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Valuation of the Direct Benefits of Candlenut for Communities around the Forest on the Slopes of the Gawalise Mountains

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Abstract: Candlenut plants can function as conservation plants to reclaim marginal lands that have been degraded. The development of candlenut plants on degraded land can not only increase the economic value of the land, but can also be used as plants with high economic value. The general objective of this study was to determine the economic value of candlenuts located on the slopes of the Gawalise Mountains in Uwemanje Village, Kinovaro Regency, Sigi Regency, Central Sulawesi. Specifically, the objectives of this study are; To determine the production of candlenut fruit, and the productivity of candlenut stands. This study uses primary data and secondary data. Primary data is obtained from direct interviews with respondents and the results of candlenut stand measurements. Secondary data is information obtained from data that is already available. both from literature and from related agencies. Data analysis uses quantitative descriptive, namely income analysis and stand productivity analysis. The results of the study showed that the community in Uwemanje Village, Kinovaro District, Sigi Regency, has obtained economic benefits from candlenut trees in the form of candlenut seed products, candlenut shells, and tree trunks. The total economic value of direct benefits of candlenut trees in Uwemanje Village, Kinovaro District, Sigi Regency, Central Sulawesi is IDR 282,950,000/year. The highest value of the three products is the average candlenut stem value of IDR 262,500,000/hectare (91.16%), then the average candlenut seed value of IDR 25,000,000/year (8.68%) and the lowest is the average shell value of IDR 450,000/year (0.16%). Of the three products, the benefits of candlenut trees that can be felt most directly and have the highest selling value are candlenut seed products because they immediately get a lot of cash from the sales.

Keywords: Benefits; Candlenut; Economic value

Introduction

Forest resources are economic resources that have diverse potentials in the form of wood, non-wood (tangible) such as rattan, bamboo, resin, medicinal plants and others and intangible forest products such as environmental protection, genetic diversity and so on. However, in some areas it has had an impact on changes or decline in the quality (degradation) of forest and land resources (López, 2022; Hallaj et al., 2024; Gunawan et al., 2024). The area of critical land in Indonesia has increased from year to year due to natural factors and uncontrolled exploitation. Efforts to save forest and land degradation can be done in various ways, including sustainable forest management and reforestation. One of the reforestation efforts that can simultaneously provide many benefits, both ecological and socio-economic benefits for the community is the management of candlenut plants (Cunningham et al., 2015; Boissière et al., 2021; Kim et al., 2021). Candlenut plants can function

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as conservation plants to reclaim marginal land that has been degraded.

The development of candlenut plants on degraded land not only increases the economic value of the land, but can also be used as plants that have high economic value. Candlenut (Aleurites moluccana Willd) is a native plant of Indonesia and is spread across Southeast Asia, Polynesia, South Asia and Brazil. In Indonesia, candlenuts have long been planted, both for commercial purposes and for subsistence to support people's daily lives, used for various purposes, namely the seeds can be used as lighting media, cooking spices and medicines, while the stems can be used for wood (Susilowati et al., 2020; Jayusman et al., 2022; Beatrice et al., 2023). Candlenut is one type of plant that is classified as a spice plant that is quite widely cultivated by people in Indonesia as an option in agroforestry-based forest management (A.Samsu et al., 2022).

Candlenut plants have many uses, one of which is as a food ingredient (Anaba et al., 2021). The part of the candlenut plant that can be used as a flavoring and consistent thickener in soups is the candlenut fruit. According to Brutu et al. (2022), candlenut plants have many benefits for human life, because almost all parts of the plant can be utilized.The various benefits produced from the candlenut plant require an accurate assessment of the true value of natural resources that have been cultivated and utilized by the community in Uwemanje Village for quite a long time. Uwemanje Village is one of the villages located on the slopes of the Gawalise mountains that has the potential for candlenut plants. Since 1974, the community in Uwemanje Village has planted candlenuts and until now it has reached approximately 60 ha so that Uwemanje Village has become a candlenut producing area. This potential can provide benefits to the community, both ecological and socio-economic benefits (Heckwolf et al., 2021; Leonard & Iileka, 2024; Wu et al., 2020).

In addition, candlenuts in Uwemanje Village are classified as fruits that have quality seeds. Since 1990, it has received certification from the Palu-Poso BPDAS and in 2007 it again received certification for quality candlenut seeds. Some research results related to the economic value of candlenut plants, namely (Wonggo et al., 2023; Dalya & Mujetahid, 2020; Vo et al., 2023), with the title of his research, Utilization and Contribution of Candlenut (NTFP) to Farmers' Income in Bontocani District, Bone Regency, South Sulawesi. This study examines the contribution of candlenut to farmers' income where the cultivated land contains more than one type, namely there are cocoa plants between candlenut plants (agroforestry pattern) (Markum et al., 2021; Alam et al., 2024), with the title of his research, Analysis of Income of Candlenut and Cocoa Agroforestry Farmers in Sigimpu Village, Palolo District, Sigi Regency.

