following aspects: Physical Mapping: Covers land topography, soil type, and drainage conditions. Mining land usually has damaged soil structure and slope that requires special treatment. Chemical Mapping: Covers soil pH, heavy metal content, and available nutrients. Post-mining soil tends to be poor in nutrients and may contain toxic materials such as heavy metals. Biological Mapping: Covers the biodiversity in the area, such as local plant species or soil microbes that are able to survive in degraded land. Damage Level Mapping: Helps identify the most damaged areas and requires more intensive intervention than relatively stable areas. This mapping data is very important for designing recovery plans and selecting appropriate management techniques according to land conditions.

2. Mining Land Management Techniques; Based on the mapping conducted, here are some techniques that can be applied to manage and rehabilitate mining land: Topographic Reclamation; Restore or stabilize land topography to reduce erosion and make the land safer and ready for recovery. Mining land reclamation with Cocomesh (Figure 9.2) stabilizes topography in the long term and red Kaliandra cultivation as a provider of renewable energy sources.

   a. Technique: Backfilling of ex-mining areas, or grading steep slopes to make them stable and less prone to landslides. Benefits: Reduces the risk of erosion, facilitates soil management, and prevents contaminants from being carried by surface flow.

   b. Topsoil Replacement; Topsoil is the most fertile layer of soil rich in organic matter and soil microorganisms, which is often lost or damaged due to mining. Technique: Collecting and redistributing topsoil to ex-mining land, or adding topsoil from outside the mining area if it has been lost. Benefits: Increasing soil fertility and providing a better environment for plant growth.

c. Soil Chemistry Management; Addressing soil chemistry problems such as high acidity or heavy metal content that can damage plants and ecosystems. Techniques: Liming to neutralize soil pH, gypsum application to bind heavy metals, and use of organic materials to help neutralize toxicity. Benefits: Reduces soil acidity and toxicity, making the soil more friendly to plants and microorganisms.

d. Application of Organic Materials and Fertilizers; Post-mining soils are often poor in nutrients. Organic materials such as compost or manure can improve soil quality. Technique: Gradual application of organic fertilizers to increase nutrient content and improve soil structure. Benefits: Increase soil fertility and support the development of soil microorganisms.

e. Planting Pioneer Plants or Legumes; Pioneer plants are types of plants that are resistant to extreme conditions and are able to grow in nutrient-poor land, as well as improve soil structure. Technique: Planting plants such as legumes (eg beans) or local species that have adaptations to ex-mining land conditions. These pioneer plants can be combined with ground cover plants to reduce erosion. Benefits: Adding nitrogen to the soil, increasing organic matter, and stabilizing the soil to allow for the growth of more complex vegetation in the future.

f. Use of Biofertilizers and Soil Microbes; Biofertilizers contain microorganisms that help the soil recovery process by accelerating the decomposition of organic matter and increasing nutrient availability. Technique: Application of soil microbes, such as phosphate-solubilizing or nitrogen-fixing bacteria, which can support plant growth on degraded land. Benefits: Improves soil biological structure, increases nutrient absorption, and supports further plant growth.

g. Erosion Control with Vegetation; Erosion is a major problem in exposed mined areas. Ground cover vegetation can help control erosion and reduce soil loss. Technique: Plant grasses or shrubs that have strong root systems and are resistant to extreme soil conditions to stabilize slopes and exposed areas. Benefits: Reduce erosion rates, improve soil stability, and increase organic matter content.

h. Water Management; Managing water systems in ex-mining areas is essential to prevent puddles that cause further degradation. Techniques: Creating drainage channels or water retention ponds to control water flow, and implementing irrigation techniques that support plant growth. Benefits: Preventing damaging water accumulation, reducing the risk of metal contamination to surrounding water bodies, and maintaining soil stability.

i. Remediation with Phytoremediation; Description: Phytoremediation is a technique using certain plants to absorb or accumulate contaminants from the soil. Technique: Using plants that are able to absorb heavy metals or specific contaminants from the soil, such as water hyacinth or acacia. Benefits: Reduces the levels of contaminants, such as heavy metals, in the soil, making it safer for the ecosystem and other plants.

Management of post-mining land requires an integrated approach, including physical techniques (topographic reclamation and erosion control), chemical techniques (liming and heavy metal remediation), and biological techniques (planting of pioneer plants and application of biofertilizers). With good mapping and the application of appropriate rehabilitation techniques, post-mining land can be restored for various functions, whether as a conservation area, agriculture, or forestry. This supports environmental sustainability and prevents further damage to the surrounding ecosystem.

Figure 9.1 Former Open Mining Land (Left) and Planted with Pineapples (B)

Figure 9.2 Mining Land Reclamation with Cocomesh and Caliandra Cultivation for renewable energy sources

X, MAPPING AND APPROPRIATE TECHNIQUES IN LAND MANAGEMENT ORGANICALLY MARGINAL

Organic management of marginal land is one of the environmentally friendly solutions to increase the productivity of less fertile land, such as land with low organic matter content, high acidity, or land that has experienced degradation. The organic approach not only increases soil fertility but also maintains ecosystem sustainability and reduces dependence on chemicals. Mapping and implementing appropriate organic management techniques will support the recovery and improvement of marginal land quality. The following is an explanation of the mapping and techniques for managing marginal land organically:

1. Marginal Land Mapping

Land mapping is the first step in planning proper management of marginal land. This mapping includes several important aspects:

a. Soil Physical Characteristics Mapping; Assess soil texture, soil depth, soil structure, and drainage capacity. Identify physical problems such as soil compaction or waterlogging that can inhibit plant growth.

b. Soil Chemical Mapping; Measuring soil pH, acidity or alkalinity levels, and the content of key nutrients such as nitrogen, phosphorus, and potassium. Detecting heavy metals or toxic compounds that can affect the health of plants and soil microorganisms.

c. Biological Mapping; Assessing the diversity of soil microorganisms, the presence of earthworms, and other organisms that play a role in the decomposition of organic matter. Identifying whether there are deficiencies of certain microbes that can affect soil health.

d. Social and Economic Mapping; Assess the social and economic potential of the land, as well as the factors that influence farmers' decisions to switch to organic farming. Identify possible resources that can support the use of organic technology, such as local organic materials (e.g. compost or manure).

