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THE INFLUENCE OF SOIL TEXTURE TYPES ON LAND RESILIENCE TO DROUGHT IN SOUTH NIAS

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Abstrak

Penelitian ini bertujuan untuk menganalisis pengaruh tipe tekstur tanah terhadap ketahanan lahan terhadap kekeringan di Nias Selatan, dengan fokus pada kapasitas tanah dalam mempertahankan kelembaban selama musim kemarau yang panjang. Data yang dikumpulkan mencakup tipe tekstur tanah (pasir, debu, liat, dan lempung) serta sifat fisik tanah yang mempengaruhi retensi air. Hasil penelitian menunjukkan bahwa tanah bertekstur pasir memiliki kapasitas menahan air yang rendah, menjadikannya sangat rentan terhadap kekeringan, sementara tanah liat, meskipun memiliki retensi air tinggi, sering mengalami masalah drainase yang buruk. Tanah bertekstur lempung, yang merupakan campuran antara pasir, debu, dan liat, menunjukkan ketahanan yang lebih baik terhadap kekeringan, dengan keseimbangan antara retensi air dan drainase. Penelitian ini juga mengidentifikasi pentingnya strategi pengelolaan tanah yang sesuai dengan tipe tekstur tanah untuk meningkatkan ketahanan lahan terhadap kekeringan, termasuk penggunaan mulsa, irigasi tetes, dan peningkatan kadar bahan organik. Berdasarkan temuan ini, disarankan untuk menerapkan teknik konservasi tanah yang lebih efektif guna mendukung keberlanjutan pertanian di Nias Selatan.

Kata Kunci *Tekstur tanah; ketahanan lahan; kekeringan; retensi air;pengelolaan tanah, agroklimat; irigasi tetes.*

Abstract

This study aims to analyze the influence of soil texture types on land resilience to drought in South Nias, with a focus on the soil's capacity to retain moisture during prolonged dry seasons. The collected data include soil texture types (sand, silt, clay, and loam) and physical soil properties that affect water retention. The results indicate that sandy soils have low water-holding capacity, making them highly vulnerable to drought. In contrast, clay soils, while having high water retention, often face poor drainage issues. Loamy soils, which are a mixture of sand, silt, and clay, demonstrate better drought resilience due to a balanced capacity for water retention and drainage. The study also highlights the importance of soil management strategies tailored to soil texture types to enhance land resilience to drought. These include mulching, drip irrigation, and increasing organic matter content. Based on these findings, the

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application of more effective soil conservation techniques is recommended to support sustainable agriculture in South Nias.

Keywords: *Soil texture; land resilience; drought; water retention; soil management; agroclimate; drip irrigation.*

A. Introduction

Drought is one of the major challenges in the agricultural sector, particularly in tropical regions with irregular seasonal rainfall. It poses a serious threat to agricultural productivity in these areas, where the majority of farming activities depend heavily on consistent rainfall patterns. The impacts of climate change, including rising temperatures and altered precipitation patterns, have exacerbated drought conditions in many tropical regions (Houghton, 2021). Uneven rainfall distribution throughout the year can lead to prolonged dry spells, threatening food security and reducing agricultural yields (Mishra & Singh, 2019). In Indonesia, this phenomenon is occurring with increasing frequency. Most regions, including areas such as South Nias, are highly dependent on the rainy season for agricultural activities. The lengthening of the dry season has further intensified the vulnerability of these regions. South Nias, in particular, is prone to the impacts of drought due to its predominantly highland geography and the dominance of dryland farming systems.

Land resilience to drought is a crucial factor in agriculture, especially in areas experiencing extended dry periods like South Nias. One of the primary factors influencing land resilience is soil texture. Soil texture, defined by the proportion of sand, silt, and clay particles, plays a significant role in determining the soil's capacity to retain and transmit water. According to Nasution et al. (2022), loamy soils tend to exhibit better drought resilience compared to sandy soils, due to their balanced composition and improved water retention capacity. Soils with a sandy texture have large pore spaces, allowing water to move quickly through the soil profile (Abdullah et al., 2021). However, the water-holding capacity of sandy soils is relatively low, making them prone to rapid moisture loss, which can be detrimental to plant growth. In contrast, clay-textured soils have smaller and denser pore spaces, enabling them to retain water for longer periods. Nevertheless, if the clay becomes overly compacted, it may suffer from poor drainage, which can hinder water movement and root development.