This study examines the value of farmers' income from candlenut and cocoa agroforestry results. From the two studies, there is a difference with the research presented here, namely examining the economic value of candlenut without other types of plants on community land on the slopes of the Gawalise mountains. Based on this, the author is interested in conducting research on the economic value of candlenut plants in Uwemanje Village, Kinivaro District, Sigi Regency, Central Sulawesi. Based on this background, the formulation of the problem is how much is the economic value of candlenuts on the Slopes of the Gawalise Mountains, Uwemanje Village, Sigi Regency, Central Sulawesi. The general objective of this study is to determine the economic value of the direct benefits of candlenut plants on the Slopes of the Gawalise Mountains, Sigi Regency. Specifically, the objectives of this study are; To determine the production of candlenut fruit and the productivity of candlenut stands.

The results of this study can be used as information for the government, other agencies and the general public regarding the economic value of candlenuts on the Slopes of Mount Gawalise, Sigi Regency, so that in the future the potential of candlenuts can be further improved.

Method

Research Location

This research was conducted on the slopes of Mount Gawalise, Uwemanje Village, Kinovaro District, Sigi Regency, Central Sulawesi Province.

Figure 1. The slopes of Mount Gawalise, Uwemanje Village, Kinovaro District, Sigi Regency, Central Sulawesi Province

Tools and Materials

The tools and materials used in this study are: Writing instruments, Questionnaires/question lists, Mobile Phone Cameras.

Data Types

This study uses primary and secondary data. Primary data is obtained from direct interviews with respondents using questionnaires and from the results of measuring stand productivity. While secondary data is information obtained from literature/references.

Sampling Method

Respondents

The selection of respondents was carried out using Purposive Sampling. The number of candlenut farmers in Uwemanje Village is 386 families, so the number of respondents was set at 25 people, this is based on the opinion of Arikunto (2016), if the research object is more than 100 then 10-15% or 20-25% or more can be taken.

Land Samples

Measurement of candlenut stand productivity was carried out using Purposive Sampling by making a plot measuring 20 m x 100 m.

Data Analysis

The data was analyzed descriptively qualitatively and quantitatively. Quantitative data used in the analysis:

Total Cost

All expenses that can be valued in money during candlenut management activities. These costs include fixed costs and variable costs. The formula used :

$$TC = FC + VC \quad (1)$$

Where:
TC = Total Cost (IDR/year)
FC = Fixed cost (IDR/year)
VC = Variable cost (IDR/year)

Revenue

All results that can be valued in money obtained from the business, formula (Yusdi et al, 2019):

$$TR = Q \times P \quad (2)$$

Where:
TR = Total Revenue / Total receipts (IDR / year)
Q = Total Production (kg / year)
P = Product Selling Price (IDR)

Income

Income analysis can be calculated using the following formula:

$$\Pi = TR - TC \quad (3)$$

Where,
$\boldsymbol{\pi}$ = Income (IDR / year)
TR = Total Revenue / total receipts (IDR / year)
TC = Total cost / Total Cost (IDR / year).

Candlenut Stand Productivity

Determination of tree/ stand volume, using the formula (Pakaya, 2015).

$$V=1/4\ \pi.d^2\ h.Fe \quad (4)$$

Description:
V = Tree volume (m^3)
d = Tree diameter (cm)
h = Tree height (m)
Fe = 0.7 Tree shape correction factor

Total Economic Value of Direct Benefits of Candlenut

Total Economic Value of Direct Benefits of Candlenut with the formula:

$$TNEMLK = NMEBK + NMECK + NMETK \quad (5)$$

Where:
TNEMLK = Total Economic Value of Direct Benefits of Candlenut
NMEBK = Economic Benefit Value of Candlenut Fruit
NMECK = Economic Benefit Value of Candlenut Shell
NMETK = Economic Benefit Value of Candlenut Stand

Result and Discussion

Uwemanje Village is located in Kinovaro District, Sigi Regency, Donggala Regency, Central Sulawesi Province, with hilly topography with an altitude of 400 m above sea level with a slope of more than 40% so that it is susceptible to erosion and land degradation and has an impact on community farming activities. Uwemanje Village is directly adjacent to a protected forest, with an area of 21.000 Ha which is used for plantations, agriculture, and settlements. The livelihoods of the people in Uwemanje Village are generally gardening and farming on dry land. The results of observations in the field show that the use of land cultivated by the community in Uwemanje Village, namely the development of candlenut plants, has a significant impact on community income (Rachman et al., 2021; Ngongo et al., 2022).

