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The Potential of Aren (*Arenga Pinnata* (*Wurmb*) *Merr.*) Stands in Cimantaja Resort, Mount Halimun Salak National Park

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Abstract

An abundance of sugar palm trees can be found in the Cimantaja Resort Area, where all stands in Cimantaja's Resort are stands that grow naturally/wildly, and without any planting or cultivation activities. The aim of this study to estimate the potential (number of individual, inventory of regeneration number and stand productivity) of sugar palm stands. The methods used in estimating the potential in question are interviews and standing inventory. This research was able to show that there was a large potential for stands from the level of poles and unproductive trees with a percentage of 84% being productive trees. In the standing inventory, the regeneration level decreased in value starting from the seedling level to the trees with the sustainable category. Stand productivity in terms of age and time class, the total potential for palm sugar from the four largest villages is in the class of age 12-15 class year of 100,933 kg/year with 189 trees, but the total production from a range of age aren, 8-11 class year had percentage of 56% contribute all of the yields. The conclusion of this study stated that Aren has a large potential for stands to be utilized and able to support the economy of aren farmers in the future which of course needs to be supported by the treatment and knowledge of farmers about palm tree cultivation.

Keywords: potential, productivity, regeneration, sugar palm, utilization

1. Introduction

Cimantaja Resort has an abundance of palm stands that are randomly scattered and grow wildly, which means that there is no definite measurement data on how the composition structure of the palm stands. The composition structure of these palm stands is closely related to the number of individuals and the regeneration of the stands. In accordance with the existing conditions in the field, it is necessary to estimate the composition structure that collaborates between field observations and interviews with local farmers.

The estimation of the number of individuals is important to do because of the abundance of sugar palm stands in Cimantaja Resort which occurs randomly, with the aim of ensuring how the stand data is more measurable so that later it can be a reference for farmers to carry out management and maintenance efforts for existing sugar palm stands. Proper processing and maintenance needs to be done to be able to get the maximum and best production from the palm stands [1].

The maximum and best production of the Cimantaja Resort sugar palm stands is focused on sugar palm derivative products that have high economic value, which if they have optimal results will help improve the welfare of farmers, especially sugar palm farmers. In addition to the efforts in estimating the number of individual sugar palm stands, estimation of sugar palm regeneration is important where each level of sugar palm regeneration will also affect how the potential of Cimantaja Resort sugar palm. This regeneration value will show the tendency of the arenas to dominate the local population and can be utilized in the long term.

Estimating palm sugar productivity is important considering that palm sugar is a palm derivative product with high economic value. The export value of palm sugar alone reached 36.5 thousand tons with a value of USD49.3 million in 2019, which increased to 39.4 thousand

tons with a value of USD63.5 million in 2020, which will certainly have an impact on improving the national economy. The product with the greatest economic value is palm sugar [2].

In short, palm sugar is the result of sap water tapping that is cooked and then molded, where the main factor affecting the quality of palm sugar can be the quality of the sap water. One of the factors that affect the quality of the sap water is the age of the sugar palm stand, meaning that there is a growth cycle of the sugar palm marked by the age of the stand. The growth of sugar palm in Cimantaja Resort occurs wildly or naturally meaning that there is no exact data on the age of the stand because there is no planting process, therefore it is necessary to measure the age of the sugar palm seen from its morphology such as the height of the frond-free stem and the growth of flowers either female or male flowers [3].This study aims to estimate the potential (number of individuals, inventory of regeneration number and stand productivity) of sugar palm stands.

2. Research Methodology

The research was conducted in Cimantaja Resort which covers Mekarnangka, Gunung Malang, Cikiray, and Cikarae Thoyybah villages from October to December 2022 (Figure 1) which was selected as the research location to determine the potential utilization and production costs of palm stands in an effort to optimally utilize and conserve the aren palm. The research was conducted from September 12 to November 17, 2022.

