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KALANJANA GRASS PRODUCTIVITY IN BUNDER GRAND FOREST PARK COMMUNITY ZONE

Sabiqul Marom, Anggie Saputri, Ariq Zaidan, Harish Faza, Izmi Jaatsiyah, Lelita Gian Widiya Arista, Muhibun Khanam, Siti Zahra, Yus Andhini Bhekti Pertiwi, Ana Agustina*

Forest Management Study Program, Faculty of Agriculture, Universitas Sebelas Maret, Surakarta, Central Java, Indonesia

*Email: ana.agustina2018@staff.uns.ac.id

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ABSTRACT

Bunder Grand Forest Park is one of the conservation areas that serves as a source of sustenance for surrounding communities by implementing agroforestry initiatives within the Community-Use Zone. Although previous studies have confirmed the biophysical suitability of this site for kalanjana grass (Brachiaria mutica) cultivation, no study has established quantitative productivity data across the five Forest Farmer Group (KTH) management units, leaving a critical gap in the empirical basis needed for sustainable harvest management and carrying capacity assessment. This study addresses this gap by quantifying the productivity of kalanjana grass (Brachiaria mutica) across five farmer groups in the Community-Use Zone of Bunder Grand Forest Park. Field observations were conducted using 30 1×1 m plots to measure plant height, leaf number, and fresh weight, while interviews with 30 respondents collected data on land management practices and economic valuation. Grass cultivation practices and productivity were assessed using descriptive analysis of interview and observation data. Results showed that productivity varied considerably across KTHs: KTH Langgeng recorded the highest yield at 98,856 kg/ha/year (IDR 49,428,000/ha/year), followed by KTH Puntuk Srumbung (74,808 kg/ha/year; IDR 37,404,000/ha/year), KTH Wana Makmur (48,630 kg/ha/year; IDR 24,315,000/ha/year), KTH Ngreksobawono (40,590 kg/ha/year; IDR 20,295,000/ha/year), and KTH Ngudi Lestari (32,605.71 kg/ha/year; IDR 16,302,857/ha/year). Productivity variation across KTHs was influenced by biophysical site conditions and farmers' socioeconomic characteristics. To optimize community empowerment, it is recommended to diversify the species and products cultivated by each KTH, while accounting for local environmental factors and upholding conservation principles.

Keywords: *Agroforestry; Kalanjana Grass; Productivity; Tahura Bunder*

INTRODUCTION

Forest Park is a conservation area with a buffer function that may designate traditional-use blocks as part of its spatial zoning framework to accommodate livelihood activities of local communities that have been practiced for generations, provided that ecological conditions and conservation objectives remain uncompromised (Nurhaliza *et al*., 2024). One of the forest park areas with a strategic role as an ecological buffer zone is Bunder forest park in Gunungkidul, Yogyakarta, which serves to support both ecological functions and the socio-economic needs of communities surrounding the forest area (Utami *et al*., 2023). Buffer zones contribute to rural livelihoods by enhancing food security and income diversification while simultaneously reducing anthropogenic pressures on protected forests (Ariandi *et al*., 2024; Elpie *et al*., 2022). Nevertheless, the failure to adequately address local socio-economic needs may intensify pressures on conservation areas, ultimately threatening both environmental sustainability and the livelihoods of local communities (Nugroho *et al*., 2023).

In response to these challenges, the management of Bunder Forest Park has implemented a conservation partnership program through the empowerment of five Forest Farmer Groups (Kelompok Tani Hutan, KTH), namely KTH Langgeng, KTH Ngreksobawono, KTH Puntuk Srumbung, KTH Ngudi Lestari, and KTH Wana Makmur. These groups are distributed across four buffer villages, including Ngalang, Bunder, Nglegi, and Gading, and are granted access to manage non-timber forest products (NTFPs) and conduct cultivation activities within a Community-Use Zone covering an area of 125.97 ha. The primary cultivated commodity is kalanjana (*Brachiaria mutica* (Forssk.) Stapf), integrated with Multipurpose Tree Species (MPTS), given its adaptability to low rainfall and acidic soils, which correspond to the forest park's biophysical characteristics (Rokhayati, 2025). For several local farmers, the commercialization of livestock feed is a primary livelihood source, with household income directly influenced by the productivity of forage resources (Nurainy *et al*., 2024). Therefore, ecological sustainability in the surrounding buffer zone highly depends on accurate land productivity assessments as a fundamental basis for evaluating carrying capacity, determining sustainable harvesting regimes, and preventing resource degradation (Rao *et al*., 2015).