2. Organic Marginal Land Management Techniques

After mapping, organic marginal land management techniques can be applied to improve soil fertility and productivity. Some of these techniques include:

a. Application of Organic Materials (Compost and Manure). Description: Adding organic materials such as compost, manure, or mulch can increase the organic matter content of the soil, improve soil structure, and increase the soil's capacity to store water. Technique: Application of compost that

b. well-decomposed or manure regularly to marginal land. For very poor land, organic matter application is done gradually to avoid waste and ensure sustainability. Benefits: Increase soil fertility, improve soil structure (help overcome compaction), and increase cation exchange capacity (CEC) so that nutrients are more easily absorbed by plants.

c. Use of Organic Mulch; Description: Organic mulch, such as dry leaves, straw, or grass, is used to cover the soil surface. Technique: Place mulch evenly over the soil surface to protect the soil from erosion, maintain soil moisture, and provide organic matter that continues to decompose. Benefits: Reduces water evaporation, prevents erosion, controls weeds, and increases the soil's organic matter content as it decomposes.

d. Crop Rotation and Cover Crops; Description: The practice of crop rotation and the use of cover crops helps maintain soil fertility, control pests and diseases, and increase biodiversity. Technique: Planting legumes (such as beans) as cover crops or nitrogen-fixing crops in certain seasons, and alternating the main crop each season to avoid declining fertility. Benefits: Adds nitrogen to the soil, reduces soil fatigue, improves soil structure, and reduces dependence on chemical fertilizers.

e. Liming and Soil pH Adjustment; Description: Marginal soils often have very low or very high pH, which affects the availability of nutrients to plants. Liming uses natural materials such as dolomite or calcium lime to adjust the soil pH. Technique: Liming is done based on the results of soil analysis to increase the pH in acidic soils. In alkaline soils, pH reduction techniques can be done by using organic acid materials such as fermented compost. Benefits: Provides a better environment for plants to absorb nutrients and improves the pH balance of the soil.

f. Bioactivators and Biofertilizers; Description: Biofertilizers contain microorganisms that help increase the availability of nutrients and improve soil health. Technique: Use of bioactivators or soil microbes such as phosphate-solubilizing bacteria, nitrogen-fixing bacteria, and mycorrhizae (root fungi) that can increase the efficiency of nutrient absorption by plants. Benefits: Improves the biological quality of the soil, increases nutrient absorption, and reduces dependence on chemical fertilizers.

g. Erosion Control with Soil Conservation Techniques; Description: Soil erosion is often a problem on marginal land that is bare or not covered by vegetation. Erosion control is important to maintain soil integrity. Techniques: Application of terracing, creation of good drainage channels, and planting of plants ground cover such as grass or legumes to protect the soil from erosion. Benefits: Reduces soil loss due to erosion, improves soil structure, and maintains soil quality for long-term use.

h. Agroforestry and Polyculture; Description: Agroforestry is a farming system that combines trees with food crops or other plants, while polyculture is the planting of several types of plants in one area. Technique: Implementing agroforestry by planting trees that are compatible with the main crop (such as legumes that improve soil quality) and adopting polyculture to increase plant diversity. Benefits: Provides soil protection, reduces erosion damage, and improves biodiversity that can support a farming system that is more resistant to pests and diseases.

i. Soil Microbiology Restoration; Description: Soil microbiology plays an important role in the breakdown of organic matter and nutrient cycling in the soil. Technique: The use of compost or biofertilizer containing beneficial microbes to improve the quality of soil microbiota, as well as planting plants that can stimulate the activity of soil microorganisms. Benefits: Increases soil biological activity, accelerates the decomposition of organic matter, and supports healthier plant growth.

Organic management of marginal land requires a holistic approach involving detailed soil mapping, application of sustainable physical, chemical, and biological management techniques. Techniques such as application of organic matter, mulching, crop rotation, liming, and use of biofertilizers can gradually increase soil fertility (Figure 10.1) with the SALT model. Proper management not only increases soil productivity but also maintains ecological balance and agricultural sustainability.

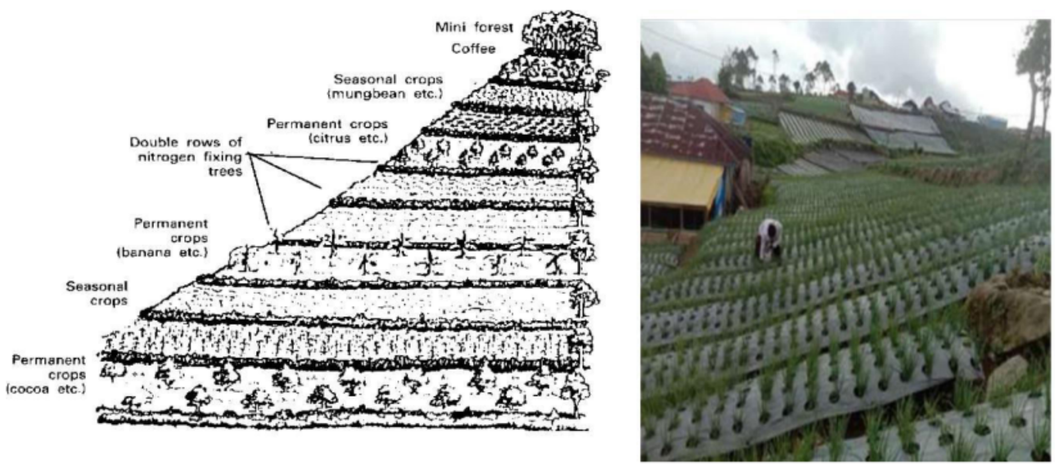

Figure 10.1. SALT (Slope Agriculture Land Technology) Model, Shallot Cultivation on Sloping Land That Has Not Fully Fulfilled Conservation Measures

XI. CATEGORY OF CHARACTERISTICS OF WATERSHED AREA

In the context of natural resource management, especially for watersheds (DAS), DAS areas can be categorized based on various characteristics that affect the process of water flow, soil quality, and the ecosystems within them. This categorization is important for planning appropriate management and conservation to reduce ecosystem damage and improve the sustainability of natural resources. The following are categories of watershed area characteristics based on various aspects:

1. Physical Characteristics of Watershed;

a**. Topography**

Watersheds can be distinguished based on the slope of the land (gradient). Land with a high slope is usually more susceptible to erosion and drains water faster. Conversely, watersheds with a low slope have better water absorption potential, but are more susceptible to flooding. Mountain watershed areas: High slope, drain water quickly, more susceptible to erosion and landslides. Lowland watershed areas: Flatter, water flow is slower, but more susceptible to flooding and decreased water quality. Soil Type; Soil in watershed areas varies greatly, from loose soil that easily absorbs water to dense soil or clay that is slow to absorb water. Sandy Soil: Tends to have good water absorption capacity, but is easily eroded. Clay Soil: Able to hold water, but is more susceptible to flooding and limited in air circulation for plant roots.

b**. Water Resources**

These characteristics include the number and types of water flows in the watershed area, such as major rivers, tributaries, and drainage channels. Watersheds with Large Major Rivers: Have large flow capacities and are often connected to larger ecosystems. Watersheds with Many Tributaries: Flow is more distributed and may be more susceptible to local pollution.