Loamy soils, which are a balanced mixture of sand, silt, and clay, provide an optimal equilibrium between water retention and drainage. This balance is crucial to ensure the availability of water for plants under varying environmental conditions, particularly during prolonged dry periods

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(Zhang et al., 2020). One of the key factors influencing land resilience to drought is soil texture. Soil texture, which refers to the relative composition of sand, silt, and clay particles, plays a critical role in determining soil physical properties, such as water retention capacity, infiltration, and porosity (Bouma, 2019). Coarse-textured soils like sand tend to have large pore spaces, resulting in low water-holding capacity, as water quickly infiltrates and becomes less available to plants (Lehmann et al., 2020). On the other hand, fine-textured soils such as clay possess a higher water retention capacity, but they often suffer from poor drainage, which may impede root development and cause stress due to reduced oxygen availability.

Soils with a sandy texture tend to dry out quickly and require more frequent irrigation, increasing their vulnerability to drought (Kumar et al., 2021). In contrast, while clay soils retain moisture for longer, excess water can become trapped within compacted soil layers, leading to anaerobic conditions that restrict root respiration and nutrient uptake (Lehmann et al., 2020). Therefore, understanding soil texture is essential for designing appropriate soil and water management strategies in drought-prone regions.

Loamy soils, which are a mixture of sand, silt, and clay, offer a more balanced water retention capacity and are generally more suitable for maintaining soil moisture during dry seasons. However, they still require proper drainage management to prevent waterlogging (Zhang et al., 2022). A study by (Soedjito et al. 2019) highlighted that soils with a well-balanced texture can enhance drought resilience by optimizing the soil's ability to retain and transmit water according to plant needs. In the highland areas of South Nias, the types and textures of soil vary significantly, influenced by factors such as elevation, land use, and vegetation cover. Therefore, it is crucial to investigate how the specific soil texture types in this region affect land resilience to drought, particularly in terms of water-holding capacity, water use efficiency by crops, and their ultimate impact on agricultural yields. Understanding these relationships is essential to support sustainable agricultural systems, especially in rainfed farming areas where water availability is highly seasonal and unpredictable.

Several previous studies have highlighted the relationship between soil texture and water retention capacity. For instance, a study by (Fadhli & Andayono 2021) revealed that soil texture significantly influences the infiltration rate in agricultural lands. Similarly, (Wijayanti et al. 2022) confirmed that the soil's ability to retain water is heavily affected by the clay fraction and organic matter content, both of which are closely related to the soil texture type. However, specific studies focusing on the

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influence of soil texture on land resilience to drought in local contexts such as South Nias remain scarce. This makes the present research essential as a scientific foundation for land-use planning, soil and water conservation, and climate change adaptation in agriculture. The outcomes of this study are expected to offer practical recommendations for farmers, agricultural extension agents, and local policymakers to manage land more efficiently and improve drought resilience.

Understanding how soil texture affects land resistance to drought in South Nias is still limited. Therefore, research focusing on the interaction between soil texture and drought resilience in this region is crucial. Such studies can provide the necessary insights to develop effective land management strategies, enhance water-use efficiency, and ensure the sustainability of agricultural production in South Nias.

B. Research Method

This study employs a library research method, which involves the collection, review, and analysis of secondary data from various relevant scientific sources (Sukmadinata, 2016). Library research is a method used to gather, examine, and analyze data obtained from existing literature, including books, journal articles, research reports, and other academic documents (Creswell, 2014).