Based on the results of interviews with respondents, initially the management of community land for candlenut development was by planting candlenut plants and at the same time planting types of seasonal crops (secondary crops) between candlenut plants such as corn, green beans, chilies, turmeric,

lemongrass and so on (agroforestry pattern) (Ekasari et al., 2021; Li et al., 2025). The mixed plants were intended to meet daily needs and some were for sale (Kassab et al., 2023; Martinho et al., 2024; Todd & Faour-Klingbeil, 2024). Several years later, as the candlenut plants grew larger and taller and had wide crowns, some people no longer planted seasonal crops (secondary crops) between the candlenut plants (Gai & Wang, 2024). There were those who still planted intercrops such as turmeric, galangal and lemongrass which were only to meet their own needs (subsistence) and not for sale (commercial). Candlenut plants have many benefits (Shintawati et al., 2022). The direct benefits obtained by the community from candlenut trees consist of three types, namely seeds, shells and tree trunks. These direct benefits are carried out using market prices to determine the magnitude of the direct benefit value of candlenut trees in Uwemanje Village.

Candlenut Seeds

Candlenut plants play an important role in supporting the economy for the people of Uwemanje Village. The people of Uwemanje Village feel that it is easier to spend money on candlenut planters because the costs used in planting to harvesting are relatively small so that it is considered that candlenut cultivation is a land utilization activity that can provide more income. Candlenut trees in Uwemanje Village bear fruit at the age of 4-5 years, and when they bear fruit, the candlenut trees can bear fruit all year round. The ages of the respondents' candlenut trees are between 6 and 58 years. The peak harvest period for candlenut fruit usually lasts for two to three months, namely from October, November, and December.

In general, candlenuts are able to produce fruit at the age of 3-4 years from seeds, and from vegetative seedlings they can bear fruit starting at the age of 2 years (Mustafiz et al., 2021; Dissanayake et al., 2023; Arias et al., 2022). Candlenut trees in Uwemanje Village sometimes bear fruit not simultaneously so that the collection of candlenut fruit cannot be done all at once. However, even though they do not bear fruit simultaneously, the production is still high because generally the community has a large number of candlenut trees and has quite large candlenut land. The average respondent has a candlenut land area of 2.92 ha. The number of candlenut trees varies from 140 - 150 per hectare. The number of candlenut trees varies because some respondents did not use planting distance when planting candlenuts. Candlenut trees in Uwemanje Village bear fruit three times a year. Some of the ways that people harvest candlenuts are by climbing the tree, some use poles, and some let the candlenuts fall to the ground and leave them for a few days so that the candlenuts can be collected in large quantities.

The candlenuts are left so that the outer skin of the candlenut becomes weathered and brittle, making it easier to peel. Peeling the fruit skin is done manually and then dried in the sun for three or four days, and if it is the rainy season, the drying time will be longer. The dried candlenut seeds are then ready to be sold and a small part is for personal consumption, and some continue to break the candlenut shells. Only a small number of people in Uwemanje Village break the candlenut shells because in general respondents sell candlenuts in the form of seeds (still with shells). The breaking of the candlenut shells is done manually and the tool used is made of rattan and then pounded against a stone. Candlenut production in Uwemanje Village is generally used for sale (commercial) and only a small portion for personal consumption (subsistence). The selling price of candlenut seeds is IDR 10.000/Kg. Each respondent obtained candlenut seed production varying between two to six tons per year, with an average of 2.500 kg/year. Candlenut seed production can be seen in Table 1.

Table 1. Candlenut Seed Production in Uwemanje Village

Number of Candlenut Seed Products	Number of Respondents (People)	Percentage (%)
(Kg/Year)	2	8
1.000-2.000	13	52
3.501-5.000	8	32
>5.000	2	8
Amount	25	100

Based on Table 1, it is known that 13 respondents (52%) have a production of 2,000-3,500 kg/year of candlenut seeds, and 8 respondents (32%) have a production of 3.501-5000 kg/year of candlenut seeds. The age of the candlenut trees in Uwemanje Village can affect the production of candlenut fruit, but there are also candlenut trees that are the same age but have different production amounts. In addition, there are many other factors that can affect candlenut fruit besides age, such as land area, plant care and so on.

Candlenut Shells

In addition to candlenut seeds that can be used as income, candlenut shells can also provide direct benefits for the community in Uwemanje Village, although only a small number of respondents use them as an additional source of income. The shells are collected and then put into sacks until they are collected in large quantities and then sold. Candlenut shells are one of the raw materials for making charcoal, so there are several traders who deliberately look for candlenut shells in Uwemanje

Village. Candlenut shell production in Uwemanje Village averages 15 sacks/year. The type and size of sacks used are 50 kg rice sacks. The price of candlenut shells is IDR 15.000/sack. Candlenut shell production can be seen in Table 2.