2**. Hydrological Characteristics of Watershed**

Rainfall; Rainfall in a watershed greatly affects water flow and erosion potential. Watersheds with high rainfall are more susceptible to flooding and erosion, especially in areas with damaged vegetation. Watersheds with High Rainfall: Vulnerable to flooding and surface erosion. Watersheds with Low Rainfall: Experience water shortages, especially during the dry season.

Water flow

Water flow in a watershed can be categorized based on its speed and capacity to carry water and sediment. Fast flow in a hilly watershed area will result in higher erosion potential. Fast Flow: Usually found in watersheds that located in mountainous or hilly areas. Slow Flow: Found in flatter watersheds, which allows for more effective water percolation and infiltration.

3. Ecological Characteristics of Watersheds

Vegetation; The existence of vegetation greatly affects the process of water flow, soil quality, and erosion prevention. Watershed areas with good vegetation cover can reduce surface water flow and prevent erosion. Watersheds with Dense Forests: Store a lot of water, slow down water flow and reduce erosion. Watersheds with Open Vegetation: Vulnerable to erosion due to the lack of plant root protection against the soil. Biodiversity; Biodiversity in the watershed area is closely related to ecosystem quality. Watersheds with high biodiversity support environmental sustainability and natural resources. Watersheds with High Biodiversity: More ecologically stable and have healthier ecosystems. Watersheds with Low Biodiversity: Vulnerable to environmental degradation and ecosystem disturbances.

4. Social and Economic Characteristics of Watershed

Land Use; The type of land use within a watershed can affect hydrological processes and soil quality. Intensive land use (such as agriculture, plantations, and settlements) can lead to decreased water and soil quality. Watersheds with Intensive Land Use:
Tend to experience decreased water and soil quality due to deforestation and erosion. Watersheds with Open Land Use or Conservation: Support sustainable natural resource management and tend to be more ecologically stable. Economic Activity; Economic activities in the watershed, such as agriculture, industry, and mining, can affect water and soil quality. Watersheds with Industrial Activity: More vulnerable to water pollution and environmental damage. Watersheds with Sustainable Agricultural Activity: Can support soil and water quality conservation, depending on the methods used. Population and Community Involvement; Population and community involvement in watershed management greatly influence conservation success. Densely Populated Watersheds: May face greater pressure on natural resources and potentially increase ecosystem damage. Watersheds with Communities Involved in Conservation: Tend to be more successful in sustainable natural resource management.

5. Characteristics of Water Quality in Watersheds

Water Quality; Water quality in a watershed depends on a variety of factors, including industrial pollution, agriculture, and domestic activities. Mapping water quality is essential for effective watershed management. Watersheds with High Water Quality. Support sustainable aquatic and agricultural ecosystems. Watersheds with Low Water Quality: Vulnerable to pollution and environmental degradation.

5. Characteristics of Sensitivity to Natural Disasters

Vulnerability to Natural Disasters; Watersheds located in disaster-prone areas, such as landslides, floods, or droughts, require more careful management to reduce the impact of disasters (Figure 11.1). Watersheds with High Landslide Potential: Require stricter soil and water conservation management. Watersheds with High Flood Potential: Require good water control infrastructure and planting vegetation that can reduce surface water flow.

Watershed areas can be categorized based on various physical, hydrological, ecological, social, and economic characteristics. Each of these categories affects natural resource management and soil and water conservation. Comprehensive mapping of watershed characteristics is essential for planning sustainable management, reducing ecosystem degradation, and improving the quality of life of communities that depend on watershed natural resources.

Figure 11.1 Condition of Watershed Damage Due to Natural Disasters (Coastal Abrasion and Volcanic eruptions) and landslides due to human actions

XII. UTILIZATION OF HARVEST RESIDENTS AND C/N VALUE

Utilization of crop residues and management of the carbon (C) to nitrogen (N) ratio in soil are important strategies in managing marginal land, especially to increase soil fertility, improve soil quality, and support agricultural sustainability. Marginal land often has limitations in terms of nutrient content, especially nitrogen and carbon, which are essential for plant growth. The following is an explanation of the utilization of crop residues and C/N values in managing marginal land:

1. Utilization of Harvest Remains; Crop residues are parts of plants that are not harvested or discarded after the harvest process, such as leaves, stems, roots, and other plant waste. In marginal land, the use of crop residues has many benefits as part of a sustainable land management system.

a. As Organic Material to Increase Soil Organic Matter Content; Harvest residues, such as rice straw, corn stalks, or leaves of other plants, can be utilized to increase soil organic matter content. This utilization helps improve soil structure, increase water retention capacity, and increase soil microorganism activity. Utilization Techniques: Compost: Processing harvest residues into compost can increase nutrient availability and improve soil structure. The composting process reduces agricultural waste while producing nutrient-rich organic matter. Mulch: Spreading harvest residues directly on the soil surface as mulch to maintain moisture, prevent erosion, and add organic matter to the soil as it decomposes.

b. As an Energy Source for Soil Microorganisms; Crop residues contain carbon that can be used by soil microorganisms for decomposition processes and to improve soil quality. Benefits: Crop residues left on the soil surface provide an energy source for microorganisms, which in turn improve soil fertility and increase nutrient availability for plants.

c. As Animal Feed; In areas that utilize integrated farming systems, crop residues can be used as animal feed, such as straw or other plant waste. Benefits: Providing crop residues as animal feed not only reduces agricultural waste, but also produces organic fertilizer from animal manure that is rich in nutrients for reuse on the land.

