

## Infiltration rates in sugar palm agroforestry: A case study in Bonelemo Barat Suso watershed

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### ABSTRACT

Agroforestry has benefits in improving ecological balance, such as helping prevent soil erosion, reducing land degradation, and improving the water cycle by slowing surface water flow and increasing infiltration into the soil. One of the agroforestries that is developing in the Suso watershed is sugar palm (*Arenga pinnata*). This research aims to identify the infiltration rate in sugar palm agroforestry and the physical soil properties that influence it. The research was carried out by measuring the infiltration rate using a double-ring infiltrometer and taking soil samples in a plot measuring 20 × 20 m, as well as identifying the vegetation in the plot by making sub-plots measuring 10 × 10 m, 5 × 5 m, and 2 × 2 m. The highest infiltration rate value on sugar palm agroforestry land is in plot 7, while the lowest is in plot 2. Plot 7 has an infiltration rate value of 102 mm/hour (medium fast), which is on a flat slope with a high canopy density (91, 29%). Plot 2 has an infiltration rate of 12 mm/hour (medium slow), which is on a steep slope with a sparse canopy density (38.76%). The presence of forest plants such as sugar palm (*Arenga pinnata*), jabon putih (*Anthocephalus cadamba*), and white teak (*Gmelina arborea*) on agroforestry land can increase the infiltration rate. The use of sugar palm agroforestry land, which combines forest plants and other plants in it, is better compared to using land with just one type.

**Keywords:** agroforestry, *Argena pinnata*, infiltration, watershed.

### INTRODUCTION

The challenge of increasing the infiltration rate in watersheds lies in human activities that damage the soil, such as deforestation. Deforestation refers to the reduction in forest area due to land-use changes influenced by population growth, agricultural expansion, and industrialization in forest areas. Vegetated land within watersheds is essential for mitigating the impact of raindrops on soil to prevent soil aggregates from being damaged, which can clog soil pores and lead to soil compaction, ultimately decreasing the infiltration rate (Tumangkeng et al., 2021). The Suso watershed is one of the watersheds in South Sulawesi, specifically located in Luwu Regency. The Suso watershed covers an area of 38,486.62

hectares. Common disasters in this watershed include flooding and landslides. Flooding occurred in 2020, affecting two sub-districts, East Lamasi and East Walenrang, with nine villages directly impacted. This highlights the lack of vegetated land in the watershed owing to land-use changes and deforestation (Maricar, 2021). Agroforestry is an approach to curbing deforestation and the conversion of land to agricultural and plantation areas, where communities can utilize the land optimally while enhancing biodiversity. Agroforestry is a land-use practice that combines agricultural and forestry crops to create an integrated and sustainable land-use system (Wulandari, 2011).

Implementing an agroforestry system provides economic and ecological value to farmers by ensuring forest resource sustainability,

reducing land degradation, increasing plant biodiversity, providing ecosystem services, conserving water resources, and preventing landslides and erosion (Qurniati, 2023).

One of the agroforestry systems developed in the Suso watershed is the cultivation of the sugar palm (*Arenga pinnata*). In the West Bajo Sub-district, for instance, specifically in Bonelemo Barat Village, which has an area of 1,900.86 hectares, sugar palms are utilized in various ways, such as producing palm sugar and traditional beverages. Additionally, the sugar palm is used to make thatched roofs and fiber brooms. Sugar palms not only provide economic benefits, but also play an essential role in maintaining ecosystem balance and ensuring the sustainability of natural resources. For example, sugar palms help to maintain soil fertility. The leaves and other parts of the tree that fall to the ground decompose and enrich the soil with organic matter (Rindiani, 2021).

This study aims to measure infiltration rates in sugar palm (*Arenga pinnata*) based agroforestry systems in the Suso watershed and to identify the biophysical factors influencing soil water infiltration, such as canopy density, vegetation type, slope gradient, and soil physical properties. According to Mulyani et al. (2025), sugar palm trees play a conservation role because their deep and extensive

root systems are highly effective in preventing soil erosion. Likewise, their dense foliage and trunks covered with fiber (ijuk) are effective in reducing the direct impact of rainfall on the soil surface, thereby minimizing surface runoff. Research on infiltration rates under sugar palm trees remains limited, therefore, this study is important for watershed management. We hypothesize that canopy density and soil physical properties in agroforestry systems improve soil characteristics and structure, thereby increasing soil water infiltration rates.