Table 2. Candlenut Shell Products in Uwemanje Village

Number of Candlenut Products (Sacks/Year)	Number of Respondents (People)	Percentage (%)
1-10	2	13.33
11-20	10	73.33
21-30	2	13.33
Amount	14	100

Table 2 shows that out of 25 respondents, 14 respondents used candlenut shells for commercial purposes. The largest production of candlenut shells was 11-20 sacks per year, with 10 respondents (73.33%). This proves that the people in Uwemanje Village have used candlenut shell products to sell so that they can increase their income.

Candlenut Trees/Stands

The natural scenery in Uwemanje Village shows many candlenut stands growing both in the yard and in the garden. The trees are large and have interlocking crowns (Hao et al., 2023; Chi et al., 2024). Candlenuts are deliberately planted and some grow naturally (Zulharman & Noeryoko, 2023). The people in Uwemanje Village believe that planting candlenuts will provide many benefits or functions, so that people do not immediately want to cut down candlenut trees (Chazali et al., 2024). The use of candlenut trees/stands by the people in Uwemanje Village can be done if there are candlenut trees that fall. The community uses them to make fences or for materials to make huts in the garden. Candlenut stands in Uwemanje Village are not for sale, but economically candlenut stands have direct benefits. Based on the results of interviews with respondents and information from wood traders, candlenut trees have a selling value of IDR 500.000/m3. The tree measurement sample was 0.2 ha on each respondent's land. The results of measuring tree height and tree trunk circumference, then the tree volume can be calculated. Based on the calculation results, the average tree volume was 109.25 m3/0.2 ha or 525 m3/ha. Thus, the economic value of candlenut stands is IDR 262.500,000/ha.

Total Economic Benefit Value of Candlenut

The total economic value of the direct use value/benefit of candlenut is the sum of all that is produced from candlenut tree products, namely from seed product income, shell product income and stand income. The results of calculating income from the direct use value of candlenut can be seen in table 3.

Table. 3. Total Economic Value of Direct Benefits of Candlenut Products

Candlenut Products	Average Production/year (Kg, sack, M3)	Unit Price (Rp)	Total Price (Rp)	Percentage (%)
Candlenut Seeds	2.500	Unit Price (Rp)	Total Price (Rp)	Percentage (%)
Shells	222		15.000	450.000
Stems	525	10.000	25.000.000	8.68
Total		15.000	450.000	0.16

Based on Table 3, it shows that the total economic value of the direct benefits of candlenut trees in Uwemanje Village, Kinovaro District, Sigi Regency, Central Sulawesi is IDR 282.950.000/year. The highest value of the three products is the average candlenut trunk value of IDR 262.500.000/hectare (91.16%), then the average candlenut seed value of IDR 25.000.000/year (8.68%) and the lowest is the average shell/shell value of IDR 450.000/year (0.16%). Of the three products, the benefits of candlenut trees that can be felt most directly and have the greatest selling value are candlenut seed products because they immediately get a lot of cash from the sales (Nirzalin et al., 2018).

Candlenut Production Costs

Several types of costs that must be incurred by farmers starting from seed preparation, land processing, planting, maintenance, harvesting and post-harvest (Sjaf et al., 2022; Zhang et al., 2022). Types of costs can be seen in table 4.

Table 4. Types of Costs

Activities	Cost
Seed preparation	800.000
Soil cultivation	500.000
Planting	1.000.000
Plant maintenance	500.000
Harvesting	300.000
Drying	100.000

Table 4 shows that the total costs incurred by respondents in Uwemanje Village in cultivating candlenuts from seed preparation to post-harvest are IDR 3.200.000.

Income

Respondents' income from candlenuts is the result of income from candlenut products after being reduced by the costs incurred in cultivating candlenuts. Respondents' income can be seen in Table 5.

Table 5. Total Income from Candlenut Products

Details	Total
Receipts	(Rp/Year)
Expenses	287.950.000
Income	3.200.000

Source: Primary Data After Processing 2021

Based on Table 5, the amount of income from candlenut business obtained by respondents in Uwemanje Village is IDR 284.750,000/year. This income is income that comes from the direct benefit value of candlenut plant products in the form of seeds, shells/shells and candlenut stems (Halysh et al., 2023).

Conclusion

Based on the research results, it can be concluded that: The community in Uwemanje Village has obtained direct benefits from candlenut trees amounting to Rp. 287.950.000, which comes from three products, namely candlenut seeds amounting to Rp. 25.000.000/year, candlenut shells/shells amounting to Rp. 450.000/year, and candlenut tree trunks amounting to Rp. 262.500,000; The income received by respondents as a whole is Rp. 284.750,000/year.

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Author Contributions

Conceptualization; S. A, M.; methodology.; R.; validation; A. S. A.; formal analysis; S. A, M.; investigation.; R; resources; A. S. A; data curation: S. A, M.; writing—original; R.; draft preparation. S. A, M.; writing—review and editing: R.; visualization: A. S. A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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