2. Carbon (C) to Nitrogen (N) Ratio in Marginal Land Management

The C/N ratio is the comparison between the amount of carbon and nitrogen in organic matter. This ratio is very important in the process of decomposition of organic matter and availability of nutrients for plants. A balanced C/N ratio is essential to ensure that organic matter can decompose efficiently without causing nutrient imbalances that are detrimental to plants.

a. Ideal C/N Ratio; Ideal C/N Ratio for Decomposition: Soil microorganisms require a C/N ratio of around 25-30:1 for optimal decomposition. If the C/N ratio is too high (e.g. more than 40:1), decomposition will be slow because microorganisms have difficulty obtaining sufficient nitrogen. Low C/N Ratio: If the C/N ratio is too low (e.g. below 20:1), microorganisms will use up the nitrogen in the soil for decomposition of organic matter, which can lead to nitrogen deficiency for plants.

b. Effect of Crop Residues on C/N Ratio; Straw and Crop Residues with High C/N: Many types of crop residues, such as rice straw or corn stalks, have a high C/N ratio. This can limit the availability of nitrogen to plants during the decomposition process. Therefore, it is important to balance this ratio with nitrogen-rich organic matter, such as manure or compost from more nitrogen-rich materials. Proper Processing and Use: In order to balance the C/N ratio and support faster decomposition, crop residues can be processed by combining them with materials that are richer in nitrogen or accelerating the decomposition process by using bioactivators.

c. Adding Nitrogen to Balance the C/N Ratio; On marginal soils that are often deficient in nitrogen, adding organic matter with a high nitrogen content such as manure, compost, or nitrogen-rich cover crops (such as legumes) can help balance the C/N ratio. Examples of Techniques: Legumes: Cover crops from the legume family (such as peanuts or mung beans) can add nitrogen to the soil through symbiosis with nitrogen-fixing bacteria. Nitrogen-Rich Organic Fertilizers: Applying nitrogen-rich manure or compost can improve the C/N ratio in soils that are high in carbon.

d. Impact of C/N Ratio on Soil Fertility; Excess Carbon (C): If the C/N ratio is too high, the decomposition of organic matter will be slow, and microorganisms will compete with plants for limited nitrogen. This can inhibit the growth of plants that require nitrogen for protein and enzyme synthesis. Excess Nitrogen (N): If the C/N ratio is too low, microorganisms will consume nitrogen more quickly, and plants may experience nitrogen deficiency. Excess nitrogen can also cause the formation of ammonia, which can be harmful to plants.

3. Harvest Residue Management Strategy and C/N Ratio on Marginal Land. A number of The strategies for managing harvest residues and C/N ratios on marginal land that can be applied are:

   a. Composition of Harvest Residue and Organic Fertilizer Mixture; Compiling the right mixture of harvest residue with nitrogen-rich materials (such as manure or green materials) to accelerate the decomposition process and maintain the appropriate C/N balance (Figure 12.1).

   b. Use of Ground Cover Crops; Planting ground cover plants such as legumes that can increase the nitrogen content in the soil and help improve the C/N ratio.

   c. Technological Innovation to Manage Crop Residues; Using technologies such as fermentation or mechanical processing to break down crop residues more efficiently, increase nitrogen availability, and improve the C/N ratio in the soil.

   d. Utilization of Mulch and Compost; Use of mulch from harvest residues or compost to maintain soil moisture and increase the activity of soil microorganisms that can help regulate the C/N ratio naturally.

Utilization of crop residues and management of C/N ratio are two important aspects in sustainable marginal land management. By utilizing crop residues as organic matter, we can improve soil quality and support healthy decomposition. In addition, maintaining the right balance of C/N ratio ensures optimal nutrient availability for plants. The combination of good crop residue management and C/N ratio regulation will increase soil fertility, improve soil structure, and support sustainable agriculture on marginal land.

Figure 12.1 Making Compost as Organic Fertilizer to Reduce C/N and fertilizer application for onion plants

XIII. PRODUCTION AND BENEFITS OF ORGANIC FERTILIZER AND LIQUID FERTILIZER

Production and Benefits of Organic and Liquid Fertilizers; Organic and liquid fertilizers play an important role in increasing soil fertility and agricultural productivity, especially in marginal lands that often lack nutrients. Both have different characteristics and ways of working, but both can complement each other to create a more sustainable agricultural system. The following is an explanation of the production and benefits of each fertilizer.

1. Organic Fertilizer;

a. Organic Fertilizer Production; Organic fertilizer comes from natural materials, such as plant residues, animal waste, or other decomposed organic materials. There are various methods for producing organic fertilizer, including:

Composting: The process of decomposing organic materials (such as straw, leaves, manure) with the help of microorganisms under controlled conditions. During the composting process, these materials are converted into humus which is rich in nutrients. Vermicomposting: Using earthworms to process organic waste into fertilizer which is rich in nutrients, and improves soil structure. Fermentation: Processing organic materials using certain microorganisms to speed up the decomposition process and produce liquid organic fertilizer. Manure: Collecting and processing animal waste such as cows, chickens, or goats into organic fertilizer which can be used to improve soil quality.

b. Benefits of Organic Fertilizer; Increases Soil Organic Matter Content: Organic fertilizers add organic matter to the soil, which increases the soil's capacity to hold water and nutrients. This is especially important in marginal lands that often lack organic matter. Increases Soil Microorganism Activity: Organic fertilizers provide an energy source for soil microorganisms, which in turn increase soil fertility and support nutrient cycling. Improves Soil Structure: Organic fertilizers improve soil texture, reduce soil compaction, and increase soil porosity, which facilitates plant roots to grow well. Increases Erosion Resistance: By improving soil structure, organic fertilizers can help prevent soil erosion, which is especially important in marginal lands, especially in areas prone to landslides. Increases Efficiency of Inorganic Fertilizer Use: Organic fertilizers can increase the effectiveness of chemical fertilizer use because organic matter can increase the availability of nutrients in the soil.

2. Liquid Fertilizer;

a. Liquid Fertilizer Production; Liquid fertilizer is a fertilizer that is dissolved in water and can be easily applied to plants through spraying or irrigation.

Liquid fertilizers can be produced from organic or inorganic materials, with different manufacturing processes. Some methods of producing liquid fertilizers include: Organic Liquid Fertilizers: Usually produced through the fermentation or dissolution process of organic materials, such as livestock manure, compost, or plant waste, using microorganisms that decompose the material.

Inorganic Liquid Fertilizer: Made by dissolving chemical fertilizers (such as urea, NPK, and KCl) in water to produce liquid fertilizer that is easily absorbed by plants through the leaves or roots.

b. Benefits of Liquid Fertilizer; Quickly Absorbed by Plants: Due to its liquid nature, liquid fertilizer can be easily absorbed by plants through the leaves and roots. This allows plants to immediately obtain the nutrients they need. More Efficient Fertilization: Liquid fertilizer allows for more even and controlled fertilization, especially for plants that require intensive fertilization or in certain conditions such as on marginal land. Can be Applied Through Irrigation Systems: Liquid fertilizer can be applied efficiently through drip or sprinkler irrigation systems, which allows for even distribution of nutrients throughout the planting area. Accelerate Plant Growth: Liquid fertilizer can provide nutrients quickly to plants that are in the active growth phase, thereby accelerating plant development. Improve Micronutrient Availability: Liquid fertilizer can be enriched with micronutrients that plants need in small amounts (such as boron, iron, manganese, copper) which are often insufficient in marginal land. Easier to Adjust Dosage: Liquid fertilizer allows farmers to adjust fertilizer dosage more easily, depending on plant needs and soil conditions.