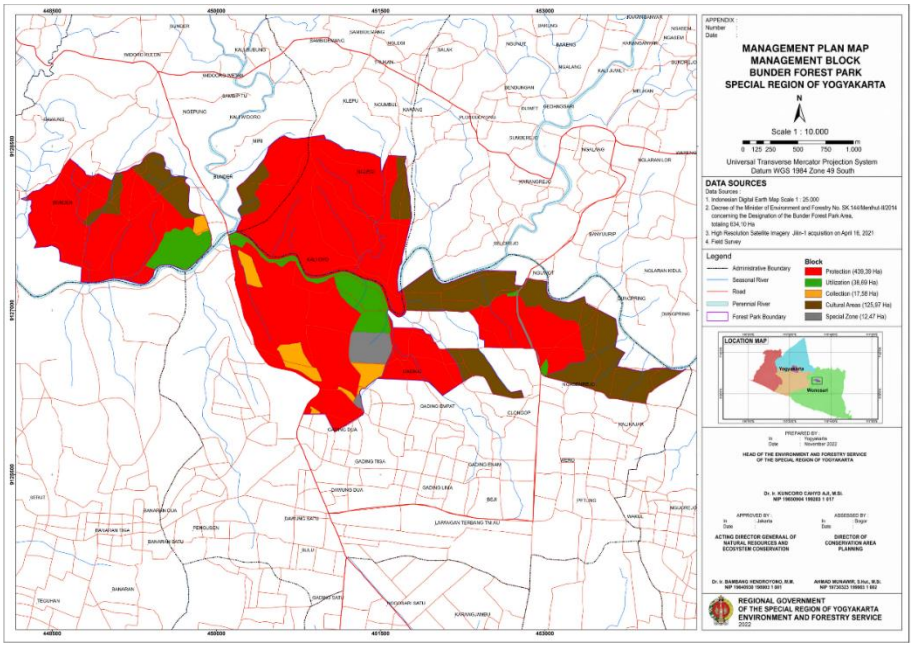
In response to these challenges, the management of Bunder Forest Park has implemented a conservation partnership program through the empowerment of five Forest Farmer Groups (Kelompok Tani Hutan, KTH), namely KTH Langgeng, KTH Ngreksobawono, KTH Puntuk Srumbung, KTH Ngudi Lestari, and KTH Wana Makmur, distributed across four buffer villages of Ngalang, Bunder, Nglegi, and Gading. Under this program, the five KTHs are granted access to manage non-timber forest products (NTFPs) and conduct cultivation activities within a Community-Use Zone covering 125.97 ha. The primary cultivated commodity is kalanjana grass (*Brachiaria mutica* (Forssk.) Stapf), integrated with Multipurpose Tree Species (MPTS), owing to its adaptability to the low rainfall conditions and acidic soils that characterize the karst landscape of the forest park (Rokhayati, 2025). The commercialization of kalanjana grass as livestock feed serves as a primary livelihood source for many of these farming households, making its sustained productivity a critical determinant of both community welfare and the long-term viability of the conservation partnership itself (Nurainy *et al*., 2024). Consequently, any decline in forage productivity - whether driven by seasonal drought, soil degradation, or unsustainable harvesting practices - not only threatens household income but may also undermine community commitment to conservation, potentially intensifying pressure on the protected forest (Nepal & Spiteri, 2011).

Previous research on kalanjana grass in the Community-Use Zone of Bunder Forest Park, Gunungkidul, was conducted by Utami *et al*. (2023), who analyzed the environmental carrying capacity for the development of the block and found that kalanjana grass is suitable for cultivation within the Community-Use Zone because the biophysical conditions of Bunder Forest Park fulfill its growth requirements. However, to date, no study has established quantitative data on the productivity of Kalanjana grass across the five Community Forest Farmer Group (KTH) management units. Productivity data are essential for determining whether the current harvesting intensity remains within the carrying capacity limits of the karst landscape, where shallow soils and seasonal water scarcity constrain biomass production (Matheus *et al*., 2019). Therefore, this study aims to provide a comprehensive assessment of kalanjana grass productivity in the Community-Use Zone of Bunder Forest Park, Gunungkidul.

METHODS

Time and Location of Research

This research was conducted in Bunder Grand Forest Park (Tahura Bunder), Gunungkidul Regency, Special Region of Yogyakarta. Field data collection took place over five days, from August 5 to 9, 2024. The study area is situated at coordinates 110°32'55"–110°34'35" E and 7°53'25"–7°55'10" S, encompassing a total area of 634.10 ha. Specifically, this study was conducted within the Community-Use Zone (Fig. 1), which covers 125.97 ha.



Sources: Balai Tahura Bunder (2022)

Figure 1. Map of research location

Tools and Materials

The instruments employed in this study included a compass, tally sheet, questionnaire sheets, thermometer, hygrometer, measuring tape, scale, smartphone (equipped with Avenza Maps), camera, stationery, and a sickle. The primary material used in this study was kalanjana grass samples.

Research Methods

This study utilized a mixed-method approach, combining field observations, in-depth interviews, questionnaires, documentation, and a literature review. Field observations were conducted to measure kalanjana grass productivity using 1 x 1 m square plots. These plots were established using purposive sampling, selected based on the land managed by the interviewed respondents (30 respondents in total; 6 per KTH). Additionally, observations of woody plants and Multi-Purpose Tree Species (MPTS) were conducted in 20 x 20 m plots, nested at the same sampling points as the grass observation plots (Fig. 2). Kalanjana grass productivity was determined based on plant height, number of leaves, and fresh weight of plants per plot (Riyanto *et al*., 2022). Arikunto (2020) states that if the population size exceeds 100 people, the sample size can be set at 10–15% or 20–25%, depending on the researcher's capabilities. Thus, given that the total population of respondents in this study is 301, a sample of 30 people (10%) was selected. Respondents, consisting of 10% of the total grass farmers in KTH Langgeng, KTH Ngreksobawono, KTH Puntuk Srumbung, KTH Ngudi Lestari, and KTH Wana Makmur, were interviewed using a structured questionnaire. A comprehensive review of existing literature was also conducted to support the descriptive analysis.