## MATERIALS AND METHODS

### Tools and materials

The tools used in this research included a measuring tape, stakes, raffia string, double-ring infiltrometer, water container, stopwatch, soil sample rings, sample bags, hammer, labels, GPS receiver, scales, oven, dropper pipette, glassware, burette, pipes, stationery, digital camera, and laptop. The materials used included soil, water, distilled water,  $K_2Cr_2O_7$ , and  $H_2SO_4$  solutions, the National digital elevation model (DEM), and the Suso watershed boundary map. The research locations and procedures are shown in Figures 1 and 2.

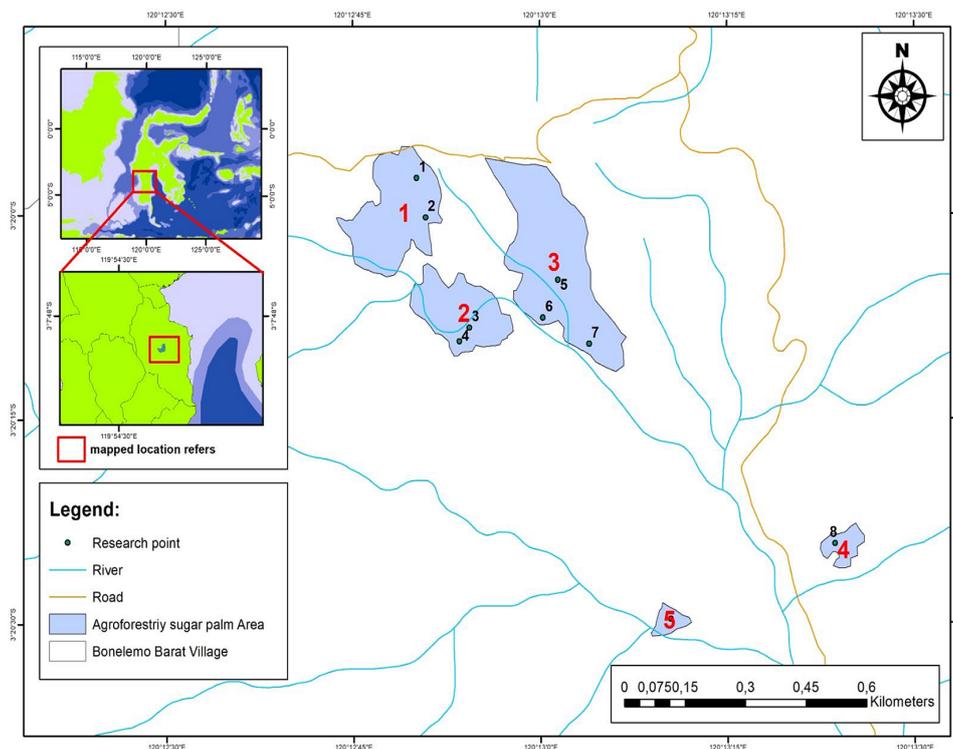


Figure 1. Research location in South Sulawesi



**Figure 2.** (a) Plot creation; (b) infiltration measurement; (c) soil sampling; (d) soil testing organic matter

Slope map creation was conducted using GIS analysis, utilizing data from the National DEM and the boundary of Bonelemo Barat Village. The results of this analysis were then divided into five slope class classifications based on the classification of (Indonesia Ministry of Forestry, 2009). The slope classes are listed in Table 1.

Canopy density analysis was conducted using ImageJ software. Canopy density photos were taken, with five images captured at each research plot, and then analyzed using the software. The photographs consisted of the canopy along with the sky in the research plot. Based on these canopy images, ImageJ software was used to determine the percentage of canopy density by comparing the pixel count of the canopy to that of the sky. The analysis results are listed in Table 2, where N represents the total number of pixels in the image, mode 255 represents the number of canopy pixels, and mode 0 represents the number of sky pixels.

**Table 1.** Five slope class classifications

Class	Slope (%)
Flat to gently sloping	0–8
Slightly sloping	8–15
Moderately sloping	15–25
Steep	25–45
Very steep	>45

The percentage canopy density was calculated using the following formula (Dharmawan, 2020):