The primary objective of this approach is to explore and synthesize previous research findings related to the influence of soil texture types on land resilience to drought, particularly within the context of highland regions such as South Nias. The method allows for a comprehensive understanding of how different soil compositions-such as sand, silt, and clay-affect soil's water retention capacity and overall drought resistance.

By reviewing current and credible scientific literature, the study aims to provide a conceptual framework and recommendations that can be used to support sustainable land management practices in drought-prone agricultural areas.

1. Research Approach

The research adopts a qualitative-descriptive approach, focusing on the identification, review, and synthesis of prior studies relevant to the research topic (Flick, 2018). This study examines the types and characteristics of soil textures, including sand, silt, clay, and loam combinations, and their influence on land resilience to drought.

Moreover, the study explores the physical properties of soils that affect their water-holding capacity, a critical factor in maintaining soil moisture during dry seasons. The review also covers key concepts and indicators of land drought resilience, analyzing how these elements interact with local agroclimatic conditions.

In addition, the research investigates the agroclimatic characteristics and land-use patterns in South Nias, aiming to provide a

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comprehensive understanding of land management in the region. The synthesis of findings from various scholarly sources is expected to contribute new insights into strategies for improving land resilience against drought.

2. Data Sources

In this study, secondary data were collected from various credible sources to ensure the accuracy and completeness of the literature review (Babbie, 2013). These sources included peer-reviewed scientific journal articles, textbooks on agriculture and soil science, research reports, seminar proceedings, and official documents from government and research institutions such as the Meteorological, Climatological, and Geophysical Agency (BMKG), the Central Statistics Agency (BPS), and the Soil Research Institute. Additionally, literature searches were conducted through various online databases such as Google Scholar, Scopus, ResearchGate, and DOAJ. To maintain the relevance and quality of the data, inclusion criteria were established, focusing on literature published since 2015, with a priority given to articles from 2022 onward. These sources were required to have a direct relevance to the topic of soil texture, water retention, and land resilience to drought, and must be scientific in nature, supported by a peer-review process to ensure the credibility of the information used in this study.

3. Research Steps

a. Identification and Selection of Sources

The researcher conducted an in-depth literature search using a variety of relevant keywords to ensure the completeness and accuracy of the information. Keywords used included soil texture, drought resistance, soil moisture retention, Nias Selatan, and upland agriculture. This search was conducted across various platforms and scientific databases, such as Google Scholar, Scopus, ResearchGate, and DOAJ, to find journal articles, research reports, and other relevant sources related to the topic. These keywords were selected because they encompass critical aspects relevant to the study, such as the impact of soil texture on drought resistance and the soil's ability to retain moisture.

Additionally, by including Nias Selatan and upland agriculture, the researcher ensured that the literature found was directly related to the conditions and agricultural practices in the study area. This approach ensures that the gathered literature is not only scientifically valid but also specific to the region under investigation, allowing for a more focused and localized analysis of the topic (Patton, 2015).

b. Literature Review

Each selected article or reference will be analyzed in depth to evaluate its suitability and relevance to the research focus. The analysis process begins by examining the fundamental concepts presented in each reference, such as the basic theory of soil

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texture, the soil's ability to retain water, and land drought resistance. The researcher will then assess the findings presented in these studies, evaluating whether the results support or enrich the understanding of the relationship between soil texture and land resilience.

Following this, an evaluation of the appropriateness of each reference within the context of this study will be carried out, particularly focusing on the impact of soil texture on drought resilience in Nias Selatan. Articles that provide insight into local factors, agroclimatic conditions, and agricultural practices in the region will be prioritized for inclusion in the literature review. This approach ensures that the researcher can obtain a more comprehensive and contextually relevant understanding of the topic, which will ultimately enrich the analysis and recommendations for managing land resilience against drought.

c. Data Analysis and Synthesis

The data gathered from various sources will be organized and synthesized to provide a clear picture of the influence of soil texture types on land resilience to drought. Each soil texture type—such as sand, silt, and clay—will be analyzed to determine how its physical characteristics affect the soil's ability to store and drain water, as well as its resistance to drought. This analysis will focus on the relationship between soil texture and key factors like water retention capacity, infiltration rate, and drainage efficiency.