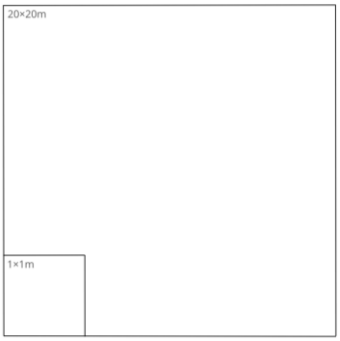


Figure 2. Illustration of a 1x1 Plot for Kalanjana and A 20x20 Plot for Forestry Plants

Data Analysis

Data were analyzed using both qualitative and quantitative approaches. Data obtained through interviews and observations (questionnaires) were tabulated and analyzed descriptively to provide an overview of grass cultivation techniques and productivity at the observation site. Productivity analysis was performed by estimating the respondents' grass yield per hectare, which was subsequently converted into annual yield estimates. Furthermore, the economic value was estimated based on the interview results, assuming that one bundle of grass weighs 10 kilograms and has a market price of IDR 5,000.00 (the pricing approach is based on the average selling price reported by KTH, as obtained through interviews).

RESULTS AND DISCUSSION

Environmental Characteristics

Bunder Forest Park (Tahura Bunder) in Gunungkidul, Yogyakarta, is situated within a karst landscape characterized by thick limestone formations. According to Balai Tahura Bunder (2022), the soil in this area is predominantly dark grayish-brown with a silty clay loam texture. A biophysical analysis of the Community-Use Zone by Utami *et al*. (2023) identified a diversity of soil orders, including Entisols (young soils with thin solum dominated by pioneer plants), Vertisols (montmorillonite-rich clays prone to periodic swelling and cracking, typically found in flat to hilly areas near the Oyo River), and Inceptisols (immature, fragile soils often featuring rock outcrops). Additionally, Mollisols and alluvial soils have been noted in the area. It is well established that clay soils, with their fine pore structure, generally exhibit lower drainage capacity compared to coarser soil types. Salawangi *et al*. (2020) noted that plant growth is generally more optimal in soils with larger pores (e.g., sandy soils) compared to compact soils, as restricted pore space can impede root penetration. Field analysis indicates that soil color in the Community-Use Zone ranges from grayish-brown to dark blackish-brown. As noted by Fitriani *et al*. (2022), such dark coloration is indicative of high organic matter (humus) content resulting from decomposition. This aligns with Marlinae *et al*. (2021), who observed that increased organic matter darkens soil color, signaling the soil's potential fertility. An analysis of the geological conditions in the Community-Use Zone of TAHURA Bunder reveals an altitude of 120.98-193.34 meters above sea level, accompanied by a flat to undulating physiography, a rocky terrain, and a slope of 0-25%, classified as a flat to slightly steep slope class based on the slope class classification from Van Zuidam (1983).

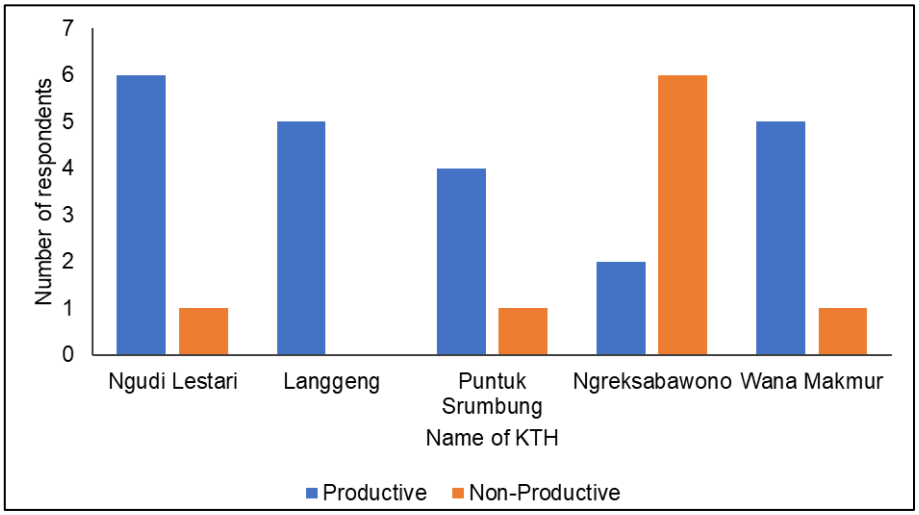
The Bunder Grand Forest Park area also has a water source from the Oyo River, which flows for 106.75 km. The Oyo River is fed by several tributaries, including the Widoro River, Juwet River, and Dondong River, which traverse the Bunder Grand Forest Park (Balai Tahura Bunder, 2022). A study of environmental parameters in Community-Use Zones revealed temperature ranges of 21-31.4°C and humidity levels of 48-72%. The Tahura region experiences an average annual rainfall of 1,900 millimeters, with a dry season that extends from two to six months per year, during which less than 60 millimeters of precipitation is recorded. Conversely, the highest precipitation levels are observed from December to February, with an average monthly accumulation of 200 millimeters (BMKG, 2024). The light intensity observed during the study varied across KTH blocks, influenced by the canopy cover of cajuput trees.