$$\% \text{ Canopy density} = \text{mode} (255/N) \times 100 \quad (1)$$

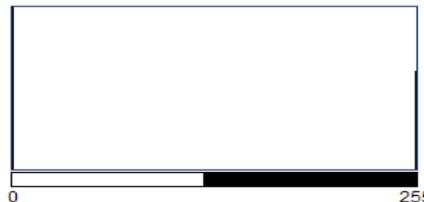
### Plot creation

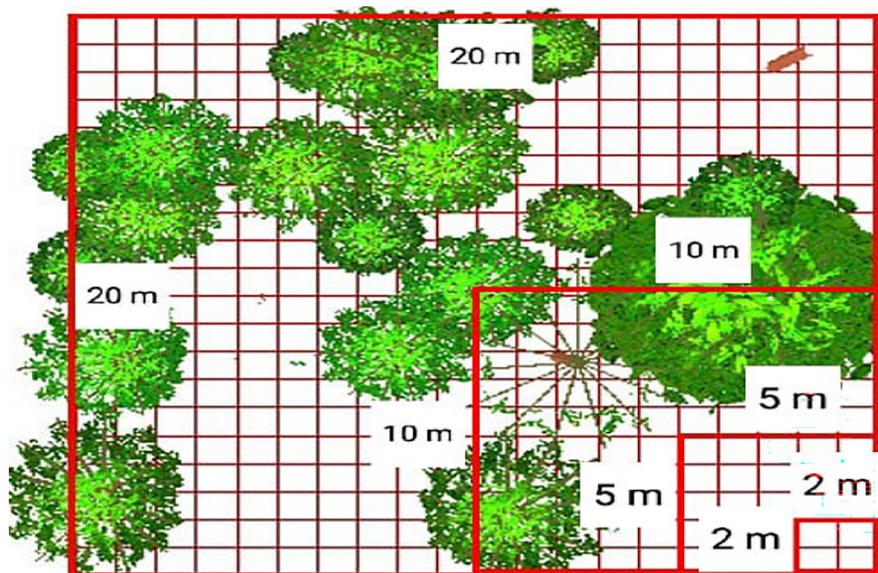
The plots were determined based on a field survey that assessed vegetation density classes and slope gradients in the agroforestry land of sugar palms in Bonelemo Barat Village. Based on the survey results, nine points with different criteria were identified as the research plots. Each plot in the study area measured 20 × 20 m for tree (Djamadi et al., 2024). Within these plots, infiltration rate measurements, soil sampling, and identification of tree vegetation and sugar palm were conducted. Additionally, sub-plots measuring 10 × 10 m, 5 × 5 m (Djamadi et al., 2024), and 2 × 2 m (Pertiwi et al., 2029) were established within each plot to assess the pole, sapling, seedling and other understory vegetation like shrubs vegetation. The layout of these plots is shown in Figure 3.

### Infiltration measurement

Infiltration rate measurements were conducted using a double-ring infiltrometer within a 20 × 20 m plot. The process begins with the preparation of all the necessary tools and materials. The double-ring

**Table 2.** Canopy density analysis using the ImageJ software

Image	Pixel analysis	Category
	 <p>N: 995328      Min: 0                      Mean: 180.322      Max: 255                      StdDev: 116.044      Mode: 255 (703841)</p>	high
	 <p>N: 995328      Min: 0                      Mean: 135.619      Max: 255                      StdDev: 127.241      Mode: 255 (529355)</p>	Medium
	 <p>N: 995328      Min: 0                      Mean: 95.859      Max: 255                      StdDev: 123.512      Mode: 0 (621165)</p>	Low



**Figure 3.** Vegetation analysis plot sketch

infiltrometer was then carefully installed in the soil by gently pressing it to ensure proper placement. Water was gradually added to the infiltrometer to avoid any disturbance. Once the water level inside the ring stabilized, the stopwatch began to timing the infiltration process. Observations were made by recording the rate at which the water level decreased over time. This procedure was continued until the water level decline reached a constant rate, indicating that the infiltration capacity of the soil was accurately measured.

### Soil sampling

Soil sampling within a 20 × 20 m plot was performed using a systematic approach. Initially, the soil surface was leveled and cleaned to prepare it for sampling. A soil-sample ring was placed vertically on the prepared surface. Using a small block, the ring was pressed into the soil until approximately three-quarters of it was embedded. A second ring was then positioned on top of the first ring and pressed down until it was approximately 1 cm into the soil. The area around the ring was carefully excavated until the first ring was completely visible. Soil beneath the first ring was also collected to ensure a complete sample. Finally, the soil within the ring was transferred into a sample bag and labelled for further analysis. This method ensured the collection of consistent and representative soil samples for accurate research outcomes.

### Vegetation identification

Vegetation identification was conducted systematically to provide a detailed assessment of the plant species and their abundance within the research plots. The process began by identifying and counting the species and number of trees and sugar palms (*Arenga pinnata*) in a 20 × 20 m plot. In the 10 × 10 m sub-plot, the focus shifted to identifying and quantifying pole-sized plants. Furthermore, within a 5 × 5 m sub-plot, saplings were identified and counted. Finally, a 2 × 2 m sub-plot was used to identify and count the seedlings and other understory plants. This comprehensive approach ensures that all layers of vegetation are accurately documented and analyzed for a thorough understanding of the plant community in the study area.