2. Comparison Between Organic Fertilizer and Liquid Fertilizer

Aspect	Organic Fertilizer	Liquid Fertilizer
Source	Organic materials such as agricultural waste, animal manure, green manure crops	Organic or inorganic materials dissolved in water
Production Process	Composting, vermicomposting, fermentation	Dissolving fertilizer ingredients in water
Primary Benefits	Improves soil fertility, enhances soil structure, increases water retention capacity	Quickly absorbed by plants, can be applied via irrigation, accelerates plant growth
Dosage and Application	Dosage depends on soil conditions, can be applied directly or as compost	Dosage is easier to control, applied by spraying or irrigation
Effect on Soil	Increases organic matter and soil microorganisms	Does not add organic matter, but directly boosts nutrient availability

4. Use of Organic Fertilizer and Liquid Fertilizer on Marginal Land

Organic Fertilizer: Very useful for improving soil structure on marginal land that usually tends to lack organic matter. Regular use of organic fertilizer can help restore eroded soil fertility, increase the soil's capacity to store water, and support long-term plant growth. Liquid Fertilizer: More effective for providing fast nutrition to plants growing on marginal land. In soil conditions that are poor in nutrients, liquid fertilizer can provide faster nutrient intake, especially during the active growth phase or when plants experience nutrient deficiencies.

Both types of fertilizers, both organic and liquid, have significant benefits in managing marginal land. Organic fertilizers focus more on improving soil quality in the long term, increasing the soil's capacity to store water, and supporting soil microorganisms. Meanwhile, liquid fertilizers are more suitable for providing rapid nutrient intake to plants, especially in soil conditions that lack nutrients (Figure 13.1). The right combination of these two types of fertilizers can support a more sustainable and efficient agricultural system, especially in marginal land that requires extra attention in its management.

Figure 13.1, Production of Liquid Organic Fertilizer to Replace Part of Fertilizer Needs Artificial (Left) And Application Of POC On Soybean Plants

XIV. BENEFITS OF GREEN FERTILIZER AND PROCUREMENT OF GREEN FERTILIZER PRODUCING PLANTS

Benefits of Green Fertilizer

Green manure is an organic fertilizer produced from plants or plant parts that are specifically grown to be processed into fertilizer and incorporated into the soil. Some of the main benefits of green manure include:

1. Increasing Soil Fertility; Green manure enriches the soil with essential nutrients, such as nitrogen (N), phosphorus (P), and potassium (K). Legumes, such as beans, which are often used as green manure, are able to bind nitrogen from the air, thereby increasing the nitrogen content in the soil.

2. Improvement of Soil Structure; Organic matter from green manure helps improve soil structure, increases aggregation, and improves soil aeration. This is important for compacted or clayey soils, as green manure can increase the soil's ability to retain water and facilitate root penetration.

3. Reduce Soil Erosion; Green manure plants, when grown, protect the soil surface from wind and water erosion. The root system of green manure plants can hold soil particles, reduce surface runoff, and increase water infiltration.

4. Increase Soil Microorganism Activity; Green manure provides a food source for soil microorganisms after being processed into organic matter. The activity of these microorganisms is very important for nutrient cycling, decomposition of organic matter, and maintaining soil health.

5. Reducing the Use of Chemical Fertilizers; With the presence of green manure, the need for chemical fertilizers can be reduced. Green manure containing nitrogen can replace some of the nitrogen from chemical fertilizers, thereby reducing agricultural input costs and reducing the negative impact of chemical fertilizers on the environment.

6. Soil Water Retention; Green manure can increase the soil's capacity to retain water. This is very useful in areas with water shortages or during the dry season, because green manure can help maintain soil moisture longer.

Procurement of Green Fertilizer Plants

Procurement of green fertilizer producing plants can be done in several ways:

1. Selection of the Right Type of Plant; The selection of the type of green manure plant is adjusted to the condition of the land and the purpose of its use. Examples of green manure plants are legumes (such as beans, lamtoro, calliandra) and non-legumes (such as grasses and wild spinach).

2. Planting in the Area to be Improved; Green manure plants can be planted as intercrops between main crops or planted specifically in land that needs improvement. These plants are allowed to grow for some time until they reach the optimal vegetative phase, then cut and processed into the soil.

3. Utilization of Naturally Growing Plants; Sometimes, wild plants that have the potential as green fertilizer can also be utilized, such as Chromolaena odorata or nutsedge. These plants can be managed and used as green fertilizer after being cut and processed.

4. Crop Rotation and Planting Schedule; Green manure crops can be used in crop rotation with the main commodity to improve soil fertility between planting seasons (Figure 14.1). This technique helps maintain the availability of organic matter in the soil in a sustainable manner.

By utilizing green manure and green manure-producing plants appropriately, farmers can maintain soil fertility naturally, reduce dependence on chemical fertilizers, and improve the sustainability and health of the soil ecosystem.

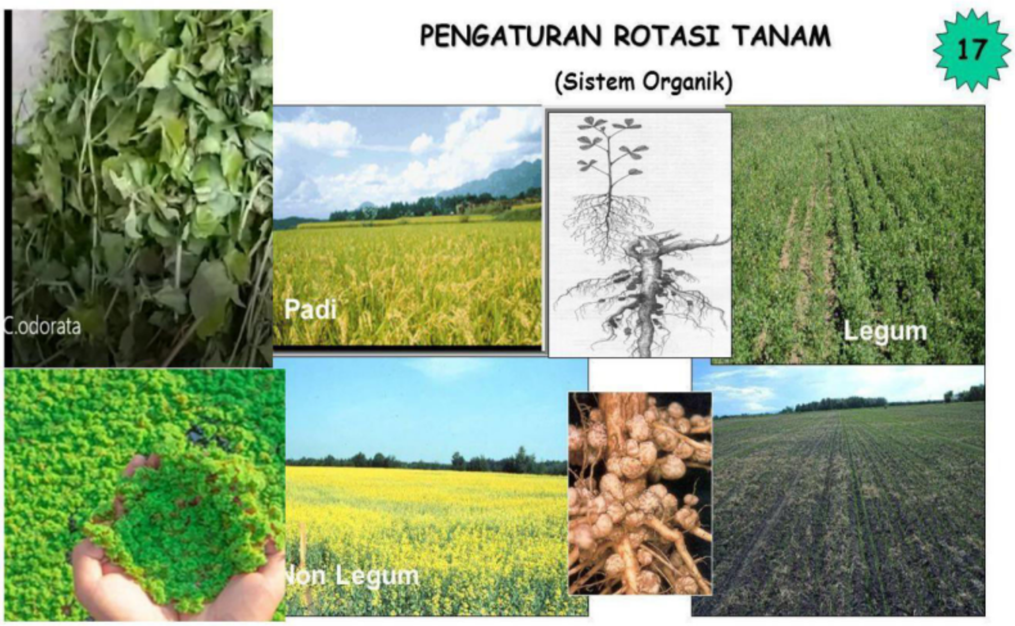

Figure 14.1 Crop Rotation and Introduction to Azolla and Chromolaena odorata a Manure Sources Rich in Nitrogen Content