Characteristics of Respondents

1. Age of Respondents

The respondents' ages were predominantly within the productive age demographic, as determined by the interviews. Palihema *et al*. (2024) reported that the productive age range is from 15 to 64 years. Conversely, KTH Ngreksobawono showed a predominance of individuals in the non-productive age group, ranging from 50 to 72 years (Fig. 3). A subset of farmers who are not of working age continues to be employed due to the need to generate income and the

absence of social safety nets for the elderly. Furthermore, some farmers continue working into their advanced years, driven by a sense of physical capability and a desire to maintain their contribution to the agricultural sector. As indicated by Yanti *et al*. (2022), age exerts a substantial influence on labor productivity. This influence is rooted in the interplay between age and various factors, including an individual's physical condition, creativity, and accumulated knowledge. These elements have been demonstrated to impact an individual's professional success (Yanti *et al*., 2022). This finding indicates that age significantly influences the quality and quantity of the output from traditional areas managed by the community. It is a primary determinant of the community's capacity to produce goods and services.

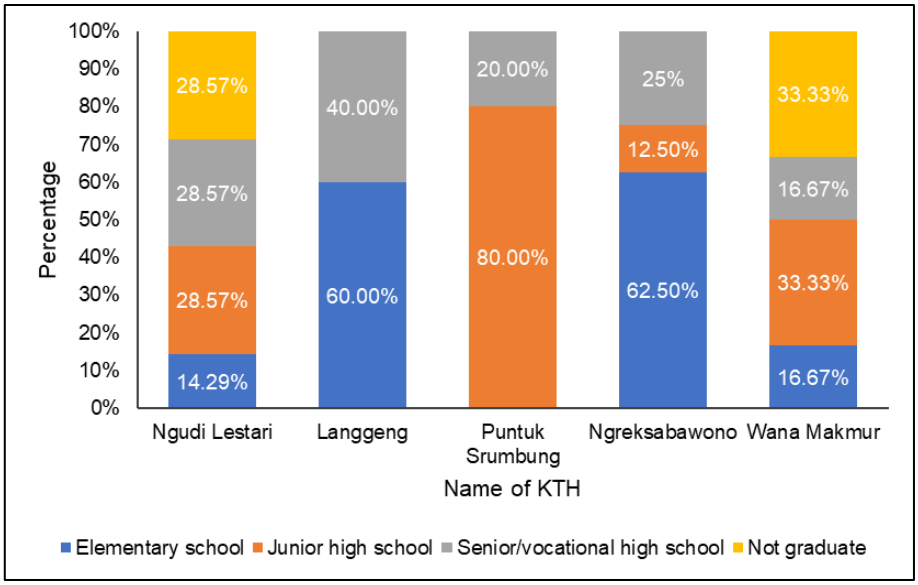


Source: Primary data

Figure 3. Age characteristics of respondents per KTH

2. Education of Respondent

Yuhani (2024) states that education level is positively correlated with area management activities; specifically, higher educational attainment typically leads to improved management quality. As illustrated in Figure 2, respondents' educational backgrounds vary significantly across the Forest Farmer Groups (KTH). Elementary school graduates predominate in KTH Langgeng and KTH Ngreksobawono, accounting for approximately 60% of the respondents in these groups. In contrast, KTH Puntuk Srumbung is dominated by junior high school graduates, who constitute approximately 80% of the group. Meanwhile, educational profiles in KTH Ngudi Lestari and KTH Wana Makmur show distinct patterns. In KTH Ngudi Lestari, 28.57% of respondents have completed junior high and senior/vocational high school. Conversely, KTH Wana Makmur has a notable proportion of uneducated respondents, with 33.33% having no formal education. According to Arikunto (2020), education levels are categorized as "low" (elementary to junior high school) and "high" (senior high school to college). Based on this classification, the majority of respondents in this study are categorized as having a low level of education. As noted by Febianti *et al*. (2023), productivity is closely linked to education, as higher levels of knowledge foster greater awareness of its importance.



Source: Primary data

Figure 4. Educational characteristics of respondents per KTH

3. Occupations of Respondents

Table 1 illustrates the diverse occupational backgrounds of KTH members in Tahura Bunder, which include farmers, ranchers, farm laborers, retired civil servants, entrepreneurs, restaurant employees, and housewives. Overall, the data indicate that agriculture is the predominant sector across the surveyed groups. Specifically, KTH Ngreksobawono is entirely composed of farmers (100%). In KTH Wana Makmur, 66.67% of respondents are farmers, followed by retired civil servants and restaurant employees (16.67% each). KTH Puntuk Srumbung consists of 60% farmers, with housewives and farm laborers each accounting for 20%. KTH Ngudi Lestari shows a more varied profile: 57.14% are farmers, while laborers, entrepreneurs, and mixed farmer-ranchers each make up 14.29%. Meanwhile, KTH Langgeng exhibits an even distribution (50:50) between farmers and housewives. Although agriculture is the primary occupation for the majority, some community members treat it as a secondary activity. This tendency is largely due to the severe dry season in Gunungkidul, which creates challenging farming conditions. As noted by Palihema *et al*. (2024), climatic conditions—particularly water scarcity—significantly impede crop growth. Consequently, this study found that land productivity is closely linked to the respondents' occupational focus. Respondents who identify farming as their primary occupation exhibit higher land productivity than those who regard it as a secondary occupation. This is likely because full-time farmers have greater time availability for field management and have developed more specialized agricultural competencies than those engaged in non-agricultural primary jobs.