Additionally, the research will highlight case studies conducted in regions with agroclimatic conditions similar to Nias Selatan to understand the relevance of these findings in the local context. Based on the results from previous studies, the researcher will develop recommendations for soil management strategies, including water conservation techniques, the selection of suitable crops, and soil management practices that can improve drought resilience.

The synthesis aims to provide a robust scientific foundation for more efficient and sustainable land management practices in Nias Selatan, which will help enhance agricultural productivity and drought resistance in the region. By combining theoretical insights and practical case studies, the research will offer actionable recommendations for local stakeholders, including farmers, agricultural extension services, and policymakers.

d. Compilation of Study Results

All results obtained from the literature review will be systematically organized, beginning with the identification of soil texture types and their impact on land resilience to drought. These results will then be linked to the local context of Nias Selatan, considering factors such as agroclimatic conditions, land use, and agricultural practices typical to the region. Each finding

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from previous studies will be correlated with field conditions in Nias Selatan to ensure the relevance and applicability of the research outcomes.

This approach aims to provide comprehensive conclusions regarding how soil texture influences land resilience to drought in the region. The findings will not only contribute to understanding the current state of land management in Nias Selatan but also guide future research directions. The study will propose further research areas, such as exploring other factors that may affect land resilience to climate change, including land cover types, water availability, and socio-economic factors influencing agricultural practices.

By synthesizing the data in a manner that links theory with practice, this section aims to present actionable insights that can be used by local stakeholders, such as farmers, extension workers, and policymakers, to improve land management strategies. Additionally, recommendations for future studies will be presented to enhance the understanding and management of drought resilience in Nias Selatan.

C. Results and Discussion

Results

This study aims to understand how various soil textures, such as sand, silt, clay, and loam combinations, influence land resilience to drought in Nias Selatan. The research examines the effect of soil texture on water retention capacity and the soil's ability to support plant growth during the dry season.

1. Effect of Soil Texture on Land Resilience

Based on the collected data analysis, it was found that soil texture has a significant impact on land resilience to drought. Soil texture, determined by the proportion of sand, silt, and clay, plays a crucial role in the soil's ability to store and transmit water. Sandy soils have low water retention capacity because their large pore spaces allow water to quickly drain out of the soil profile (Bouma, 2019). As a result, such soils experience rapid moisture depletion during the dry season, making them highly susceptible to drought (Zhang et al., 2020).

In contrast, clay soils exhibit high water retention capacity. The fine particles of clay enable the soil to hold water for a longer period. However, the compact structure of clay soils can lead to poor drainage, hindering the movement of air and water, and disrupting root growth (Lehmann et al., 2020). This condition can cause waterlogging around the roots, increasing the risk of physiological stress on plants, despite the high water content in the soil.

Meanwhile, loam soils, which are a balanced mixture of sand, silt, and clay, tend to exhibit the most ideal physical properties. Loam soils have good water retention capacity while providing adequate drainage and aeration for plant growth. This balance

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makes them more resistant to drought compared to soils dominated by sand or clay (Hillel, 2013; Liang et al., 2022).

The results of this study align with previous research, highlighting the relationship between soil texture and water retention capacity. Sandy soils, due to their large pores, are prone to water loss, making them vulnerable during extended dry periods. This finding confirms the need for effective water management strategies in regions with sandy soils, such as Nias Selatan, especially during the dry season. On the other hand, while clay soils can retain water for longer periods, their tendency to create waterlogged conditions can lead to root stress, reducing plant productivity. Therefore, improving soil drainage is a key consideration in areas dominated by clay, particularly during the wet season, to ensure that the soil's water retention capabilities are optimized without harming plant roots.