XV. VARIOUS STUDIES OF PHYSICAL RECOVERY, CHEMICAL RECOVERY AND BIOLOGY

Land restoration is an effort to improve the condition of land that has experienced degradation, so that it can return to optimal function and productivity. The following are various studies of land restoration from the aspects of physics, chemistry, and biology.

1. Physical Soil Restoration

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Physical soil restoration focuses on improving the physical properties of the soil, such as structure, porosity, water retention capacity, and aggregate stability. Some physical soil restoration techniques include:

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a. Addition of Organic Materials; Addition of organic materials such as compost, manure, and biochar can increase aggregate stability and soil porosity, thereby improving aeration and water infiltration.

b. Plantation Management; The use of ground cover plants or erosion-resistant plants can protect the soil surface, improve soil structure, and reduce the impact of erosion due to wind and rain.

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c. Use of Soil and Water Conservation Techniques; Techniques such as terracing, bunds, or the creation of drainage channels can reduce runoff and erosion, thereby preventing physical degradation on sloping land or in areas prone to erosion.

d. Minimal Tillage; Minimal tillage or no-tillage techniques can reduce soil compaction and help maintain stable soil structure and aggregates.

2. Chemical Soil Restoration

Chemical soil restoration aims to improve nutrient content, pH, and neutralize toxic substances that may be present in the soil. Common methods used include:

a. Fertilization; Application of chemical or organic fertilizers aims to increase the content of nutrients such as nitrogen (N), phosphorus (P), and potassium (K) which are important for plant growth.

b. Liming; Liming is done on acidic soil to increase the soil pH. Soil that is too acidic often causes the availability of certain nutrients to decrease and can be toxic to plants. The addition of lime can neutralize soil acidity and improve the availability of nutrients.

c. Soil Amendment Application; The use of amendments such as gypsum, dolomite, or other materials can help reduce soil salinity or alkalinity, improve structure, and add minerals needed by plants.

e. Soil Detoxification; For soil contaminated with heavy metals or other toxic materials, application of certain materials (e.g., phosphate or biochar) can reduce toxicity through immobilization or adsorption, so that pollutants are not easily absorbed by plants.

3. Biological Soil Recovery

Soil biological restoration involves increasing the activity of soil microorganisms as well as using plants or other organisms to improve soil health. Some methods of soil biological restoration include:

a. Soil Microbial Inoculation; The use of beneficial microorganisms, such as Rhizobium, Azospirillum, and mycorrhiza, can increase nutrient availability and improve soil health. These microbes help bind nitrogen, dissolve phosphate, or increase water and nutrient uptake by plants.

b. Crop Rotation and Cover Crops; Crop rotation with legumes or cover crops can increase the organic matter and nitrogen content in the soil, as well as reduce the development of pathogens or pests specific to certain crops.

c. Biofertilizer or Biological Fertilizer; The use of biological fertilizers, which contain nitrogen-binding or phosphate-solvent microbes, helps provide nutrients for plants in a more natural and sustainable way.

d. Phytoremediation; Phytoremediation is a soil remediation technique that uses certain plants to absorb, accumulate, or stabilize contaminants in the soil. For example, plants such as poplar or mustard tree**s are used to absorb heavy metals.**

e. Use of Biochar and Other Organic Materials; Biochar can increase microbial activity, bind toxic substances, and provide a stable habitat for soil microorganisms. In addition, biochar also helps increase the soil's capacity to hold water and nutrients.

With a holistic restoration approach**,** which combines physical, chemical and biological aspects, degraded land rehabilitation efforts become more effective and sustainable.

CLOSING

This Marginal Land Management course is designed to provide students with an in-depth understanding of the importance of optimizing marginal land in supporting food security and environmental sustainability. Through a systematic approach, students will be equipped with theoretical knowledge and practical skills in applying appropriate technology and land management to utilize marginal land.

With this ability, it is expected that students can actively contribute to overcoming the problems faced by modern agriculture, such as limited fertile land, land conversion pressure, and climate change challenges. In addition, the skills acquired will also help students to develop agricultural innovations in the future that focus on increasing productivity and environmental conservation.

We hope that this course can strengthen the readiness of Agrotechnology Masters students in facing the increasingly complex challenges of the agricultural world. Hopefully, through the knowledge and skills gained, graduates of this course can play an important role in building a more sustainable, competitive, and positive agricultural sector for society.

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Finally, I hope this course*Marginal Land Management*This can provide benefits and positive contributions for students in developing knowledge and skills in the field of sustainable agriculture. We hope that graduates of this course can become agents of change who are able to overcome the challenges of marginal land management in the future.

BIBLIOGRAPHY

Andri, S., Nelvia, N., and Saputra, SI 2016. Application of TKKS compost and cocopeat to Ultisol subsoil soil on the growth of oil palm seedlings (*Elaeis guineensis* Jacq.) in pre-nursery.Journal of Agrotechnology, Vol. 7 No. 1 : 1 – 6.

Anonymous, 2012. Fertilizers and Fertilization of Agricultural Land. Pustaka Buana Jakarta

Asroh, A. 2010. The Effect of Manure Dosage and Interval of Biological Fertilizer Application On the Growth and Yield of Sweet Corn Plants (*Zea mays saccharata* Linn). Journal of Agronomy, 2 (4), 1–6.

Bachtiar, B., Ghulamahdi, M., Melati, M., Guntoro, D., and Sutandi, A. 2016. Nutrient sufficiency phosphorus on soybean growth and production with water-saturated cultivation in mineral and peaty soils. Journal of Soil and Environmental Science, 18(1), 21-27.

Central Bureau of Statistics. 2020. Harvested Area, Production and Productivity of Corn According to Districts/Cities in West Sumatra Province in 2018. https;//sumbar.bps.go.id Accessed on December 10, 2021.