Table 1. Occupational characteristics of respondents per KTH

Name of KTH	Job	Frequency	Percentage
Ngudi Lestari	Farmers	4	57.14%
	Laborers	1	14.29%
	Self-employed	1	14.29%
	Farmers and ranchers	1	14.29%
	Total	7	100,0%
Langgeng	Farmers	2	50%
	Housewives	2	50%
	Total	4	100%
Puntuk Srumbung	Farmers	3	60%
	Housewives	1	20%

	Farm laborers	1	20%
	Total	5	100%
Ngreksobawono	Farmers	8	100%
	Total	8	100%
Wanamakmur	Farmers	4	66.67%
	Retired civil servants	1	16.67%
	Employees	1	16.67%
	Total	6	100%

Source: Primary Data

4. Land Area

The Community-Use Zone of Bunder forest park covers a total area of 125.97 ha and is further subdivided into several plots managed by five KTHs, with varying land areas. Based on the interviews, the land areas reported in Table 2 indicate that each respondent's land ranged from 0.008 to 1 ha. KTH Langgeng and KTH Puntuk Srumbung exhibited the same mean land area of 0.45 ha. KTH Ngudi Lestari had a mean land area of 0.22 ha, with the largest plot measuring 0.5 ha and the smallest 0.05 ha. KTH Ngreksobawono recorded the smallest mean land area of 0.09 ha. In KTH Wana Makmur, all respondents managed a uniform land area of 0.25 ha.

The land area managed by respondents across each KTH generally approximated 0.25 ha. The smallest range was recorded at KTH Ngreksobawono, at 0.008 ha, while the largest plot was found at KTH Langgeng, at >1 ha. According to Wijayanti (2021), in agricultural activities, land area is indicative of the magnitude of production output. Land size substantially influences the number of plants cultivated, thereby affecting overall productivity. A larger managed land area is expected to yield greater Kalanjana harvests, as land area is directly associated with the productivity level of the cultivated grass.

Table 2. Land area characteristics of respondents per KTH

Name of KTH	Land area (ha)	Amount of land	Average land area (ha)
Ngudi Lestari	0.5	2	0.22
	0.25	1	
	0.1	2	
	0.05	2	
Langgeng	0.6	1	0.45
	0.25	1	
	1	1	
	0.08	1	
	0.3	1	
Puntuk Srumbung	0.25	1	0.45
	0.5	4	
Ngreksobawono	0.25	2	0.09
	0.05	3	
	0.008	1	
	0.025	2	
Wana Makmur	0.25	6	0.25

Source: Primary Data

Productivity of Kalanjana Grass

Based on field observations, KTH Langgeng had the highest average yield per land area, at 4,834.64 kg, on an average land area of 0.45 ha. KTH Puntuk Srumbung, with the same average land area of 0.45 ha, had an average yield per land area of 3,017 kg, which was lower than that of KTH Langgeng. Meanwhile, KTH Wanamakmur, with an average land area of 0.25 ha, has a lower yield per unit area of 1,013.13 kg. KTH Ngudi Lestari, with an average land area of 0.22 ha—slightly smaller than Wanamakmur's—has a significantly lower average yield per unit area of 598.4 kg. Meanwhile, KTH Ngreksobawono, with the smallest average land area of 0.09 ha, has the lowest average yield per unit area of 274.3 kg. Thus, it can be concluded that the average land area of each KTH influences the variation in the average yield per unit area of Kalanjana grass. Anggraini & Yulianto (2023) also noted that one of the factors influencing forage production in a region is land area, along with soil fertility levels and climate conditions during the harvesting period.

Table 3. Productivity of Kalanjana Grass per Hectare

Name of KTH	Land area (ha)	Yield per area (kg/area of land)	Yield per hectare (kg/ha)	Estimated 1 Year (kg/ha/ year)*	Economic value per area (Rp/year)**	Economic value per hectare (Rp/year)**
Ngudi Lestari	0.22	598.4	2,717.14	32,605.71	3,590,400	16,302,857
Langgeng	0.45	4,834.64	8,238	98,856	29,007,840	49,428,000
Puntuk Srumbung	0.45	3,017	6,234	74,808	18,102,000	37,404,000
Ngreksobawono	0.09	274.3	3,382.5	40,590	1,645,793	20,295,000
Wanamakmur	0.25	1,013.13	4,052.5	48,630	6,078,750	24,315,000

Source: Primary data

Description: *: 12 harvests in 1 year, based on respondents' information

**: Economic value of 1 bundle of grass (estimated weight 10 kg) Rp5,000.00

Based on Table 3, the comparison of average yields and economic value of kalanjana grass across each KTH varies. The economic value of kalanjana grass is calculated based on the estimated yield per hectare in one year, converted to yield per unit of land area. The estimated economic value is calculated using the estimated price from interviews for a 10 kg bundle of grass, which is IDR5,000. The highest average economic value per hectare per year among the 5 KTHs was recorded by KTH Langgeng at IDR49,428,000, with a higher average yield per hectare compared to KTH Puntuk Srumbung on the same land area. Meanwhile, the Ngudi Lestari KTH has the lowest average annual yield per hectare at 32,605.71 kg/ha/year and the lowest economic value per hectare among all KTHs at IDR16,302,857. On the other hand, the Ngreksobawono KTH, despite having the smallest average land area, has a higher average economic value than Ngudi Lestari.

