The vegetation structure and economic value of *Arenga pinnata* Merr by community surrounding forest of Mount Halimun Salak National Park, Indonesia

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**Abstract.** *Aren* is a non-timber forest product in Mount Halimun Salak National Park (MHSNP) that supports conservation and community welfare. This study was conducted to determine the potential economic value of *aren* for the local community. Sukajaya Village was selected purposively as the center of palm sugar production. The data were collected by vegetation inventory and interviews in Sukajaya Village selected by random sampling. Vegetation measurements were done in the forest areas of Mount Rongocono, i.e., Cibedug Resort. In the mixed garden of MHSNP forest areas, the *aren’s* density was 237 trees per ha with an Important Value Index (IVI) of 139.59%. Unfortunately, there was no regeneration of *aren* seedling. Aren tapping is an essential livelihood. Thirty farmers who work as tappers as their main or side jobs earn an average of IDR 654,000 months⁻¹ individual⁻¹. This figure accounts for 64.36% of the total household income of farmers. To eliminate the conflict areas, the local community needs to cultivate aren and fruits from forest areas near their settlement, or boundary land of MHSNP closed to their settlement. Derivation and product variations such as *nira* processing into powdered palm sugar and processing the sugar palm fruit are also important to increase their economic value. Therefore, the local community around MHSNP needs assistance and institution to develop the utilization of *aren* plantation.

1. Introduction

*Aren* or palm sugar (*Arenga pinnata* (Wurmb) Merr.) with its status as a good forest product. This commodity can solve the problems related to profitable and sustainable natural resources, poverty alleviation, and biodiversity conservation [1]. From a biological point of view, *aren* is a renewable resource, and there is very little damage to the plant due to their sap water (*nira*) tap collection activity. Therefore, it has economic importance on local and regional markets, which provide cash income, especially to the forest’s local community.

*Aren* belongs to the Arecaceae (Palmaceae) family with no spiny stem and no branches. The tree height and diameter can reach 25 m and 65 cm, respectively. This tree can grow well in all soil conditions such as clay, sandy, and lime soil and does not need fertile soil to grow. The ideal rainfall for this plantation is about 1200 mm year⁻¹, groundwater depth between 1-3 m, average temperature 25°C, moderate until wet temperature. This species can be found and distributed in most-Indonesian areas, especially in 14 provinces with an estimated 60,482 ha [2, 3].
Conservation and development of NTFPs commodities were urgently needed because they were livelihood resources and reduced poverty [1]. The community utilized aren trees to produce brown sugar, granulated aren, palm wine, and the other uses were their fibers (ijuk) as palm-fiber broom, the leaves as a funnel, roof of the house [4]. Production of aren sap per year from 14 provinces was about 303,760 liters [2]. However, the community has not optimized aren management due to lack of technology and unsuccessful conservation efforts [5], such as processing palm wine to become bioethanol through fermentation of Saccharomyces cerevisae bacteria [6]. The most significant utilization was mainly found in the male flower portion for nira tapping as a raw material for making aren that also increased community income [7].

These potentials need to be conserved to ensure environmental sustainability and the welfare of surrounding communities. For example, one of the villages in the buffer zone of Mount Halimun Salak National Park (MHSNP) is Sukajaya village as the center of the aren production. Aren in this village was planted in multiple years plantation amounted about 72.9 ha and protection forest about 267.8 ha as conflict areas of MHSNP [8]. This condition was found in the forest of many national parks, such as in Meru Betiri National Park and Mount Leuser National Park [5, 9]. Other forest areas that can also be used to tap nira are the community areas around the Grand Forest Park (TAHURA) and customary forests [10-12]. Based on the function and role of aren plantation, the community considered it was necessary to carry out an aren conservation strategy to aren value by cultivating aren plants with an agroforestry system, forming farmer groups, and providing assistance to aren farmers [5, 9].