Baka, YN, & Tematan, YB (2020). The effect of providing rice straw mulch and fertilizer chicken coops on shallot production (Allium cepa L. var. Ascalonicum). *Spizaetus: Journal of Biology and Biology Education*,*1*(2).

Basith, MIA, & Guntoro, D. (2023). Technical Plan and Cost of Tin Mine Reclamation Sangau Block B. 3 PT XYZ.*Journal of Mining Engineering Research*, 41-46.

Bockheim, J.G., Gennadiyev, A.N., Hartemink, A.E., & Brevik, E.C. (2014). Soil-forming factors and Soil Taxonomy.*Geoderma*,*226*, 231-237.

Budiman, Haryanto. 2013. Organic Corn Cultivation, New Varieties That Are Increasingly Sought After.Putra New Library. Yogyakarta. 206 pages.

Diansih, AD 2015. Effectiveness of Fresh Azolla Dosage and Application Time on Growth and Production of Long Bean Plants (*Chinese evergreen*L.) (Doctoral dissertation, Muhammadiyah University of Jember).

Fabians JD Hitijahubessy and Adelina Siregar. 2016. The Role of Organic Materials and Fertilizers NPK Compound in Determining the Acceleration of Corn Plant Growth (*Zea mays saccharata*L.). On Inceptisol Soil (A Study of Plant Growth Analysis). J. Agricultural Cultivation Vol. 12(1): 1-9 Th. 2016 ISSN: 1858-4322

Faizin, N., M. Mardhiansya and D. Yoza 2015. Response to Giving Several Doses of Fertilizer Phosphorus on Acacia Seedling Growth (*Acacia mangium*Willd.) and Phosphorus Availability in Soil. Jom.4 Faperta, 2(2): 1–9.

Faranso, D., & Susila, AD 2015. Recommendations for phosphorus fertilization in caisin cultivation (*Brassica rapa*L. cv. caisin) in andosol soil. Indonesian Journal of Horticulture,*6*(3), 135-143.

Hartatik, W. 2011. Natural Phosphate, a Cheap Source of P Fertilizer. Research and Development News. Agricultural Development,*33*(1), 10-12.

Iqbal, M., Husna, R., and Syafruddin, S. 2019. The Effect of Types of Liquid Organic Fertilizers and Concentration on Growth and Yield of Melon Plants (*Cucumber Melon*L); The Effect of Liquid Organic Fertilizer Types and Concentration on the Growth and Yield of Melon (Cucumis melo L). Agricultural Student Scientific Journal, 4(3), 11-20.

Irwan, AW, and Nurmala, T. 2018. The Effect of Compound Biofertilizer and Phosphorus Fertilizer On Soybean Growth and Yield in Inceptisol Jatinangor. Cultivation, 17(3), 750-759.

Jamilah, J. and Junearti.2014. Test Of Liquid Organic Fertilizer Originated C. Odorata And Coconut Fiber With Various Composition By Length Fermentation. Journal Of Environmental Research And Development, 9(1), 1-6.

Jamilah, & Novita, E. 2016. The Effect of Crocober Liquid Organic Fertilizer on Plants Red onion (*Allium ascalonicum*L.). Journal of Applied Science and Technology, 1. 67-73.

Jamilah, Ediwirman, & Ernita, M. 2015. The Effect of Fermented Liquid Organic Fertilizer and Potassium for Nutrient Uptake and Yield of Rice At Tropical Upland. J. Environ.Res.Develop., 9(04), 1–6.

Jamilah, J. (2022). The Addition of Trichoderma sp. in various types of organic liquids fertilizer to increase NPK nutrient uptake and soybean production in ultisol.*Tropical Plants*,*10*(1), 27-33.

Jamilah, J., Ahmad, R. and Ernita, M., 2020. Use of Liquid Fertilizer *Chromolaena odorata* And Potassium In Suppressing Emptiness And Increasing Yield Of Black Madras Purple Rice. Jurnal Agronida, 6(1), pp.55-63.

Jamilah, J., Kurniawan, B. and Herman, W., 2017. Response of rice plants (*Oryza sativa*L.) kabir 07 on liquid organic fertilizer Crocober Plus specifically for Padang city with an af climate. Solum Journal, 14(1), pp.18-27.

Joseph, S., Cowie, A.L., Van Zwieten, L., Bolan, N., Budai, A., Buss, W., ... & Lehmann, J. (2021). How biochar works, and when it doesn't: A review of mechanisms controlling soil and plant responses to biochar.*Gcb Bioenergy*,*13*(11), 1731-1764.

Jusmar, AA 2014. The effect of humic acid administration on growth and yield chili plants (*Capsicum annum*L.). Faculty of Agriculture, Tamansiswa University, Padang.

Ministry of Agriculture. 2015. Empowerment Module in Special Efforts to Improve Rice, Corn and Soybean Production in 2015. Cooperation between the Indonesian Ministry of Agriculture and Universities. Jakarta. 34 pages.

Kristina, N. 2016. The Effect of NT45 Fertilizer and Phosphate Fertilizer on Growth and Yield of Peanut Plants. Journal of Agrotechnology,*6*(2), 9-14.

Khotimah, SN, & Widayati, S. (2022). Technical and Economic Plan of Mine Reclamation at PT. X Baleendah.*Journal of Mining Engineering Research*, 65-74.

Marjenah, 2012. Morphological Response of Agarwood Seedlings (*Aquilaria malaccensis*Lamk) Against Differences in Application Techniques and Concentration of Liquid Organic Fertilizer. National Seminar of the Indonesian Wood Research Society XV. Faculty of Forestry, Hasanuddin University, Makassar, Indonesia. November 6-7, 2012

Marjenah, Kustiawan, W., Nurhiftiani, I., Sembiring, KHM and Ediyono, RP 2017. Utilization of Fruit Peel Waste as Raw Material for Making Liquid Organic Fertilizer. – J Hut Trop 1(2): 120-127.

Maulana, AI, Alfandi, A., & Wahyuni, S. 2017. Effect of Phosphate and Dolomite Rock Doses On the Growth and Yield of Peanuts (*Arachis Hypogaea*L) Tuban Cultivar. Agroswagati Journal of Agronomy,*5*(2).

Maulana, I., ES Bayu, LAP Putri. 2015. Evaluation of Morphological Characters and Production of Mutants Rice with Different Applications of N and P Fertilizers. Online Journal of Agrotechnology, Vol. 1 (4): 1120 – 1129

Mulyani, SI, and Jumiati, E. 2014. Increasing rice productivity through a sustainable approach. Integrated Plant Management Field School (SLPTT) in Sesayap Hilir District, Tana Tidung Regency. Agrifor: Journal of Agricultural and Forestry Sciences, 13(1), 75- 84.