Loam soils, with their balanced characteristics, provide a more stable environment for plant growth during both dry and wet periods. Their combination of good water retention and adequate drainage makes them more resilient to drought, thus supporting sustainable agriculture in regions with seasonal rainfall, such as Nias Selatan. This study also emphasizes the importance of understanding local agroclimatic conditions when managing land for drought resilience. In Nias Selatan, where dry seasons can extend for long periods, managing soil texture through practices such as mulching, organic matter addition, and crop selection can enhance land resilience to drought. Additionally, appropriate water management techniques like drip irrigation can further improve the efficiency of water use in agriculture, particularly for sandy and clay-rich soils.

By recognizing the importance of soil texture in drought resilience, local farmers and policymakers can make informed decisions about land use and water conservation practices that can mitigate the impacts of drought and improve agricultural productivity in Nias Selatan.

2. Case Study in Regions with Characteristics Similar to Nias Selatan

Case studies in regions with characteristics similar to Nias Selatan, such as several areas in the highlands of Sumatra, reveal similar patterns regarding the relationship between soil texture and land resilience to drought. In these regions, sandy soils require more intensive management, including the use of mulch to reduce evaporation and drip irrigation systems to maintain soil moisture during long dry seasons (Zhang et al., 2020). Mulch helps maintain soil moisture by shielding the soil surface from direct sunlight, reducing the rate of water evaporation, and improving soil moisture retention. Additionally, appropriate irrigation management ensures an adequate

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water supply for crops, even though sandy soils have limited water retention capacity (Lehmann et al., 2020).

On the other hand, clay soils tend to require conservation techniques focused on erosion prevention and effective drainage management. Dense clay soils can impede the movement of water and oxygen, which are crucial for plant root health. Therefore, soil conservation measures that improve soil structure and enhance water flow are essential to prevent waterlogging and promote healthy plant growth (Bouma, 2019).

In Nias Selatan, much of the agricultural land is located in the highlands with varying agroclimatic conditions. The soil in this region is mostly loamy, with varying proportions of sand and silt, which influences its resilience to drought. Observations indicate that land resilience to drought in Nias Selatan is influenced not only by soil texture but also by farming practices implemented by local farmers. Some agricultural practices, such as soil tillage methods, crop selection, and the use of organic materials that enhance the soil's water retention capacity, play a significant role in improving soil resilience to drought. The use of organic materials, such as compost or manure, helps improve soil porosity, which in turn enhances the soil's ability to absorb and retain water (Zhang et al., 2020).

In Nias Selatan, farmers have adapted to the challenges posed by the long dry season and varying soil types by incorporating these practices into their agricultural systems. The combination of loamy soil's favorable water retention and drainage capacity, along with good water management practices, makes this region more resilient to drought. Additionally, the implementation of sustainable farming practices such as organic farming and crop rotation can further improve soil health and drought resilience. However, challenges remain in areas where the soil texture is predominantly sandy or clayey. For sandy soils, the primary challenge is maintaining adequate moisture during dry periods, which can be mitigated through mulching and drip irrigation. For clayey soils, ensuring good drainage and preventing waterlogging are the key concerns. By integrating conservation practices and improving soil management, such as increasing organic matter content, farmers in Nias Selatan can enhance the overall sustainability and resilience of their farming systems.

3. Influence of Agroclimatic Factors on Land Resilience

Agroclimatic factors in Nias Selatan, such as rainfall, temperature, and humidity, play a crucial role in determining land resilience to drought. The unpredictable climate conditions in this region, particularly the long dry season, exacerbate the soil's ability to retain moisture. In particular, sandy soils, which tend to lose moisture quickly, are

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severely impacted by the prolonged decrease in rainfall during the dry season (Zhang et al., 2020). Sandy soils have large pores, allowing water to quickly percolate through the soil, but they cannot retain water for extended periods, making them highly vulnerable to drought (Lehmann et al., 2020).

On the other hand, clay soils have a better water retention capacity; however, drainage difficulties arise due to their denser structure. This can hinder the movement of water and oxygen, which are essential for plant root growth (Bouma, 2019). While clay soils are capable of storing water for a longer period, improper drainage can lead to waterlogging, which stresses plants due to lack of aeration. This imbalance in water retention and drainage highlights the importance of effective land and water management practices to tackle drought challenges in areas with varying agroclimatic conditions like Nias Selatan.