The utilization of non-timber forest products in forest areas is one of the alternatives in increasing local people’s income and developing efforts to conserve forest resources [13]. Therefore, the utilization of NTFPs of aren in Sukajaya Village at the buffer zone of the MHSNP area was an alternative that can accommodate the economic interests of communities around the forest. Therefore, the survey of distributions, regeneration, and habitat suitability of aren trees was needed to obtain inventory data and evaluation. Thus, all stakeholders can understand the ecological and economic aspects of managing MHSNP to optimize the area management.

2. Materials and Methods

2.1. Study site

The study was conducted in August 2017 at Sukajaya Village, Cibedug Resort, Mount Halimun Salak National Park. Administratively the research location was in Sobang SubDistrict, Lebak Regency, Banten Province.

Aren vegetation measurements were carried out at Mount Rongoco areas, Cibedug Resort. Geographically the location of the study was located at Cibedug Resort with areas about 11,526.435 ha and laid between 106°12′58″-106°20′32″ E and 06°40′58″-06°48′15″ S [14].

The altitude of the Cibedug Resort location ranged from 600-1100 m above sea level, with wavy, hilly, and mountainous topography and slope areas of about 15-40% and appertained in the B rainfall type, with an average rainfall of 4000-6000 mm year⁻¹ [15]. The average temperature is 21°C, with the lowest at 17°C and the highest temperature is 33°C, while the average humidity is 75%. Soil types were brown Latosol and reddish-brown Latosol. The other mountains surrounding areas found were Mount Nyungcung and Mount Bapang.
2.2. Material and equipment

The materials used for vegetation analysis were vegetation in observation plots at the Rongocongo Mountain forest areas of Cibedug Resort. The equipment needed in this research were: GPS, compass, hygrometer, thermometer, and tally sheet, while the benefit of aren vegetation used key respondents. The selection of respondents was conducted randomly, based on respondents who tapped aren plantations as many as 30 respondents. In addition to the respondents, in-depth interviews were also conducted with other stakeholders involved in the management of MHSNP, including community leaders, NGOs, village heads, and MHSNP staff.

2.3. Data collection

Vegetation measurements were carried out at the Cibedug Resort through data collection and measurement of tree height and diameter on each tree growing in a single plot method with randomly selected location, based on primary survey and information from the local community. The collected data were analyzed to determine individual density, frequency of species and dominance. Of the three obtained parameters, the calculated important values can be used to determine the dominant species. In addition, this inventory was conducted to know regeneration of aren grown naturally and planted by the local community in MHSNP.

The acknowledgment of communities about the benefits of aren plantation was conducted quantitatively with a qualitative approach. The study method used was a survey, observation, and in-depth interview using a questionnaire with informant selection. The selection of research villages was made purposively based on the center of aren production by the forest community. Collected data included: the amount of nira collection, the frequency of aren collection, the selling price of palm sugar, the location of the trade route for selling palm sugar, and the income from palm sugar. In addition, those assisted in finding out the utilization of aren plants by the community surrounding MHSNP areas.

2.4. Data analysis

Data were analyzed quantitatively to determine the vegetation parameters. Vegetation data were analyzed to determine the Importance Value Index (IVI) based on species density, dominance, and frequency based on the formula by [17].

Figure 1. Study area in Cibedug Resort, Mount Halimun Salak National Park, Lebak District, Banten Province, Indonesia.
Density (K) = \[ \frac{\sum \text{individu sample plot area}}{\text{area}} \]

Relative density (KR) = \[ \frac{\text{absolute density of each species} \times 100}{\text{total absolute density of all species}} \]

Dominance (D) = \[ \frac{\sum \text{basal area sample plot area}}{\text{area}} \]

Relative dominance (DR) = \[ \frac{\text{absolute dominance of each species} \times 100}{\text{total absolute dominance}} \]

Frequency (F) = \[ \frac{\sum \text{sampling point of one sample}}{\sum \text{sample plot area}} \]

Relative frequency (FR) = \[ \frac{\text{absolute dominance of each species} \times 100}{\text{total absolute frequency}} \]