Munar, A., Bangun, IH, and Lubis, E. 2018. Growth of Pakchoi Mustard Greens (*Brassica rapa*L.) On the Application of Cocoa Pod Peel Bokashi Fertilizer and Kepok Banana Peel Poc. AGRIUM: Journal of Agricultural Sciences, 21(3), 243-253.

Noza, A., H., AA Yetti., Khoiri, 2014. Effect of Dolomite and N, P, K Fertilizers On the Growth and Production of Sweet Corn Plants (*Zea mays saccharata* Sturt) in Peatlands.

Nurhidayati. 2017. Soil Fertility and Health. Inti Media. Malang.

Nuryani, E., Haryono, G., and Historiawati. 2019. Effect of Dosage and Time of Administration P Fertilizer on Bean Plant Yield (*Phaseolus vulgaris*, L.) Upright Type. Journal of Tropical and Subtropical Agricultural Sciences, 4(1): 14–17.

Paeru, RH., and Dewi, TQ. 2017. Practical Guide to Corn Cultivation. Penebar Swadaya. Jakarta.

Pandey, R., Krishnapriya, V., & Bindraban, P.S. 2013. Biochemical Nutrient Pathways in Plants Applied as Foliar Spray : Phosphorus and Iron Biochemical Nutrient Pathways in Plants Applied as Foliar Spray : Phosphorus and Iron,Division of Plant Physiology, Indian Agricultural ResearchInstitute, New Delhi 110012, INDIA, Washington, DC, USA.23p

Podungge, F., N. Musa, and W. Pembengo. 2019. The Effect of Time Interval Level Water Supply for Growth and Yield of Chili Pepper Plants (*Capsicum frutescens* L.). Journal of Agrotechnotropics, 3(8), 262-268.

Poerwanto, R., and Susila, AD 2021. Horticultural technology. PT Penerbit IPB Press. Pratama, RA 2019. Application of Benzyl Amino Purine (BAP) and Plant Growth Promoting Rhizobacteria (PGPR) on Edamame Production (*Glycine max*(L.) Merrill). Agro Wiralodra, 2(1), 23-28.

Purba, T., Situmeang, R., Rohman, HF, Mahyati, M., Arsi, A., Firgiyanto, R., Suhastyo, AA 2021. Fertilizers and Fertilization Technology. Our Writing Foundation.

Purnomo, MR, Panggabean, EL, and Mardiana, S. 2020. Response to Mixed Administration Baglog Compost with Cow Manure and Liquid Organic Fertilizer (POC) from Palm Oil Mill Liquid Waste on the Growth and Production of Long Bean Plants (*Chinese evergreen*L.). Scientific Journal of Agriculture (JIPERTA), 2(1), 33-43.

Rayes, ML (2017).*Soil morphology and classification*. Brawijaya University Press.

Rengganis, RD, Hasanah, Y., & Rahmawati, N. 2014. The Role of Arbuscular Mycorrhizal Fungi and Rock Phosphate Fertilizer on Soybean Growth and Production (*Glycine max*(L.) Merrill). Journal of Agroecotechnology, University of North Sumatra.*2*(3),1087- 1093.

Rezky FL 2018. The Effect of the Amount of Water Given with the Drip Irrigation System on Growth and Yield of Purple Eggplant Plants (*Solanum melongena*l.). Agrohita Journal. 2(2):10-19.

Rizal, S. 2017. The effect of nutrients given on the growth of mustard greens pak choi (*Brassica rapa*L.) Which is grown hydroponically. Sainmatika: Scientific Journal of Mathematics and Natural Sciences, 14(1), 38-44.

Roosenani, A., Susanti, A., and Kurniawan, DW 2020. Study of Cow Manure Fertilizer and Differences in Urea Fertilizer Dosage on Sweet Corn Plant Growth (*Zea mays saccharata*Sturt.). Exact Papers in Compilation (EPiC), 2(03), 273-280.

Soemarsono. 2011. Rice Farming. CV Yasaguna. Jakarta. 231p

Sugiono, S., & Purwanti, EW 2019. Effectiveness of Natural Phosphate Fertilizer on Plant Growth and Corn Crop Production (*Zea mays*L.). Agriekstensia: Journal of Applied Research in Agriculture.*18*(1), 8-16.

Suiatna, U. 2010. Organic Rice Farming Pattern Sri. Padi Bandung Publisher. West Java

Susilawati, S., Wardah, W., and Irmasari, I. 2016. The Effect of Various Light Intensities on the growth of Cempaka seedlings (*Michelia champaca*L.) in Nursery. ForestSains, 14(1), 59-66.

Sutoro. 1985. Estimation Method of Leaf Area of Corn Plants (Zea mays L) Thesis Postgraduate Program of IPB, Bogor. 126 pages.

Suwarno, A., Habibah, NA, and Herlina, L. 2013. Growth response of orchid plantlets *Phalaenopsis amabilis*L. var. Jawa Candiochid due to gamma ray irradiation. Life Science, 2(2).

Triadi, LBB (2020). Peatland restoration through rewetting and paludiculture.*Journal of Water Resources*,*16*(2), 103-118.

Wahyudi, A., Setiono, S., and Hasnelly, H. 2018. The Effect of Providing Bokashi Fertilizer Cow Dung on the Growth and Yield of Red Ginger Plants (*Zingiber officinale* Rosc). Journal of Agro Science, 3(2).

Wahyudin, A., Ruminta., and SA Nursaripah. 2016. Plant Growth and Yield Corn (*Zea mays*L.) Herbicide Tolerance Due to Administration of Various Doses of Potassium Glyphosate Herbicide. Journal of Cultivation. 15(2): 86-91.

Wahyunindyawati, F., Kasijadi & Abu. 2012. Effect of Providing Biogreen Organic Fertilizer Granules on the Growth and Yield of Red Onion Plants. Journal of Basic Science and Technology. (1), pp. 21-25

Widodo, HH and Sudrajat. 2016. The role of calcium fertilizer in oil palm plants (*Elaeis guineensis*jacq.) has not produced. Agrohorti Bulletin, 4(3), 276-281. Winimasari, DI, B. Waluyo and Kuswanto. 2018. Genetic Diversity of 11 Eggplant Genotypes (*Solanum melongena*L.) Local. Crop Production. 6(7) : 1412-1418.

Zahoor SA, A. S, Altaf, MG Sughra, TH Tanveer. 2014. Evaluation and selection of bread wheat genotypes grown under different environments. Internet. Biotechnol. Color J. 4(1): 8-14.

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