### Data analysis infiltration rate

The formula used to analyze infiltration rate is (Beven, 2004) and (Sihombing et al., 2025):

$$\begin{aligned} \text{Infiltration rate (mm/hour)} &= \\ &= (\Delta H)/t \times 60 \end{aligned} \quad (2)$$

where:  $\Delta H$  – the decrease in water height (mm) over a certain time interval,  $t$  – the time interval (minutes) required for the water at  $\Delta H$  to infiltrate into the soil (to convert minutes to hours, multiplied by 60).

### Soil texture

The percentage of soil texture can be determined using the United States Department of Agriculture (USDA) soil texture triangle.

### Bulk density and particle density

Soil collected from the field was dried in an oven for 24 h at 105 °C. Subsequently, it was weighed to determine soil bulk weight. The obtained weight data were calculated using the following formula (Harahap et al., 2021):

$$\text{Bulk density} = \text{Dry soil weight}/(\pi^2 t) \quad (3)$$

where:  $t$  – height of the ring (cm),  $d$  – diameter of the ring (cm),  $\pi = 3,14$ .

### Porosity

Porosity refers to the pore spaces in the soil that are occupied by water and air. Soil porosity was calculated using the following formula (Baver, 1933):

$$\begin{aligned} \text{Porosity} &= (1 - \text{Bulk density}/ \\ &\text{Particle density}) \times 100\% \end{aligned} \quad (4)$$

where: particle density = 2.65 g/cm<sup>3</sup>

### Soil permeability

Soil permeability indicates how easily rain-water penetrates or passes through the soil mass or layers (Minangkabau et al., 2022). This can be calculated using the following equation:

$$\begin{aligned} \text{Permeability (cm/hour)} &= \\ &= x/(1/4 \pi d^2 t) \end{aligned} \quad (5)$$

$$x = \text{Volume per layer}/0.25 \quad (6)$$

where:  $t$  – height of the ring (cm),  $d$  – diameter of the ring (cm),  $\pi = 3,14$ .

## Organic matter

Soil organic matter plays an important role in determining the physical, chemical, and biological activities in the soil, which influence the land carrying capacity and productivity (Machfud et al., 2018). The organic carbon content (*C*) and organic matter content were determined using the titration method and analyzed in the laboratory.

## RESULTS AND DISCUSSION

### Infiltration rate

The results of the infiltration rate measurements using a double-ring infiltrometer across the nine research plots are presented in the histogram in Figure 4. The measurement results of the infiltration rates across the nine research plots indicated considerable variation between plots. Figure 4 shows that the highest infiltration rate was recorded in Plot 7 at 102 mm/h, categorized as moderately rapid, reflecting the high capacity of the soil for water absorption. Conversely, the lowest infiltration rate was observed in Plot 2 at 12 mm/h, categorized as moderately slow, indicating a limited soil water absorption capacity. This variation suggests that infiltration rates are influenced by the interaction of several factors such as vegetation characteristics, canopy density, slope, and soil physical properties.

The explanations above demonstrate that the combination of vegetation, canopy density, and slope gradient strongly determines infiltration rates. The high infiltration rate in Plot 7 was supported by flat slopes, dense canopy cover, and the dominance of forest trees with large root systems.

In contrast, the low infiltration rate in plot 2 was due to the steep slopes, sparse canopy cover, and limited number of forest trees. This is consistent with (Abdul, 2017), which states that vegetation with a greater root mass can increase soil porosity and permeability, thereby accelerating infiltration.

Plot 7 shows an infiltration rate of 102 mm/h, categorized as moderately rapid. This plot is located in an area with a flat slope and high canopy density of 91.29%. It contains three understory species with a total of 34 individuals, one sapling species with one individual, one pole species with nine individuals, and two tree species with 12 individuals. The identification results showed that there were 14 *jabon* trees, seven *Arenga pinnata* trees, and one cocoa tree. Although the total vegetation in Plot 7 consisted of only 56 individuals, the presence of forest trees with high canopy density contributed significantly to the infiltration rate. This shows that dense canopy cover not only reduces surface runoff but also increases water absorption by the soil.

Plot 2 shows an infiltration rate of 12 mm/h, which was categorized as moderately slow. This plot is located in an area with a steep slope and sparse canopy density of 38.76%. The vegetation in this plot included four understory species with a total of 25 individuals, two sapling species with a total of five individuals, one pole species with three individuals, and one tree species with five individuals. The identification results showed that Plot 2 contained five *Arenga pinnata* trees, six clove trees, and two Langsat trees.