Important value index (IVI) for tree, pole, and sapling level

IVI = Relative density + Relative dominance + Relative frequency

Important value index (IVI) for seedlings

IVI = Relative density + Relative frequency

The analysis of the value of the economic benefits of the palm plant is carried out through the value of direct use, namely the results of aren which are processed into palm sugar which is used directly by the community surrounding the MHSNP areas. The valuation method used is the market price approach. [18] stated that value method with market price and with the procurement price can be calculated by the formula:

\[ N_i = JVi BPi \]

Remark:
N = Economic value of forest resources (Rp/unit volume)
BP = Cost of procurement (Rp/sapping aren)
JV = Total of forest resources (unit volume/procurement)
i = The kind of forest resources

3. Result and Discussion

3.1. Analysis of aren on mixed garden vegetation

Based on the identification results,18 species were found of total plant species on each growth level (saplings, poles, and trees). The community found these species in logged-over areas as a mixed garden, 4.5% of total MHSNP areas [19]. The community planted multi-years crops such as fruits, woods, etc. called agroforestry (Agriculture Minister Regulation Number 47/Permentan/OT140/10/2006, about guidelines of farming cultivation on the mountain land). The tree species contained in the requested areas consist of woody plants such as kayu afrika (Maesopsis eminii Eng ), huru (Litsea sp.), pulus (Laportea crenulata (Roxb) Gard), cangcaratan (Nauclea subdica), ki jirak (Simplocos sp.), ki sampang (Evendoria latifolia DC), jingjing (Paraserianthes falcataria (L) IC Nielsen.), ki leho (Saurauria cauliflora DC) and jabon (Anthocephalus cadamba (Roxb) Miq). The fruit plantation grown in this mixed garden were binglu (Mangifera caesia Jack ex Wall), jackfruit (Artocarpus heterophyllus Lamk), rambutan (Nepheleium lappaceum L), persimmons (Diospyros feet), limus (Mangifera foetida), durian (Durio zibethinus Rumph ex Murray), kecapi (Sondaricum kotjape Merr), pisitan (Lansium parasiticum (Osbech) Salni & Bennet), jengkol (Archidendron pauciflorum (Benth) I.C. Nielsen) and coffee (Coffea sp.).
This mixed garden is based on the number of species plantation included in good condition compared to the community garden in Batang Toru, North Sumatra 11 plant species [20]. The tree-level dominated by aren with the highest IVI (139.57%). The other dominant plantation consisted of kayu afrika (IVI = 28.42%), durian (IVI = 19.40%), nangka (IVI = 20.86%) and linus (IVI = 18.22%). The dominant plantation included the woody species of and fruit plants. According to [21], the domination of certain species in the mixed garden could occur because of the succeeding species’ adaptation in this location, besides strong influence by the community.

The analysis of IVI at the poles level depicted ki jirak (Simplocos sp, IVI = 130.77%) and jengkol (Archidendron pauciflorum (Benth) I.C.Nielsen; IVI = 169.23%) as the highest species. The local community intensively cared for jengkol because this plantation produced fruit that could be consumed or traded at local markets [22].

The sapling level showed nine species as woody and fruit plantation. Based on the analysis of IVI, they were dominated by durian (IVI = 42.14%), ki sampang (IVI = 36.27%) and kayu afrika (IVI = 20.89%), however the other plantation almost the same growth as other species where their IVI were about 16.78%. Thus, plant adaptation to the environment influenced the growth at the sapling and seedling levels [23].