The effective management of natural resources, utilizing soil conservation techniques, efficient irrigation practices, and appropriate water management, can help improve land resilience to drought. This ensures that agriculture can continue to thrive, even in the face of unpredictable climate change. Furthermore, addressing agroclimatic issues through adaptive agricultural practices can significantly mitigate the adverse effects of the long dry season, helping farmers in Nias Selatan to maintain sustainable agricultural practices and increase their resilience against drought.

4. Recommendations for Land Management Strategies

Based on the findings of this study, several land management strategies can be implemented to improve land resilience to drought in Nias Selatan:

a. Use of Mulch for Sandy Soils:

Mulching on sandy soils can significantly reduce water evaporation and maintain soil moisture, especially during prolonged dry spells. By covering the soil surface with organic or synthetic mulch, the moisture retention is improved, preventing the rapid loss of water from the soil (Zhang et al., 2020). This method is crucial for sandy soils, which naturally have lower water retention capacity.

b. Increase Organic Matter in Clay Soils:

Enhancing the organic matter content in clay soils can improve their aeration and drainage. The dense nature of clay soils can hinder water movement and root growth, leading to waterlogging. By increasing the organic content, the soil structure is improved, allowing better water infiltration and reducing the likelihood of drainage problems. This can help mitigate stress caused by excessive water retention in the rainy season, while also improving drought resilience during dry periods (Lehmann et al., 2020).

c. Use of Drip Irrigation for Sandy Soils:

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Drip irrigation is an efficient water management technique that delivers water directly to the root zone of plants, minimizing water waste. For sandy soils, where water quickly percolates through and is lost, drip irrigation can help maximize water efficiency by ensuring that the plant roots receive the necessary moisture while minimizing evaporation and surface runoff (Zhang et al., 2020).

d. Planting Cover Crops with Deep Roots:

Planting cover crops with deep root systems can help reduce soil erosion, especially on sloped or exposed lands, while simultaneously improving the soil's water retention capacity. These crops can help maintain soil structure and provide organic material that enhances soil fertility. Additionally, their deep roots can break up compacted soil layers, improving infiltration and water availability for crops (Lehmann et al., 2020).

The study highlights the significant influence of soil texture on land resilience to drought in Nias Selatan. Soils with loamy texture offer the best drought resistance, as they maintain a balanced capacity for water retention and drainage. Therefore, adopting land management strategies tailored to the specific texture of the soil is critical for enhancing land resilience and supporting the sustainability of agriculture in this region.

Further research is recommended to develop more localized soil conservation technologies suited to the specific conditions of Nias Selatan. These innovations could improve land resilience against climate change, boost agricultural productivity, and provide farmers with practical tools to manage water resources more effectively in the face of increasingly unpredictable weather patterns.

Discussion

This study aims to examine the impact of soil texture types on land drought resistance in South Nias, a region predominantly consisting of highland areas with a seasonal rainfall pattern. As one of the tropical regions with a relatively varied climate, South Nias faces significant challenges regarding land management during the long dry season. In this context, soil texture plays a crucial role in determining soil resistance to drought and the availability of water for crops.

Impact of Soil Texture on Land Resistance to Drought

One of the main findings of this study is the significant difference between sandy, clay, and loam soils in terms of water retention capacity and resistance to drought. Sandy soil has a low water retention capacity, meaning that water quickly drains and flows deep into the soil, leaving little moisture in the surface layers. This makes sandy soil highly susceptible to drought, especially during long dry seasons, as soil moisture quickly dissipates.

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Clay soil has a high water retention capacity, allowing it to retain moisture longer than sandy soil. However, clay soil often faces drainage issues. Due to its dense and compact texture, water trapped in the soil often cannot flow properly, which can lead to waterlogging on the surface and in the deeper layers of the soil (Lehmann et al., 2020).