The productivity of kalanjana grass in each KTH is also influenced by respondents' land management practices. In KTH Langgeng, which has the highest average estimated yield per hectare in one year, the respondents are predominantly of productive age and work as farmers and housewives. Concurrently, within the Ngudi Lestari, Puntuk Srumbung, and Wana Makmur KTHs, which exhibit lower average estimated annual yields than the Langgeng KTH, the productive age group predominates, alongside non-productive age groups comprising farmers and other occupations such as laborers, entrepreneurs, housewives, and others. However, KTH Ngreksobawono, which is predominantly comprised of non-productive age groups and whose members are exclusively engaged in agricultural pursuits, has attained an estimated yield that exceeds that of KTH Ngudi Lestari. Consequently, it can be posited that, given the heightened focus on agricultural pursuits among the respondents, the agricultural yield per unit area in this region will surpass that of other KTHs with non-agricultural respondents. Furthermore, farmers' educational attainment may influence the productivity of

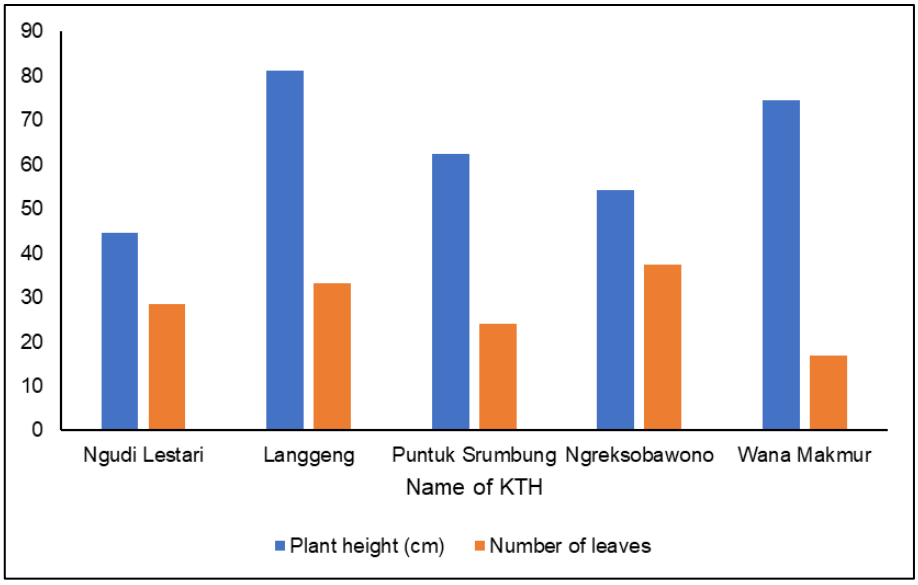
alanjana grass. However, this is not universally applicable, as evidenced by KTH Langgeng, an institution predominantly focused on elementary education, achieving the highest yield.

Variations in yield per hectare can also be attributed to other factors, such as soil fertility, maturity stage, cultivation techniques, and weather conditions (Rokhayati, 2025). Additionally, the growth of kalanjana grass is influenced by various factors, including water sources, environmental conditions, and management practices, including fertilizer application (Resthu *et al*., 2023). Tropical grasses of the *Brachiaria* genus exhibit notable adaptability to arid conditions and demonstrate resilience to drought (Wekgari *et al*., 2023). However, according to Pazla *et al*. (2023), alanjana grass demonstrates optimal growth in wet soil, is resistant to waterlogging, and is inhibited by drought in the dry season. Rukmana (2005) also posits that kalanjana grass flourishes in areas with an altitude of no more than 1,200 meters above sea level, with an annual rainfall of 1,000 mm or more, and often grows along riverbanks. The study was conducted at an altitude of 120-193 meters above sea level, with an annual rainfall of 1,900 millimeters (Balai Tahura Bunder, 2022). The soil throughout the KTH is the same type, except that the Langgeng KTH is closest to the water source, namely the Oyo River. Consequently, the productivity data collected during this arid period indicate that grass growth is stunted and yields are suboptimal in KTHs far from water sources.

The mean yield of kalanjana grass per hectare in the Ngudi Lestari and Wana Makmur community forest management units (KTH) is comparatively low, a circumstance believed to be associated with the site's topography, which is characterized by karst rocks and thin soil layers. Although all KTHs in Tahura Bunder are situated above karst areas, the prevalence of these geological characteristics is more evident in the aforementioned KTHs. According to Cahyadi (2017) and Worosuprojo *et al*. (1997), the karst hills in Gunungkidul are generally classified as land capability classes VII and VIII, which are less conducive to seasonal crop cultivation. However, the surrounding alluvial plains are classified as land capability class II. Such site conditions are also susceptible to various forms of environmental degradation, including water and surface water pollution, erosion, desertification, and landscape changes driven by geological characteristics and anthropogenic activities (Lan *et al*., 2021).