Actually, at the seedling level, there were 33 species. However, seven species have an IVI significant value of more than 10% [24] as domination species (Table 2). The species of grass-dominated in the seedling level which consisted of rumput jampang (Eulisina indica Gaertn), kakawatan (Ischaemum timorense Kunth), rumput ilat (Andropogon sp.), rumput eurih (Imperata cylindrica (L). P. Beauv).

| Species (local name) | FR (%) | Density (individual ha⁻¹) | KR (%) | DR (%) | IVI (%) |
|----------------------|--------|---------------------------|--------|--------|---------|
| Tree level           |        |                           |        |        |         |
| Kayu Afrika          | 6.25   | 125.0                     | 20.00  | 2.12   | 28.42   |
| Rambutan             | 6.25   | 25.0                      | 4.00   | 0.19   | 10.44   |
| Durian               | 12.50  | 37.5                      | 6.00   | 0.89   | 19.40   |
| Aren                 | 25.00  | 237.5                     | 38.00  | 76.57  | 139.57  |
| Ki Sampang           | 6.25   | 25.0                      | 4.00   | 0.19   | 10.44   |
| Kecapi               | 6.25   | 25.0                      | 4.00   | 0.42   | 10.67   |
| Huru                 | 6.25   | 25.0                      | 4.00   | 0.19   | 10.44   |
| Pulus                | 6.25   | 25.0                      | 4.00   | 0.42   | 10.67   |
| Nangka               | 6.25   | 25.0                      | 4.00   | 10.61  | 20.86   |
| Linus                | 6.25   | 25.0                      | 4.00   | 7.97   | 18.22   |
| Pisitan              | 6.25   | 25.0                      | 4.00   | 0.19   | 10.44   |
| Cangkaratan          | 6.25   | 25.0                      | 4.00   | 0.19   | 10.44   |
| Pole level           |        |                           |        |        |         |
| Ki jirak             | 50.00  | 100.0                     | 50.00  | 30.77  | 130.77  |
| Jengkol              | 50.00  | 100.0                     | 50.00  | 69.23  | 169.23  |
| Sapling level        |        |                           |        |        |         |
| Ki Sampang           | 25.00  | 533.0                     | 11.30  | 36.27  |
| Durian               | 8.33   | 1600.0                    | 33.80  | 42.14  |
| Kayu Afrika          | 16.67  | 200.0                     | 4.23   | 20.89  |
| Jing-jing            | 8.33   | 400.0                     | 8.45   | 16.78  |
| Leho                 | 8.33   | 400.0                     | 8.45   | 16.78  |
| Binglu               | 8.33   | 400.0                     | 8.45   | 16.78  |
| Kapi                 | 8.33   | 400.0                     | 8.45   | 16.78  |
| Aren                 | 8.33   | 400.0                     | 8.45   | 16.78  |
| Jabon                | 8.33   | 400.0                     | 8.45   | 16.78  |

Remarks: KR= relative density; DR= relative dominance; FR= relative frequency; IVI= Important value index
Besides shrub species such as *harendong* (*Melastoma malabathicum* L.), *salampak* and *paci-paci* (*Leucas lavandulaefolia*) [25].

**Table 2. Important Value Index of dominant species of seedling level in Mount Rongocongo, Cibedug Resort, MHSNP.**

| No. | Species (local name) | FR (%) | Density (individu ha⁻¹) | KR (%) | IVI(%) |
|-----|----------------------|--------|-------------------------|--------|--------|
| 1   | Rumput eurih         | 10.53  | 10,625                  | 7.76   | 18.29  |
| 2   | Kakawatan            | 2.63   | 17,500                  | 12.8   | 15.42  |
| 3   | Harendong            | 10.53  | 5000                    | 3.65   | 14.18  |
| 4   | Salampak             | 7.89   | 7500                    | 5.48   | 13.37  |
| 5   | Paci-paci            | 7.89   | 7500                    | 5.48   | 13.37  |
| 6   | Rumput ilat          | 2.63   | 12,500                  | 9.13   | 11.76  |
| 7   | Jukut Jampang        | 5.26   | 8750                    | 6.39   | 11.66  |

Remarks: FR = relative frequency; DR = relative density; KR = relative density; IVI = important value index