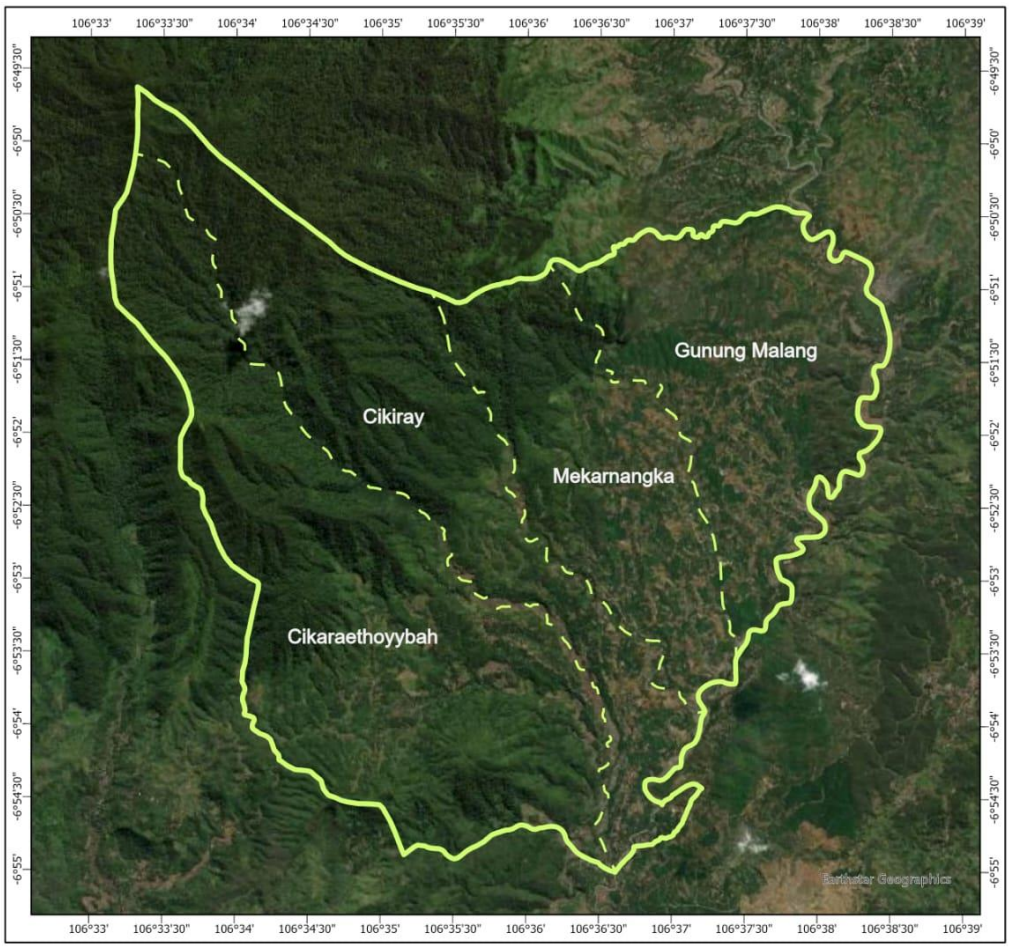


Figure 1. Location of research.

The tools used in data collection consisted of a voice recorder, camera, questionnaire, and tally sheet. The subjects in this study were sugar palm farmers in each village, village heads in each village, Cimantaja Resort managers, and (Mount Halimun Salak National Park) TNGHS

Hall managers. The objects of this research were palm stands and palm products (palm sugar).

The potential of sugar palm stands estimation was conducted by interviewing all sugar palm farmers in Cimantaja Resort. The variables measured were umber of poles, unproductive trees, and productive trees. The types and sources of primary and secondary data related to the ethnobotany of sugar palm and the characteristics of sugar palm farmers were collected using participatory observation, in-depth interviews, and documentation [4,5]. The detailed explanation of data collection in this study are presented in Table 1.