Although clay soil can store moisture for a longer period, the trapped water can hinder root growth. Plant roots struggle to access oxygen, which is essential for their growth (Zhang et al., 2020). This condition makes plants more vulnerable to water stress, even when soil moisture remains available. Excess moisture, coupled with poor drainage, can cause the roots to lack oxygen and degrade the soil quality for agriculture. Therefore, even though clay soil can retain water for extended periods, proper drainage management is key to maximizing soil resistance to drought. Soil management practices such as proper tillage and the use of efficient irrigation systems can enhance clay soil's ability to support plant growth without degrading soil quality (Bouma, 2019). Good drainage helps water flow effectively to plant roots, reducing the potential for waterlogging and promoting healthy root growth.

Loam soil, which is a mixture of sand, silt, and clay, demonstrates a more balanced result. Loam has moderate water retention, making it more resistant to drought compared to sandy soil, while still having better drainage capacity than clay soil. In this regard, loam offers a balance between drought resistance and good drainage capacity, making it an ideal choice for most crops that require adequate moisture but should not be waterlogged.

2. Agroclimatic Conditions of South Nias and Their Impact on Land Resilience

South Nias has a fairly diverse agroclimatic condition, with uneven rainfall distribution throughout the year. The region tends to experience long dry seasons, which exacerbate land conditions, especially in areas dependent on natural irrigation. The reduction in rainfall during the dry season worsens drought conditions, particularly on sandy soils, which have low water retention capacity and easily lose moisture (Bouma, 2019). Sandy soils tend to be unable to retain water for extended periods, which impacts the land's resilience to drought, making the drought effects longer-lasting and more intense.

Climatic differences can worsen the drought conditions experienced by soils with certain types. In sandy soils, which have high infiltration and drainage capacity, water quickly seeps into the soil but is lost just as quickly (Lehmann et al., 2020). Furthermore, climate change, which affects rainfall patterns, can potentially cause an imbalance between water availability and crop water requirements. Proper land management must take into account the agroclimatic factors that

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influence soil resilience to drought. Therefore, in managing land in South Nias, it is recommended to focus on conservation practices that are suitable for local climatic conditions, such as the use of efficient irrigation techniques and soil conservation to reduce water loss (Zhang et al., 2020).

3. Case Study and Soil Management Strategies

The results of this study indicate that sandy soils in South Nias require intensive management strategies. Farmers are advised to use soil conservation techniques, such as mulching, to reduce water evaporation and increase the soil's capacity to retain moisture. Additionally, the use of drip irrigation can help optimize water use on sandy soils, which are naturally deficient in moisture. The study highlights that sandy soils in South Nias need intensive management strategies to improve land resilience against drought. Sandy soils have large pores that allow water to quickly seep and drain away, leading to faster moisture loss compared to other soil types such as clay or loam (Bouma, 2019). Therefore, soil conservation techniques are necessary to retain soil moisture and reduce excessive evaporation.

One effective conservation technique is the use of mulch, which helps reduce water evaporation from the soil surface. Mulching can also improve soil structure and add organic matter that benefits plant growth (Lehmann et al., 2020). Whether using organic or plastic mulch, this method has been proven to slow down the rate of water evaporation, which is crucial for maintaining soil moisture during long dry spells, especially in regions with unpredictable rainfall patterns. In addition, drip irrigation is recommended to optimize water use on sandy soils. The drip irrigation system efficiently delivers water directly to the plant roots, reducing water wastage and ensuring that plants receive sufficient moisture (Zhang et al., 2020). This system also minimizes the likelihood of waterlogging, which can hinder root development and cause other plant health issues.

These techniques have proven effective in improving soil resilience to drought in areas with sandy soils, such as South Nias, while optimizing the use of limited water resources. For clayey soils, good drainage practices are essential to prevent waterlogging, which can harm plants. The use of cover crops and proper tillage techniques can help improve soil aeration and reduce drainage problems. On the other hand, loam soils, which have a better balance of retention and drainage, require management strategies that focus on improving organic matter, which can help enhance the soil's ability to retain water for longer periods without hindering plant growth.