Growth Performance of Kalanjana Grass

Plant height is a key indicator of plant growth and is influenced by factors such as plant age, nutrient and water availability, and other environmental conditions. An increase in plant height indicates active physiological and metabolic processes during the vegetative phase. The five KTHs studied showed different average heights, ranging from 44.57 cm for KTH Ngudi Lestari, 81.16 cm for KTH Langgeng, 62.37 cm for KTH Puntuk Srumbung, 54.36 cm for KTH Ngreksobawono, and 74.58 cm for KTH Wana Makmur (Fig. 5). This variability highlights the impact of various factors, including water distribution within each KTH. Notably, KTH Langgeng received the highest average height due to its proximity to a river. Water availability is essential for nutrient transport through the roots, and the balance of nutrients significantly influences plant growth and development (Heraini *et al*., 2022). Nutrients are crucial for plant growth; a lack of nutrients can cause plants, especially smaller ones, to die, emphasizing the need to assess nutrient availability. Nutrient sufficiency within each plant in each KTH is also affected by planting distance; closer spacing increases competition for nutrients (Riyanto *et al*., 2022). Aside from KTH Langgeng, the average plant height was lower during the dry season, when water availability was limited, leading to suboptimal productivity.



Source: Primary data

Figure 5. Average height and number of leaves of Kalanjana grass per KTH

The application of organic fertilizer to KTH land has been shown to yield higher crop yields than land that does not receive this treatment. It has been demonstrated that KTH, which has been administered organic fertilizer, such as KTH Langgeng, KTH Puntuk Srumbung, and KTH Wana Makmur, has yielded higher results than KTH Ngudi Lestari and KTH Ngreksobawono, which have not been administered organic fertilizer. Organic fertilizer provides essential micro- and macronutrients for Kalanjana grass growth. Among the nutrients essential for plant growth, magnesium (Mg) and manganese (Mn) are components of chlorophyll and activators of enzymes. Ca plays a role in root growth, while Fe and Cu play a role in the formation of chlorophyll, carbohydrates, fats, proteins, and enzymes. The nutrient content of the solid organic fertilizer used is sufficient to meet plant nutrient requirements (Rajiman, 2020).

Farmers in each KTH start with organic fertilizers, then move to chemical fertilizers. They receive government subsidies for fertilizers intended for MPTS, but some respondents also use them to fertilize kalanjana grass. The use of chemical fertilizers is most prevalent at Langgeng KTH, helping achieve higher crop yields than at other KTHs. Chemical fertilizers supply only some of the nutrients needed for plant growth and cannot provide carbon compounds that improve soil quality. Relying solely on chemical fertilizers can harm the soil over time. Therefore, it is recommended that organic fertilizers be used in larger amounts than chemical fertilizers. This aligns with research by Ganti *et al*. (2023), which shows that organic fertilizers can improve both the quantity and quality of agricultural output and prevent land degradation, even with long-term use.

The number of leaves is one indicator of plant productivity (Resthu *et al*., 2023). The number of leaves is influenced by a variety of factors, including physical and biological factors. The quantity of leaves was determined by collecting samples from the measurement plot and subsequently computing the values depicted in Figure 3. Therefore, the mean number of leaves per KTH shows significant variability. KTH Ngudi Lestari exhibits an average number of leaves of 28.57, while Langgeng, Puntuk Srumbung, Ngreksobawono, Wanamakmur, and Langgeng 33.26 display average numbers of 33.26, 24.19, 37.32, and 16.83, respectively. The Ngreksobawono KTH exhibited the highest average number of leaves. The findings indicate an inverse relationship between productivity and the number of employees, suggesting that the Ngreksobawono KTH exhibits lower productivity than other KTHs. Conversely, the lowest mean number of leaves was observed in the Wanamakmur KTH. The findings demonstrate a positive correlation between the results and productivity levels, suggesting that the economic value is comparatively low relative to other KTHs. This

phenomenon may be attributable to other factors that affect leaf growth, thereby influencing productivity levels on a specific plot of land.

The Community-Use Zone at Tahura Bunder during the dry season exhibited a temperature range of approximately 27-31.4°C, with clay to dusty loam soil conditions, and was classified as dry and rocky. Conversely, kalanjana grass is only able to thrive in conditions of wet to waterlogged soil, thereby indicating that such land conditions impede the growth of this grass species. This observation aligns with the findings reported by Pazla *et al*. (2023). In cases of inhibited growth, the number of leaves per clump will be low. The growth of kalanjana grass is influenced by several factors, including shade and prevailing seasonal conditions. As stated by Resthu *et al*. (2023), the growth of kalanjana grass is not significantly affected by shade, as it tolerates such conditions. This attribute is a result of kalanjana grass's adaptation to survive in shaded environments, a trait that differs from other grass species, which are unable to withstand substantial levels of shade (Resthu *et al*., 2023). The dry season, following shaded land, also influences productivity, including the number of leaves produced.

Forestry Plants

Farmers in each KTH in Tahura Bunder predominantly cultivate land, employing an agroforestry model that combines trees and grasses. The planting patterns within this agroforestry model exhibit significant variation across KTHs and remain unstandardized, a phenomenon attributed to the land's diverse topography and individual farmer preferences. The agroforestry pattern examined in this study was implemented by nearly all respondents, comprising timber trees, multipurpose tree species (MPTS), and kalanjana grass. MPTS (multipurpose tree species) are a category of woody plants that offer a range of ecological and economic benefits (Utomo *et al*., 2024). The planting of MPTS plants is carried out in accordance with directives issued by the Bunder Tahura manager, who collaborates with the KTH in implementing this process. The MPTS plants cultivated in the Community-Use Zones of Bunder Tahura include avocado, mango, petai, and jackfruit.