Table 1. Data Type, Collected Methods, and Data Collection

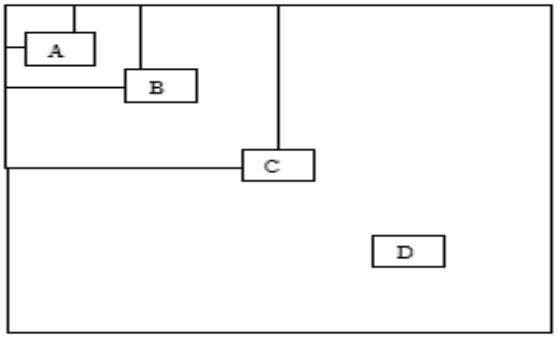
Data Type	Collection Methods	Data Collection
Estimation of potential population, stand and productivity of Aren (*Arenga pinnata*)	Number of individual sugar palm stands at the level of poles, unproductive trees, and productive trees. Inventory of regeneration number of individuals in sample plots of 20 m x 20 m as many as 2 plots in each village Stand productivity potential based on age class interview and field observation	Interview and field observation

In the inventory of sugar palm regeneration, using the method of purposive sampling which is this sampling is used to determine the potential of sugar palm by making a plot that cuts the contour line of the settlement by making two observation plots in each village with a plot size of 20x20m (Figure 2) with a total observation area of 0.32 ha. Data collection of sugar palm at each growth stage refers to Regulation of the Ministry of Agricultural No.133 (2013) as follows, 2x2 m plots to seedling (height <0.5 m stem free of fronds), 5x5 m plots to sapling (0.5-1.5 m height of frond-free stem), 10x10 m plots to poles (1.5-3 m tall of frond-free stems) and 20x20 m plots to trees (>3 m tall of- frond-free trunk).

2.1 Vegetation Analysis

Vegetation analysis was conducted at the regeneration level of palm stands to determine the density at each regeneration level in each sample plot size, which was calculated by the formula by Odum (1993) [6]:

$$Density\ (K) = \frac{Number\ of\ species}{Area\ of\ sample\ plots} \quad (1)$$



Note:

A : 2x2 m plots to seedling (height <0.5 m stem free of fronds)

B : 5x5 m plots to sapling (0.5-1.5 m height of frond-free stem)

C : 10x10 m plots to poles (1.5-3 m tall of frond-free stems)

D : 20x20 m plots to trees (>3 m tall of, frond-free trunk)

Figure 2. Sample plots of sugar palm regeneration inventory

3. Results

3.1. Estimation of Aren Stand Potential

The results of data estimating the potential of sugar palm stands number of individual, inventory of regeneration number and stand productivity and based on the age class of stands from 8-11 years old and 12-15 years old were obtained by interviewing 71 sugar palm farmers in the four villages, whereas 27 people in Mekarnangka Village, 11 people in Gunung Malang Village, 11 people in Cikiray Village and 22 people in Cikarae Thoyybah Village. The number of farmers is the total number of sugar palm farmers in each village. The object of estimating the potential of sugar palm stands used includes poles, unproductive trees, and productive trees (Table 2).

Table 2. Number of objects estimation of sugar palm stands in Cimantaja Resort

Village	Number of Farmers	Utilization Area (Ha)	Potential Estimation Object		
			Poles	Non-Productive Trees (<8 years old)	Medium Productive Trees (8-15 years old)
Mekarnangka	27	8.78	25	48	53
Gunung Malang	11	2.52	12	18	18
Cikiray	11	2.56	11	37	46
Cikarae Thoyybah	22	7.56	31	77	112
Total	71	21.42	79	114	229

The area of utilization was obtained based on information from farmers who have cultivating the land sugar palm stands. In each village there are sugar palm stands that are not utilized, due to the limited ability of farmers to utilize land with dense and steep stope arable land with unutilized sugar palm stands was not counted in this study.

Based on the results of the interview, the total number of productive trees was 229 stands, followed by unproductive trees of 114 stands and total poles of 79 stands. The object of estimating the potential of the stands taken is based on morphology (poles) and age (trees) towards the productive stage up. The age range is 6-7 years, while the productive trees were 8-15 years old at the time of the study. At the pole stage and unproductive trees there are no new buds that are mature/ready to be tapped (Fatriani *et al*. 2012), but both stages have the potential to enter the productive stage which means ready to be tapped with an abundance of potential reaching 84% of the number of trees that are currently productive. This means that there is still a sustainability of palm sugar product business conducted by palm farmers in Cimantaja Resort.