At the seedling level, there was no natural regeneration of *aren* (Table 2). This condition was affected by community activity. For example, as the center of Palm Sugar, the local community in Sukajaya Village tapped male flowers almost every day to get *nira*, which produced brown sugar. They also used young fruit as *kolang-kaling*, so the plantation did not have red fleshy fruit that was eaten and predominantly dispersed by *careuh* or *luwak* civet (*Paradoxurus hermaphroditus* Pallas 1777) [26]. On the contrary, at the mixed garden of Kekait Village of the Sasak Community, West Nusa Tenggara, the distribution of *aren* was influenced by the spread of sugar palm seeds. An animal-spreading vector assists the vector (*zookori*), called Rinjani weasels (*Paradoxurus hermaphroditus rinjanicus*), so the IVI was about 52.09% which is categorized as good regeneration [20].

**Table 3. The height and diameter of *aren*, tree level in Mount Rongocongo, Cibedug Resort MHSNP.**

| No. | Diameter (cm) | Height (m) | Age (year) | No. | Diameter (cm) | Height (m) | Age (year) |
|-----|---------------|------------|------------|-----|---------------|------------|------------|
| 1   | 100           | 5          | 10         | 14  | 125           | 6          | 14         |
| 2   | 130           | 15         | 20         | 15  | 130           | 7          | 12         |
| 3   | 130           | 5          | 10         | 16  | 140           | 8          | 20         |
| 4   | 130           | 10         | 20         | 17  | 130           | 7          | 15         |
| 5   | 130           | 12         | 12         | 18  | 140           | 12         | 18         |
| 6   | 100           | 13         | 15         | 19  | 150           | 12         | 18         |
| 7   | 130           | 10         | 12         | 20  | 130           | 12         | 17         |
| 8   | 130           | 12         | 15         | 21  | 30            | 5          | 15         |
| 9   | 130           | 7          | 15         | 22  | 130           | 5          | 20         |
| 10  | 140           | 10         | 15         | 23  | 125           | 7          | 10         |
| 11  | 130           | 7          | 15         | 25  | 130           | 8          | 20         |
| 12  | 150           | 12         | 16         | 25  | 160           | 10         | 20         |
| 13  | 130           | 12         | 15         |     |               |            |            |

*Arenga pinnata* species in Sukajaya Village included in C stratum, based on five strata as mentioned by [17] and [27]. C Stratum was the third layer from the upper part of the canopy made of trees with a height ranging from 4 to 20 m. In this village, the average diameter *aren* was about 116.4 cm, indicating
that are in this area were well grown [28]. In Batang Gadis National Park, the potential of palm plants (Arenga pinnata) were 256 individuals with an average height of 12 m and an average diameter of 53.08 cm [7]. However, based on the morphological characteristics of sugar palm plants (plant age, plant height, stem diameter, tapper age of panicle level, chlorophyll a, b, and total chlorophyll), it is showed that the most influential on the production of sap is plant height and plant age (37.2%). In comparison, the most influenced part for sugar production is plant height (29.2%) [29].

3.2. Socioeconomic characteristic of respondent

According to MHSNP Management, the local communities surrounding MHSNP were generally Sundanese, which is divided into Kasepuhan (adat) and non-Kasepuhan (non-adat) communities. Social characteristics of the community include the level of education, the number of family members, the number of family dependents, the level of health and age [30, 31]. In contrast, the economic characteristics include main occupations, side jobs, land area and income [32]. Thus, the community's economic capacity tended to be low, but most of them were not included in the category of poor households (RT) [33].

All of the respondents were Moslem, Sundanese and male. Religious life is essential because it concerns inner peace and influences behavior in daily life [32]. The age of the respondents varied between 35 to 62 years (Table 4). Most respondents (96.67%) belong to productive age (over 15 years to 64 years) based on age class classification. Data showed that most respondents could move to the maximum in various efforts to meet the needs of their families. The age level influences individuals' ability related to physical condition, way of thinking, and workability.