Infiltration rate analysis revealed that *Arenga pinnata* agroforestry land use, which combines forest trees and garden crops, performs better than land use consisting only of garden crops. According to [15], the greater the root mass of

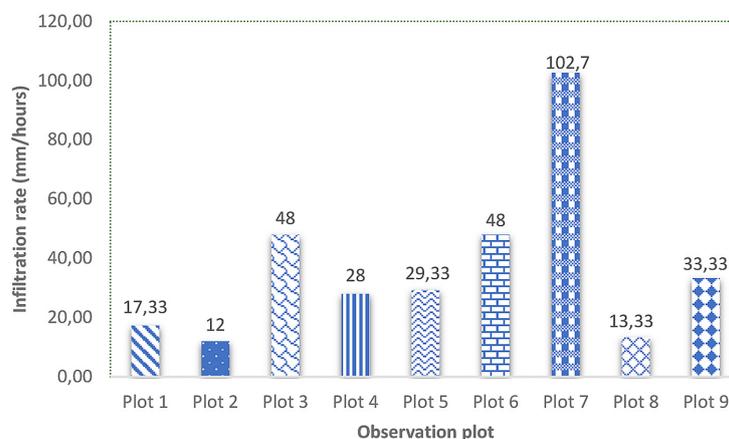


Figure 4. Infiltration rate across nine research plots

vegetation, the faster the infiltration rate, and the higher the groundwater recharge. Therefore, forest trees with larger root systems play a crucial role in improving soil porosity and permeability. This was evident in Plot 7, which recorded the highest infiltration rate, and Plot 2, which recorded the lowest infiltration rate. Plot 7 had a high canopy density and was dominated by forest trees compared to garden crops. Plot 2 not only had sparse canopy density, but also contained only five forest trees.

The presence of forest trees, such as *jabon*, *Tectona grandis* (teak), and *Arenga pinnata* (sugar palm), in the *A. pinnata* agroforestry area at the research site increased the infiltration rates. However, in some plots, higher numbers of *A. pinnata* trees did not necessarily result in higher infiltration rates. For example, Plot 8, which had nine *Arenga pinnata* trees, recorded an infiltration rate of only 13.33 mm/hour. In contrast, plot 7, with seven *Arenga pinnata* trees, achieved a much higher infiltration rate of 102 mm/h. The plot with the highest number of *Arenga pinnata* trees was Plot 6, with 10 individuals, while the lowest was Plot 9, with only two individuals. In terms of infiltration rates, Plot 6 recorded 48 mm/h, whereas Plot 9 recorded 33.33 mm/hour.

### Vegetation identification

The results of vegetation identification across the nine plots are presented in Table 3. Based on the table, Plot 7, which contained 56 vegetation individuals, was dominated by forest species, including 14 white jabon trees (*Anthocephalus cadamba*) and 7 sugar palm trees (*Arenga pinnata*), both of which possess extensive and deep root systems. These root systems contribute to increased soil porosity, thereby enhancing the

soil’s capacity to absorb water. In contrast, Plot 2 contained only 5 *Arenga pinnata* trees and was dominated by garden crops such as clove (*Syzygium aromaticum*) and langsat (*Lansium domesticum*), which generally have shallower root systems compared to forest vegetation. Differences in vegetation composition are therefore likely to contribute to the variation in infiltration rates observed among the plots.

Vegetation type and condition are known to influence infiltration rates through modifications of soil physical properties and root systems. Abdul (2017) reported that soil texture, soil moisture content, and vegetation are key factors affecting infiltration rates. Furthermore, Asrul et al. (2021) explained that infiltration is strongly influenced by soil pore characteristics, texture, structure, bulk density, soil organic matter content, and surface vegetation conditions. Thus, vegetation composition, type, and density play an important role in determining infiltration rates. Denser vegetation generally enhances infiltration through increased organic matter input, root penetration that improves soil structure, and protection of the soil surface from compaction.

### Canopy density

The distribution of canopy density across the research plots is shown in Figure 5. In addition to vegetation type, canopy density also plays a crucial role in regulating the infiltration of rainwater into the soil. The canopy intercepts rainfall through tree trunks and leaves before reaching the ground, thereby enhancing water infiltration. Canopy density in *Arenga pinnata* agroforestry systems can vary depending on the age and health of the plants (Pawitan et al., 2019). Specifically, the wide canopy of *A. pinnata* contributed to increased water

**Table 3.** Vegetation identification results

Parameter	Plot								
	1	2	3	4	5	6	7	8	9
Ground cover	18	25	43	79	25	60	34	21	27
Sapling	5	5	8	-	7	2	1	-	3
Pole-sized Tree	6	3	-	6	-	7	9	10	6
Tree	5	-	8	8	8	5	5	2	1
Palm	4	5	6	7	5	10	7	9	2
Vegetation diversity	9	7	8	8	5	8	6	9	5
Forest plants	9	5	10	9	13	18	21	14	7
Cultivated plants	12	9	6	9	7	6	1	7	5