3.2. Condition of Aren Stand Regeneration

Data collection of sugar palm regeneration inventory was carried out by making two observation plots in each village with the size of 20 x 20 m2, resulting in a total of eight plots with an area of 0.32 ha. Plotting was done using purposive sampling method that cut the contour line between the residential area and the Mount Halimun Salak National Park area in determining the observation point. Plotting was conducted on the land of sugar palm farmers whose land was sampled for plotting, which required two farmers in each village. The determination of plot points was based on the first encounter of productive and tapped sugar palm stands. The number of sugar palm individuals found in the observation plots was 497 individuals covering the growth stages of seedlings, saplings, poles, and trees. Details of the results of the number of individuals are presented in Table 3.

The table above shows that the regeneration conditions in the four villages have regeneration patterns including seedlings > saplings > poles < trees which are included in the fairly sustainable category [7], there is one level of regeneration pattern that does not show sustainable regeneration, namely at the pole level to the tree level, this is thought to occur due to the absence of planting activities so that the distribution of places to grow stands occurs. randomized and uncontrolled regeneration pattern.

The number of seedling individuals shows the largest number among other regeneration levels, because seedlings are the first level of growth that comes from the spread of plant seeds that fall to the forest floor [8]. The decrease in numbers between regeneration levels occurs due to competition for nutrients and growing space that occurs naturally. The level of regeneration of the stand is indicated by the density which is calculated based on the number of individuals per unit area of the plot. Detailed density data is presented in Table 4.

Table 2. Number of regeneration level individuals of sugar palm stands in Cimantaja Resort

Village	Rate of Regeneration

	Seedlings (2x2m^2)		Saplings (5x5m^2)		Poles (10x10m^2)		Trees (20x20m^2)	
	Plot 1	Plot 2	Plot 1	Plot 2	Plot 1	Plot 2	Plot 1	Plot 2
Mekarnangka	16	13	6	4	4	3	5	10
Gunung Malang	82	77	3	5	3	3	3	4
Cikiray	66	86	4	3	2	2	4	3
Cikarae Thoyybah	27	33	4	7	3	4	5	3
Total	400		36		24		37	

Table 4. Regeneration density of sugar palm in Cimantaja Resort

Village	Seedlings (ind/m^2)	Saplings (ind/m^2)	Poles (ind/m^2)	Trees (ind/m^2)
Mekarnangka	3.63	0.20	0.04	0.02
Gunung Malang	19.88	0.16	0.03	0.01
Cikarae Thoyybah	7.50	0.22	0.04	0.01
Cikiray	19.00	0.14	0.02	0.01
Total	50.01	0.72	0.13	0.05

The results in Table 3 show a regeneration pattern of seedlings > saplings > poles < trees with a sustainable category, but after calculating the density (Table 4), a regeneration pattern of seedlings > saplings > poles > trees with a sustainable category were obtained. This proves that the number of individuals counted in the plot of each regeneration shows an uneven distribution, but when the density calculation is done, which divides the entire number of individuals per regeneration plot, the density of each regeneration plot shows an uneven distribution.

Regeneration with each plot area (according to the regeneration level) shows an even distribution of regeneration, decreasing at the seedling level to the tree level. It should be noted that the spread of sugar palm occurs naturally, the sugar palm farmers argued that the spread of seeds is assisted by mongoose. The regeneration rate of sugar palm stands in Cimantaja Resort is stable (the number of seedlings is more than the number of saplings, poles, and trees). The density of sugar palm at each growth level can be used as a determination of the level of regeneration of sugar palm in nature. The difference in density value of each growth level is caused by the presence of differences in reproductive ability, distribution and adaptability to the environment. According to the Directorate General of Agriculture (2013) in the cultivation of sugar palm, a planting distance of 9 x 9m is used, which produces 123 stands/ha. The total area of observation in this study amounted to 0.32 ha with a total of 37 trees at the tree level. Referring to the literacy, the planting distance size of 9.3 x 9.3 with the number of trees per ha produced in this study amounted to 116 stands/ha.