4. Recommendations for Land Management in South Nias

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Based on the findings of this study, several strategic recommendations can be applied to manage land in South Nias more effectively, especially in facing the growing challenges of drought due to climate change. Below are some strategies that can be implemented:

a. Increase the use of mulch for sandy soils

To reduce the rate of water evaporation and enhance drought resistance. Using mulch, whether organic or synthetic, helps reduce direct contact between the soil and sunlight, slowing evaporation and maintaining soil moisture (Bouma, 2019). Additionally, mulch can improve soil quality by increasing organic matter content.

b. Proper soil tillage for clayey soils

To improve drainage, prevent waterlogging, and enhance aeration to support root growth. Although clayey soils have high water retention capacity, they often lack proper drainage, which can hinder plant growth (Lehmann et al., 2020). Therefore, soil management techniques such as plowing or liming are crucial to improve soil structure and water flow.

c. Implement efficient irrigation techniques

Such as drip irrigation on sandy soils, to optimize water distribution. Drip irrigation systems deliver water more efficiently and directly to the plant roots, reducing water wastage and maximizing water use in sandy soils, which tend to lose moisture quickly (Zhang et al., 2020).

d. Utilize cover crops on all soil types

To reduce erosion and improve soil moisture. Cover crops help reduce surface erosion, retain soil moisture, and add beneficial organic matter to the soil. Additionally, cover crops can enhance soil microbial life, which plays a role in the decomposition of organic materials and improving soil fertility.

By applying these strategies, it is expected that land resilience to drought in South Nias can be improved, and agricultural productivity can be maintained despite the challenges posed by climate change. Overall, this study shows that soil texture significantly influences land resilience to drought in South Nias. Loamy soil has the best drought resistance, followed by clayey soil, while sandy soil is most vulnerable to drought. Therefore, applying proper land management strategies based on soil texture is essential to enhance land resilience and reduce the impact of drought on the agricultural sector in this region.

D. Conclusion

Conclusion

Based on the findings of the study on the impact of soil texture on land resilience to drought in South Nias, it can be concluded that soil texture plays a crucial role in determining land resilience to drought. Sandy soils have low water retention capacity, making them more vulnerable to drought, particularly during long dry

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seasons. Clay soils, while having a higher capacity to retain water, often face drainage issues that can hinder plant growth. Meanwhile, loamy soils show a more balanced result between drought resistance and drainage, making them more ideal for agriculture in the South Nias region.

Additionally, the varied agroclimatic conditions in South Nias, especially the prolonged dry season, exacerbate land resilience to drought. Therefore, it is important to consider these factors when designing more effective land management strategies.

Recommendations

1. Soil Management for Sandy Soils

For sandy soils, it is recommended to use mulching techniques to reduce evaporation rates and enhance the soil's capacity to retain moisture. The use of drip irrigation is also highly recommended to maximize water use efficiency, particularly during dry seasons.

2. Improvement of Drainage for Clay Soils

For clayey soils, it is essential to implement proper drainage techniques to prevent harmful waterlogging that could negatively impact plant growth. The use of cover crops can also help improve soil aeration and prevent soil erosion.

3. Organic Matter Management for Loamy Soils

Loamy soils can be optimized by increasing organic matter content to improve soil structure and enhance the soil's ability to retain moisture without obstructing drainage. Planting cover crops can also help increase water retention and protect the soil from erosion.

3. Further Research

Further in-depth research is needed regarding specific soil management practices based on the local conditions in South Nias, as well as the exploration of modern agricultural technologies to support land resilience against climate change and drought.

4. Farmer Education and Extension

Extension services to educate farmers about the importance of soil management based on soil texture and water conservation strategies are critical for enhancing agricultural resilience in South Nias. Community-based approaches and training in appropriate technologies can help improve sustainable agricultural productivity.

By implementing these recommendations, it is hoped that land resilience in South Nias will improve, especially in facing the challenges of climate change and prolonged dry seasons.

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