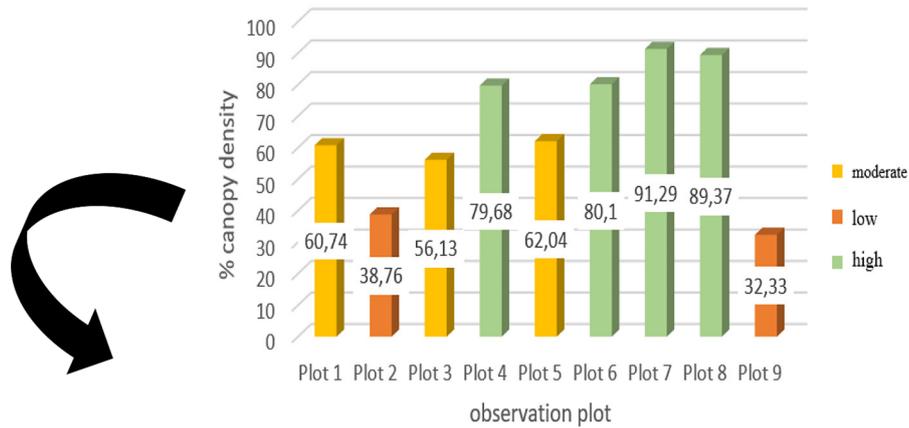


Figure 5. Canopy density histogram

infiltration by reducing the gully. Surface runoff slows the rate of rainfall reaching the ground.

Canopy density was also an important differentiating factor between plots. As shown in Figure 5, the research area consisted of four plots with high canopy density, three plots with moderate canopy density, and two plots with low canopy density. The differences in each canopy projection class can be seen in Figure 6a, 6b, and 6c. Based on Figure 5, Plots 4, 6, 7, and 8 had canopy density percentages ranging from 79.68% to 91.29% and tended to have higher infiltration rates because they reduced the direct impact of raindrops, prevented soil compaction, and maintained soil moisture. Plots 1, 3, and 5 had canopy

density percentages between 56.13% and 62.04%, while Plots 2 and 9 had canopy density percentages between 32.33% and 38.76%.

### Infiltration rate on various slope

The average infiltration rates for each slope class are listed in Table 4. The slope gradient also influenced the infiltration rates. Gentle slopes facilitate water infiltration, whereas steep slopes tend to generate runoff. The infiltration rate measurements from the nine plots covered various slope gradients, including flat, gentle, moderately steep, and steep slopes, in the Arenga pinata agroforestry area in Bonelemo Barat Village.

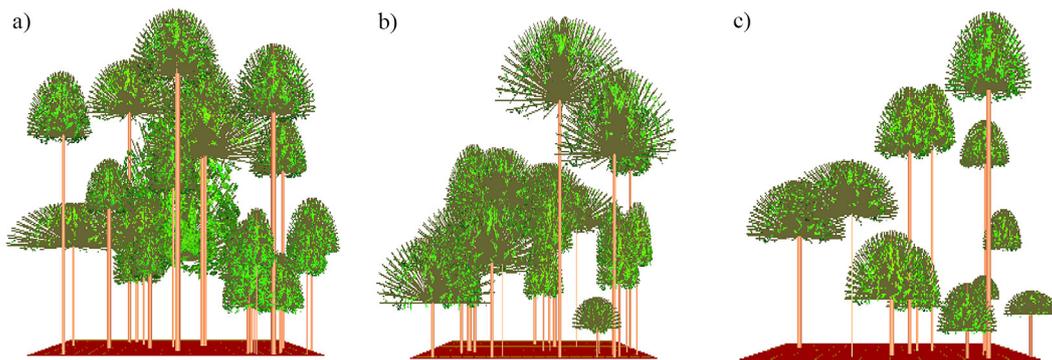


Figure 6. Canopy projection for nine plots seen from the side: (a) high canopy (b) medium canopy (c) sparse canopy

Table 4. Infiltration rate on various slope classes on agroforestry land

No.	Slope class	Infiltration rate (mm/hour)	Category
1.	Flat (Plot 9, 3 and 7)	61,33	Moderate
2.	Gentle (Plot 5 and 6)	38	Moderate
3.	Moderately steep (Plot 8)	13,33	Moderate slow
4.	Steep (Plot 2, 1 and 4)	19,11	Moderate slow

After analysis, the infiltration rates across all slope classes in the *Arenga pinnata* agroforestry area in Bonelemo Barat Village fell into the categories of moderately slow and moderate.