Table 4. Timber Tree Species and MPTS Cultivated by Farmers in The Community-use Zone of Bunder Grand Forest Park

Species	Number of Trees per Plot				
	KTH Wanamakmur	**KTH Langgeng**	**KTH Puntuk Srumbung**	**KTH Ngreksobawono**	**KTH Ngudi Lestari**
Cajuput (*Melaleuca cajuputi*)[a]	227	258	70	92	202
Jackfruit (*Artocarpus heterophyllus*)[a]	2	8	10	6	-
Mango (*Mangifera indica*)[a]	48	14	33	30	23
Avocado (*Persea americana*)[a]	13	-	-	-	10
Petai (*Parkia speciosa*)[a]	-	-	-	-	2
Kapuk (*Ceiba pentandra*)[a]	2	-	-	-	-
Bungur (*Lagerstroemia speciosa*)[a]	9	-	-	-	-

Acacia (*Acacia auriculiformis*)[b]	1	-	8	1	7
Sandalwood (*Santalum album*)[a]	-	35	10	-	-
Kesambi (*Schleichera oleosa*)[a]	-	2	3	-	-
Malacca tree (*Phyllanthus emblica*)[a]	-	16	-	-	-
Lamtoro (*Leucaena leucocephala*)[a]	-	-	14	15	-
Mahogany (*Swietenia macrophylla*)[b]	-	-	-	6	-
Sonokeling (*Dalbergia latifolia*)[b]	-	-	-	33	-
Benda (*Artocarpus elasticus*)[a]	-	-	-	-	2
Cocoa (*Theobroma cacao*)[a]	-	-	-	-	4
Gmelina (*Gmelina arborea*)[b]	-	-	-	-	2
Tarum (*Indigofera tinctoria*)[a]	-	-	-	-	20
Total	302	333	149	183	272

Source: Primary data
Notes: a: MPTS; b: timber tree species

The canopy cover of the main tree stands at the research site, which is dominated by cajuput and other tree species, will affect the productivity of kalanjana grass. This phenomenon occurs because the canopy cover acts as a shield, effectively reducing the intensity of sunlight reaching the forest floor. As postulated by Adnan and Purnomo (2023), variations in light intensity, resulting from differences in tree species composition, affect the growth of understory vegetation. The distinct types of trees comprising agroforestry systems give rise to variances in microclimate conditions (Setiawan *et al*., 2024). The composition and number of tree species present in each plot have been shown to significantly influence variations in kalanjana grass productivity. As indicated in Table 3, the highest productivity was observed in KTH Langgeng, with a grass weight of 41,190 kg/ha and 333 MPTS, predominantly cajuput species, as demonstrated in Table 4. In contrast, the lowest productivity was observed at KTH Ngudi Lestari, with an output of 19,020 kg/ha, despite a relatively high number of stands (272 individuals) and a prevalence of comparable plant species. Kalanjana grass demonstrates a robust capacity to adapt to conditions of waterlogging and dense shade (Resthu *et al*., 2023). This phenomenon is a primary factor contributing to the proliferation of this species in understory areas despite reduced light intensity. In addition to light intensity, which is affected by shade, soil moisture conditions, influenced by proximity to water sources, are also an important variable that distinguishes productivity between locations. A review of the extant data reveals a positive correlation between proximity to a body of water and productivity at the KTH Langgeng site, which is situated near the Oyo River, compared with the KTH Ngudi

Lestari location. This condition indicates that, in addition to shade, water availability is a more dominant factor in influencing kalañjana grass growth. This finding aligns with Rukmana's (2005) observation that optimal growth of alanjana grass is contingent on sufficient water availability. Conversely, the presence of MPTS in these locations does not directly reduce productivity. Consequently, locations exhibiting superior hydrological characteristics can persistently maintain sustainable productivity of the terrain beneath the stands, without compromising conservation principles. Consequently, land use activities in the Bunder National Park area can be maintained in accordance with sustainable forest management principles.

CONCLUSION AND RECOMMENDATION

This study demonstrates that kalanjana grass (*Brachiaria mutica*) productivity varies considerably across the five KTH management units within the Community-Use Zone of Bunder Forest Park, with KTH Langgeng recording the highest annual yield at 98,856 kg/ha/year (IDR 49,428,000/ha/year), followed by KTH Puntuk Srumbung (74,808 kg/ha/year), KTH Wana Makmur (48,630 kg/ha/year), KTH Ngreksobawono (40,590 kg/ha/year), and KTH Ngudi Lestari (32,605.71 kg/ha/year), a pattern primarily attributable to differences in environmental conditions and socioeconomic characteristics of the farmers. Based on these findings, KTHs with lower productivity are recommended to adopt organic fertilizer application and explore supplementary water management strategies to mitigate seasonal drought constraints inherent to the karst landscape, while product diversification is needed to encourage across all KTHs to strengthen the economic value of kalanjana grass beyond subsistence use. Future research incorporating wet season measurements is further recommended to establish a more comprehensive annual productivity baseline across all management units.

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