This shows the need for cultivation, especially planting palm stands on farmers' land. The seedling level can be moved and planted on the land where the sugar palm is tapped by farmers (insertion planting), because based on the data, it appears that the abundant number of seedlings. The adjustment of planting distance and planting holes is very important for optimal growth of palm stands. This means that no matter how well nature performs, human intervention in assisting the optimal growth of sugar palm stands must still be done. Optimal growth of the sugar palm will give the maximum yield of sap water and the sugar palm farmers will get the maximum economic value as well, so that the palm sugar business in Cimantaja Resort can continue to run and still not be detrimental to the palm farmers.

3.3. Aren Productivity Potential

The production of palm sap water can be calculated from the number of flower clusters that appear. The emergence of flower clusters is a generative growth process. Flower clusters will emerge from the upper axils of the leaf midrib. Each axil of the leaf blade have potential

flower clusters will emerge, but not all of these potential clusters will grow, some will be 'dormant' due to certain conditions. This means that the number of bunches the Aren tree will produce is proportional to the number of leaves formed and proportional to the condition of the Aren [3].

The growth period of male flower bunches or commonly called "sugar palm arms" is related to the sap water productivity period, when a stand is not producing sugar palm farmers tend to leave the stand until the stand returns to production. The waiting period for the growth of sugar palm arms to produce sap water in the research location ranges from four months to one year, while the productivity period of sap water that is ready to be tapped ranges from three to seven months. The decline in the quantity and quality of sap water production was caused by the ageing of the palm stands. Harahap (2017) [9] said that sugar palm trees can be tapped for three to four years, before the supply of foodstuffs in the trunk terrace that forms the sap water runs out, in unproductive trees and will eventually die.

Estimating the potential productivity of sugar palm stands can be seen based on age class. Lempang (2017) [10] states a good age for tapping is seven years which is a productive period for sugar palm plants, the quantity and quality of sap water produced tend to be more and better than those of sugar palms that are more than 20 years old or post-productive. Data collection for estimating the potential productivity of palm stands based on age class was carried out by interview and field observation. Because the sugar palm stands in Cimantaja resort are located in natural forests with unknown age and regeneration. The potential productivity based on age class was divided into two age classes, namely 8-11 years and 12-15 years (Table 4 and Table 5).

The sugar palm stands in the research location are naturally grown, so farmers do not know for sure how old the sugar palm stands they tap. The sugar palm farmers only estimate the age of their palm trees. The sugar palm farmers tap the sap water twice a day from each of their trees in the morning and afternoon. If the farmer gets a lot of sap water in the morning, the sap water will be molded immediately. If the sap water obtained in the morning is small, the sap water obtained in the morning will be cooked half-cooked/ before thickening and allowed to stand, the sap water obtained in the afternoon will be mixed with the collection in the morning and then printed.

Table 5. Potential productivity of sugar palm stands at age classes 8-11 years in Cimantaja Resort

Location of observation	Number of productive trees (8-11 years old)	Land area (Ha)	Sap water productivity (liters/year)	Productivity of palm sugar (kg/year)	Sap water productivity (liters/tree)	Productivity of palm sugar (kg/stand)
Mekarnangka	10	0.76	26,244	3,499	7.3	1.00
Gunung Malang	4	0.72	8,748	1,166	6.0	0.80
Cikiray	8	0.33	25,150	3,353	8.7	1.16
Cikaarae Thoyybah	25	3.63	72,171	9,622	8.0	1.10
Total	47	5.44	134,313	17,640	30.0	4.06

The product of palm sugar (kg) can be calculated based on the quantity of molds or commonly called "*ganuh*". Palm farmers sell palm sugar in one package or commonly called "*toros*" which contains four "*ganuh*" with a weight of 0.9 kg, so the weight of the ganuh is around 0.225 kg. The calculation of the quantity of palm sugar (kg) is done by calculating how many "*ganuh*" are obtained after the cooking process in two takes then multiplied by 0.225 kg then converted by multiplying by 0.9 kg.