The slope gradient also plays a significant role in determining infiltration. The data in Table 4 show that the slope class had a clear influence on the infiltration rates. The highest infiltration rate was found in the flat slope class, with an average of 61.33 mm/hour, categorized as moderate. Plots within this slope class (Plots 9, 3, and 7) tend to have topographic conditions that facilitate water infiltration because of the lower surface runoff velocity and longer contact time between water and the soil surface. This finding is consistent with Asdak (2010), who stated that slope variation affects infiltration rates: gentle slopes facilitate water infiltration, whereas steeper slopes tend to increase surface runoff.

The gentle slope class (Plots 5 and 6) showed an infiltration rate of 38 mm/h, which was also categorized as moderate, slightly lower than that of the flat slope class. This decrease is likely due

to the slightly steeper gradient, which accelerates surface runoff and reduces the time available for water to infiltrate the soil. The lowest infiltration rate was recorded in the moderately steep slope class (Plot 8) at 13.33 mm/hour, which was categorized as moderately slow. Steeper slopes increase the likelihood of surface runoff due to the gravitational acceleration of water flow, thus reducing the infiltration time. In the steep slope class (Plots 2, 1, and 4), the infiltration rate was 19.11 mm/hour, also categorized as moderately slow. Although slightly higher than that in the moderately steep slope class, this may be influenced by other factors such as vegetation type, canopy density, or soil texture, which may slightly slow down surface runoff.

### Soil physical properties

The results of the physical soil property analysis are presented in the form of a histogram in Figure 7 to facilitate data interpretation. Physical soil properties were analyzed to understand the

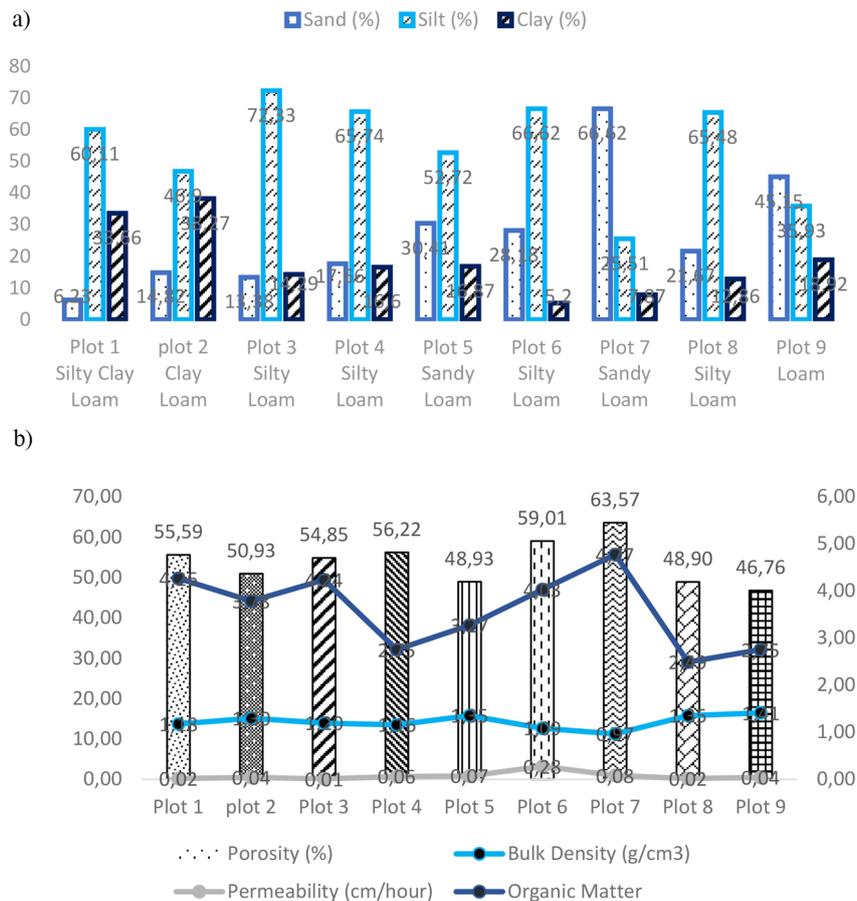


Figure 7. Soil physical properties histogram for nine plots: (a) soil texture and (b) porosity, permeability, bulk density, and organic matter

relationship between soil characteristics and infiltration rates at the research site. Factors such as soil texture, porosity, permeability, organic matter, and bulk density play a significant role in determining how quickly water infiltrates soil.