The research by [32] stated that most communities in the buffer zone of MHSNP have low education. The low education represented by respondents with formal education levels classified as elementary school (SD) was about 97.67%, and 3.33% of respondents were junior high school (SLTP). The low level of education affected working as farmers. Most of their household life depends on the livelihood of rice farming.

All respondents were local communities who have occupied the location since their birth for 20-40 years, which amounted to about 83.33%. The number of respondents with less than four family members was five (50%) (50%), the number of respondents with four family members was 26.67%. In addition, the number of respondents with more than four family members was nine (23.34%). From the number of family dependents' point of view, most respondents (50%) bear two lives, which means that one family head must work to fulfill four family members' living needs. Therefore, the number of family dependents will affect the head of the family's enthusiasm and creativity to meet the economic needs of his family [34].

The results showed that 83.33% of respondents have the main livelihood as farmers and as many as 25 respondents as farm laborers. Besides a primary job, most respondents also have side jobs to support the respondent's household's economic needs as many as 22 respondents (76.67%) as tappers of aren, farm laborer 10% and others 3.33%. As farmers, the local community needed agricultural land. However, all respondents did not own property, so they used the arable land of MHSNP. [35] stated that the problem faced by farmers in sustaining their livelihoods is limited agricultural land. The data showed that 18 respondents (60.00%) have an arable land area in forest areas with a low category (< 0.5 ha) and 12 respondents (40%) with an area of a medium type (> 0.5 ha).

Family income was measured by the accumulated income of all family members after being converted into per month. From Table 4, the data showed that as many as 13 respondents or 43.30% belong to low-income levels, under IDR 1,000,000 month\(^{-1}\). Most respondents (50%) have a total income of between IDR 1,000,000 - IDR 1,500,000 month\(^{-1}\) with a moderate income level category. As many as two respondents were in high income in the category of above IDR 1,500,000 month\(^{-1}\). When referring to the regional minimum wage (UMR), respondents' average income level is below the UMR of Lebak County, IDR 2,751,313.87 [36]. Most respondents rely on agricultural products as their primary occupation, while their side jobs are farm laborers.

The respondents of aren farmers had narrow land ownership (about ≤ 0.25 ha and > 0.25 ha) and were less than 0.5 ha. Fortunately, they had arable land of MHSNP, which was also narrow and medium
measurement (<0.5-1.0 ha), which amounted to 20 people. According to [37], farmers who manage narrow land have to increase their farm production and manage their crops to have more value as diversified processed products. Therefore, it was conducted as their competency. The competencies needed to be farmers were (1) harvesting, (2) post-harvest management, (3) marketing of products, (4) combination and diversification of other business (5) entrepreneurial spirit. Meanwhile, this condition was related to the characteristics of farmers, such as formal education, land and utilization of information, age, training, the experience of gender, and interaction with instructors. All of these aspects influenced the income of farmers.

Table 4. Characteristics of the Sukajaya community village, Sobang Subdistrict, Lebak District.