Based on the results of interviews and field observations that have been conducted, the potential productivity of palm sugar in the age class of 8-11 years stands is the largest, namely 9.622 kg/year of palm sugar in Cikarae Thoyybah Village which is located outside the TNGHS area, which means that the community utilizes sugar palm stands without following the regulations of the national park or according to the needs of the community itself. The total land area of the utilization of sugar palm stands in the village is 3.63 ha with a total of 22 sugar palm farmers, the land area and the number of utilization trees in the village are also the largest area and the largest number of trees in the village.

The least productive sugar palm stand was 1,166 kg/year in Gunung Malang Village with 4 trees. Based on the data above, the potential productivity of sugar palm (palm sugar) in the age class of 12-15 years is the largest at 55,080 kg/year in Mekarnangka Village, but the productivity of sugar per tree is only 0.8 kg/tree. The total land area for the utilization of sugar palm stands in the village was 8.02 ha with 43 trees. The least productivity of sugar palm stands was 4,009 kg/year in Gunung Malang Village with the least sugar productivity per tree of 0.5 kg/tree, the utilization area was 1.8 ha with 18 trees. Cikiray Village has the largest productivity of palm sugar which is 1 kg/tree.

Table 6. Potential productivity of sugar palm stands in the 12-15 Years Age Class in Cimantaja Resort

Location of observation	Number of productive trees (8-11 years old)	Land area (Ha)	Sap water productivity (liters/year)	Productivity of palm sugar (kg/year)	Sap water productivity (liters/tree)	Productivity of palm sugar (kg/tree)
Mekarnangka	43	8,02	413.100	55.080	6	0,8
Gunung Malang	18	1,8	30.071	4.009	4	0,5
Cikiray	41	2,23	112.630	15.017	7,6	1
Cikaarae Thoyybah	87	3,93	201.204	26.827	6	0,8
Total	189	15,98	757.005	100.933	23,6	3,1

Based on the data shown in Table 6, it is known that the age class of 8-11 years has a greater potential productivity of sap water (lt) and sugar (kg) compared to the age class of 12-15years in each village. The percentage of palm sugar productivity in the 8-11year age class with the 12-15year age class in Mekarnangka Village is 20%, Gunung Malang Village is 30%, Cikiray Village is 16% and Cikarae Thoyybah Village is 30%.

The largest percentage between age classes 8-11 years and 12-15 years was 30% in Gunung Malang and Cikarae Thoyybah villages. Sebayang (2016) suggested that sugar palm plants will reach maturity at the age of 6-12 years. The best tapping condition is at the age of 8-9 years when the mayang flower has come out [11]. The growth of the mayang on the trunk of the palm tree always decreases as the age of the palm tree increases, besides that the growth of this mayang will be closer to the ground, a sign that the production period is almost over [3,12].

4. Conclusion

Estimation of the potential of aren palm stands conducted by interviewing all aren palm farmers in each village showed the results that unproductive poles and trees have great potential to reach productive trees as shown by a percentage of 84%. Inventory of sugar palm regeneration conducted by plotting method, and using density calculation showed that the regeneration pattern in Cimantaja Resort was seedling > sapling > pole > tree with sustainable category. This shows that the spread of regeneration is evenly distributed, decreasing at the seedling level to the tree level. The magnitude of the regeneration level of sugar palm stands is shown in units of the number of individuals and also in density, the amount of density at each level can be used in determining the level of regeneration in nature. Estimation of the potential productivity of sugar palm was conducted based on age class using field observation and interview methods, with two age classes (8-11 years and 12-15 years). Age class 12-15 in Cimantaja Resort has the highest sugar palm productivity of 100,933 kg/year with 189 trees, but the total productivity (kg) for both age classes, 56% generated by 8-11 year class.

Author Contributions

Muhammad Rizqi Muhtadin: Conceptualization, Methodology, Software, Investigation, Writing - Review & Editing; Nuning Nurcahyania: Writing - Review & Editing, Supervision; Tresa Variyani Zenb: Writing - Review & Editing, Luhur Septiadi: Writing - Review & Editing, and Laji Utoyo: Writing - Review & Editing

Conflicts of interest

There are no conflicts to declare

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