The physical properties of the soil provide additional insights into this study. Physical properties are measurable characteristics of soil that play an important role in determining its capacity to absorb, store, and transmit water. Some of the soil physical properties that influence infiltration include soil texture, porosity, permeability, and organic matter content. The data for these soil physical properties are presented in Figure 7a and 7b.

Soil texture classification was determined using the United States Department of Agriculture (USDA) soil texture triangle, based on the percentages of clay, silt, and sand obtained after data analysis. As shown in Figure 7a, five soil texture categories were identified at the research site. Sandy loam soil texture demonstrates a faster infiltration rate compared to other textures owing to the presence of sand, which increases soil porosity and allows water to permeate more rapidly. For instance, Plot 7, with a sandy loam texture, recorded an infiltration rate of 102 mm/h (moderately fast), which was the highest among all plots. Conversely, Plot 2, with a clay loam texture, exhibited the lowest infiltration rate at 12 mm/h (moderately slow). This was attributed to the high soil density and limited pore space for water infiltration.

Soil porosity represents the percentage of the soil volume available for water and air. In several studies, higher soil porosity indicates that the soil has a better capacity to absorb and retain water, enabling more effective water infiltration (Herviana et al., 2021). The laboratory results presented in Figure 7b indicate that higher soil bulk density was associated with lower soil porosity. The highest porosity (63.57%) was observed in Plot 7, which had dense vegetation comprising 21 forest plants and only one cultivated plant. This higher porosity can be attributed to the abundance of roots on the soil surface, which enhances granulation and microbial activity, thereby improving the porosity and soil structure stability. Despite being categorized as good, the porosity of Plot 2 does not translate to high infiltration rates, as its slow water absorption indicates the presence of other factors impeding water penetration.

Soil permeability reflects the ability of soil to transmit water through its pores. Research has

shown that a higher soil permeability indicates better water absorption and retention, leading to more effective water infiltration. For instance, a study conducted in the Forest Area with Special Purpose (KHDTK) of Lambung Mangkurat University reported that the permeability value in mixed forest stands reached 8.15 cm/hour, which was higher than that of Mahogany and Grass stands (Dariah & Rachman, 2006). The permeability values obtained in this study are shown in Figure 7b.

Soil permeability is closely related to the soil pore space. Pores within the soil significantly influenced the movement of water through the soil. Since all permeability values across the observation plots, fall into the “very slow” category, it can be concluded that despite the relatively high porosity values in the research plots, the soil’s pore space is small. According to (Imani, 2016), the size of the pores and the connectivity between them play a critical role in determining whether the soil exhibits slow or fast permeability.

If the soil contains large pores, water can infiltrate more easily, leading to higher permeability and infiltration rates. Soil permeability is directly proportional to infiltration rates; as soil permeability increases, the infiltration rates also increase. This aligns with the findings of (Sujinah et al., 2015), which stated that higher soil permeability values result in increased infiltration rates.

Soil organic matter plays a crucial role in improving soil fertility. Research by (Dharmawan, 2020), shows that organic matter enhances soil structure, increases the ability of soil to retain water, improves soil porosity, and fosters the growth of soil microbes. Organic matter can boost the carbon content in the soil, which ultimately reduces the soil bulk density while increasing soil porosity. This is because organic matter increases the pore space in the soil, allowing water to infiltrate and percolate more easily. The organic matter content of the soil is shown in Figure 5. Of the nine plots studied, Plots 1, 2, 3, 6, and 7 had moderate organic matter content, whereas Plots 4, 5, 8, and 9 were categorized as low. Plot 7, with an infiltration rate of 102 mm/h and moderate organic matter, showed good infiltration potential, despite not having a high organic content. In contrast, Plot 2, although also having moderate organic matter content, exhibited a low infiltration rate. This difference can be attributed to the variation in other factors, such as slope, soil texture, and soil compaction, all of which influence the infiltration results.

## CONCLUSIONS

The highest infiltration rate on agroforestry land in Bonelemo Barat Village was found in plot 7, with an infiltration rate of 102 mm/h (moderate-fast). The factors contributing to the high infiltration rate in plot 7 were its flat slope, high canopy density of 91.29%, and vegetation composition, which was dominated by forest trees, including 14 jabon trees and seven aren trees. Although aren trees are present in plot 7, their number is lower compared to other plots. While the presence of aren is beneficial, its influence on reducing the infiltration rate is not significant, indicating that other factors play a larger role. Infiltration rate is greatly influenced by the physical properties of the soil, such as soil texture, porosity, permeability, and organic matter content. This is evident in plot 7, which has sandy clay soil texture, high porosity, and moderate organic matter content, resulting in a higher infiltration rate compared to other plots.

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