| Responden characteristics                  | Classification          | Number of respondents (individu) | Percentage (%) |
|--------------------------------------------|-------------------------|----------------------------------|----------------|
| Gender                                     | Male                    | 30                               | 100            |
| Ethnic                                     | Sundanese               | 30                               | 100            |
| Religion                                   | Islam                   | 30                               | 100            |
| Group of age (individual),                | Productive age (>15 year)| 29                               | 96.67          |
| Age of respondents 22-60 year             | Unproductive age (>56 year)| 1                               | 3.33           |
| Formal education level                     | Elementary School       | 29                               | 96.67          |
|                                           | Junior-Senior High school| 1                               | 3.33           |
| Non formal education (times)               | None                    | 30                               | 100            |
|                                           | 1-3 Times               | 0                                | 0              |
|                                           | >3 times                | 0                                | 0              |
| Residence status                          | Native                  | 30                               | 100            |
|                                           | Non native              | 0                                | 0              |
|                                           | ≤21 years               | 0                                | 0              |
| Periodical time (year)                    | 22–42 years             | 25                               | 83.33          |
|                                           | >42 years               | 5                                | 16.67          |
| Number of family (individu)               | <4                      | 15                               | 50.00          |
|                                           | 4                       | 8                                | 26.67          |
|                                           | >4                      | 7                                | 23.34          |
|                                           | ≤2                      | 15                               | 50.00          |
| Dependent number per household (individu) | 3                       | 7                                | 23.34          |
|                                           | ≥4                      | 8                                | 26.67          |
|                                           | Farmer                  | 25                               | 83.33          |
| Main occupation (individu)                | Nira taper              | 5                                | 16.67          |
|                                           | Others                  | 0                                | 0              |
|                                           | Farmer                  | 0                                | 0              |
| Side job (individu)                       | Nira taper              | 23                               | 76.67          |
|                                           | Labour                  | 3                                | 10.00          |
|                                           | Jobless                 | 4                                | 13.33          |
|                                           | None                    | 0                                | 0              |
| The arable land of MHSNP (ha)             | <0.5 ha                 | 6                                | 20.00          |
|                                           | 0.5-1.0 ha              | 14                               | 46.67          |
|                                           | >1.0 ha                 | 10                               | 33.33          |
|                                           | None                    | 13                               | 43.33          |
| The land ownership                        | ≤0.25 ha                | 7                                | 23.33          |
|                                           | >0.25 ha                | 10                               | 33.34          |
| Income level of jobs (IDRx1,000)          | < IDR 1000              | 13                               | 43.30          |
|                                           | IDR 1000–1500           | 18                               | 50.00          |
|                                           | > IDR 1500              | 2                                | 6.70           |
The income of farmers in Sukajaya Village from palm sugar varied from IDR 160,000 - IDR 1,600,000. The variation of tappers' income depended on the number of palm trees being managed. Besides, the difference in income is triggered by several other constraints on palm sugar production because of technology, environment, and ecology [38]. The technology to produce palm sugar still uses traditional techniques, affecting the low-quality standard and the low selling price of palm sugar. It might be due to the influence of the environment, such as the weather, that influenced the production sap of aren and processing of sugar drying. The ecology constraint was related to plant condition and availability of firewood from garden and forest areas for processing.

3.3. Benefit values of aren plantation

Sugar palm, locally known as kawung or aren (Arenga pinnata (Wurmb.) Merr.), has long been known for its various ecological, economic, and socio-cultural uses among rural people of West Java [39]. Rural people have utilized and managed aren based on their local knowledge. This species produced the sweet sap from the inflorescence and the many leaves, trunk, and underground seedlings. A thin orange pulp coating the fibers of the mature fruit is consumed fresh or dried as a paste. The large seeds, when immature, before the shell hardens, contain jelly-like kernels esteemed for food. Hence, their socioeconomic importance can be critical for the rural poor [40]. Generally, the local community produced brown palm sugar through traditional technology, as the highest economic level and the lowest as a local alcoholic drink called tuak [9].

The economic value of aren is obtained from multiplying the total harvest per species per year with the price per species. In Sukajaya, Sobang Sub-District of Lebak County, the average income from palm sugar (IDR month⁻¹ individual⁻¹) was IDR 654,000. As for comparisons, the economic value of the utilization of palm sugar by the people of Namo sialang and Sei Serdang Villages, Batang Serangan District was IDR 617,400,000 in 2010 [9]. In Tomohon, the average total income per month per individu was IDR 977,000 [10]. The average income in Tomohon was higher than in other locations because the community processed the aren juice (10-15%) to be palm sugar, and they also processed into alcohol, palm syrup, palm vinegar and ethanol. Based on the analysis results obtained, palm sugar farmers' production cost is IDR 2,196,815 month⁻¹ and IDR 26,361,780 year⁻¹. Average monthly revenues of IDR 4,1236 million and IDR 49,483,200 year⁻¹. Aren farmers' net income was IDR 1,926,785 month⁻¹ and IDR 23,121,420 year⁻¹.

Table 5. Production and income of farmer from nira sap of aren in Sukajaya Village, Lebak, Banten.

| Species plantation | Areca (Arenga pinnata) |
|--------------------|-----------------------|
| The forest areas of Cibedug resort (ha) | 4362 |
| The number of trees that tapped per day per individual | 6 |
| The sap of nira individual⁻¹ day⁻¹ (liter) | 14 |
| The sap of nira tree⁻¹ day⁻¹ (liter) | 2.3 |
| The time of processing sap nira to be palm sugar (hour) | 3 |
| The average age of aren plantation | 17 |
| Total production of palm sugar per processing | 22 |
| Average weight of one palm sugar (kg) | 0.4 |
| The number of tappers (individual) | 30 |
| The price of palm sugar (IDR kqor⁻¹) | 25,000 |
| The price of palm sugar (IDR hulu⁻¹) | 5000 |
| The distance to sap location (km) | 2.4 |
| Sap nira needed per hulu (liter) | 2.8 |
| The Production of palm sugar day⁻¹ individual⁻¹ (hulu) | 5 |
| The income from palm sugar (IDR month⁻¹ individual⁻¹) | 654,000 |
| The average of total income (IDR month⁻¹ individual⁻¹) | 977,000 |
| Respondent income (IDR month⁻¹ individual⁻¹) | 483,000-1,600,000 |
| Income contribution to total income per household (%) | 64.36 |
The contribution of *aren* farmers' income to the total household income of tappers ranged from 19.0% to 100%, with an average of 64.36%. The value of this contribution is influenced by the planting types, such as an agroforestry system. In comparison, [41] stated that income contributions of a home garden, a traditional mixed garden at private land and a mixed garden at Ambon City were 6.96%, 14% and 7.5%, respectively, while the total income contribution of agroforestry system to household income was about 27.5%. Thus, the study results showed that the agroforestry system applied has improved the farmers' welfare and benefited economically and ecologically. However, income contributions on household income varied because of estate commodity species, morphological trees, number of household members, and side-job selection.

Besides providing economic values, *aren* was also a significant subsistence, socio-cultural importance species for the community. Moreover, it also provides ecosystem protection services such as hydrological, soil retention and erosion or landslide conservation plants to be developed or cultivated in earnest by various parties [42]. Therefore, these palm trees must be conserved, developed, or cultivated in earnest by various parties.

From an economic aspect, as a potential species, *aren* gave people job opportunities by opening jobs and added income. So, in MHSNP, the local community has to domesticate aren surrounding their settlement in the buffer zone or the boundary of forest areas to solve conflict tenurial and avoid conflict with wildlife because of the location of mixed garden in the forest far away from their home. Subsequently, the farmers as nira tappers have to diversify production from *aren* tree plantation as palm sugar powder, the fruit of *kolang-kaling* (sugar palm fruit), and thatch to increase their income. So, the local community surrounding MHSNP needed assistance and institution to develop the utilization of *aren* plantation.

4. Conclusion

*Aren*ga *pinnata*, as one of Non-Timber Forest Products (NTFPs), has an economic value, so this *aren* must be conserved and cultivated by the local community in their settlement or the boundary MHSNP forest areas. In Cibedug Resort, the mixed garden of *aren* and fruit species was dominated by *aren*'s density of 237 trees per ha with the highest IVI (139.57%) at tree level. Unfortunately, *aren* has poor regeneration, especially at the seedling level, which was none in the study location.

The income of farmers from Sukajaya Village, Sobang Subdistrict of Lebak Regency, produced palm sugar ranged from IDR 160,000 - IDR 1,600,000. The average income was IDR 654,000 month$^{-1}$ individual$^{-1}$ family$^{-1}$. Morphological trees influenced the different income, number of household members and side-job selection. Finally, the income contribution from *aren* to the total household with an average of 64.34% was significant.

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