Cashew : Contribution to the household economy and carbon stock (Case study in Wonogiri regency)

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Abstract. Wonogiri Regency is a cashew crop center in Central Java. Cashew is planting in dryland at an elevation of 100 to 400 m above sea level with a monoculture and multicultural pattern. Cashew plants are cultivated as people plantations, planted regularly on each plot or as a fence on the ownership limits of dry land, plots, and mounds. Cashew plants are evergreen, have a tight canopy with sympodial branching patterns, flowering all the time so they can cover the surface of the soil. Such plant patterns provide acceptance for households and protect the environment. Research to reveal the contribution of household income, land cover rates, and carbon stocks has been carried out by survey methods. Data collection techniques were carried out by interviewing the head of the household and the measurement of cashew land. The results showed that the B / C ratio > 1 and increased with the age of the plant, it contributed to the acceptance of household income. Canopy cover and carbon stock increase every year so that it is beneficial to maintain soil fertility.

1. Introduction

The Wonogiri Regency is the center for cashew (Anacardium occidentale L.) planting because it supplies 65.1% of Central Java's cashew nut production [1]. Geographically, cashew nuts are widely spread along the Keduang River from upstream to downstream in the Gajah Mungkur Dams. Administratively, it starts from Slogohimo, Kismantoro, Jatiroto, Jatisrono, Sidoharjo, Nguntoronadi, Ngadirojo, and Wonogiri Districts empties into the Gajah Mungkur Dams. This phenomenon encourages the people of the region to depend on cashew nuts for their livelihoods. Ngadirojo District is the center for cashew business activities from upstream to downstream. Cashew products that become community activities include seeding, cultivation, cashew nuts, cashew nut shell liquid (CNSL), fruit pressing to domestic and foreign marketing. These products were managed individually, in groups, and other institutions.

Researches related to Wonogiri cashew products have been conducted but are limited, some of which can be accessed through social media, including financial analysis [2]; farming analysis, farming development strategies [3], while the contribution of cashew farming revenue to the household economy and the environment is unknown. It is important to know the contribution of
cashew products at the household level of cashew farmers to spur changes in behavior towards cashew cultivation [4]. Calculated the added value of the household scale economy from the form of logs to cashews and CNSL obtained an increase in income [5].

Cashew plants grow throughout the year (evergreen) when other plants shed their leaves, they grow to stagnate and even die so they are resistant to drought. On dry land in a two-season area, where the dry season is ± 6 months, the land is exposed to sunlight. This condition can result in changes in physical, chemical, and biological properties due to high oxidation, including increased soil acidity (pH), decreased cation exchange capacity (CEC), as a result the availability and absorption of nutrients by plants is not optimal. Excessive evaporation results in water loss in the microporous pores, the form of water can change as hygroscopic water which is difficult to absorb by plant roots. The soil microorganisms that are useful in the category of not resistant to high light will die, thus adding to CO2. In the presence of cashew plants, the soil becomes closed so that the negative effects can be suppressed. Besides, plant growth which continuously increases biomass ultimately increases carbon stock (C-stock). Research on C-stock is generally carried out in the forest, standing, and agroforestry areas [6,7]. Calculation of C-stock for plants or other trees, although estimates are still limited. If it can be done, it will add useful knowledge. To find out the C-stock in cashew plants, start by distributing age, grouping by age class referring to stands, measuring trees, and calculating the biomass potential.

2. Materials and methods
The research was conducted in Ngadirojo District as one of the planting centers. Besides, many people carried out activities related to cashew, including trading activities from collecting, processing, retailing, suppliers to exporting. The community carried out drying, peeler, frying, packaging, and transportation services.

The research was conducted using a survey method, the village samples were determined purposively, namely Pondok, Gedong, Kerjokidul, Kerjoaor, and Gemawang villages. These villages are bordered by The Keduang River which empties into The Gajah Mungkur Dams.

Respondents are farmers who own cashew plants, assigned randomly, as many as 30 people. Data were collected by interview through a list of questions that were arranged openly. Apart from interviews, he also made observations on cashew cultivation. Observation of cashew plant biomass was carried out on trees owned by respondent farmers. Observations were made for the group of plants they owned. The grouping was based on Immature Plants (TBM) and Producing Plants (TM). TM grouped by old plants of 5-10; 10-20; 20-30; 30-40 and > 40 years.

Data analysis

2.1. Contribution of revenue
The contribution of cashew plant revenue to household income analyzed by calculating income from cashew plants, household expenses, and cashew plant distribution. Data analysis of cashew cash receipts and expenditures uses the following methods [8]:

\[ \pi = TR - TC \]
\[ TR = P \times Q \]
\[ TC = TFC + TVC \]

Note:
\[ \pi \] = revenue
\[ TR \] = total income
\[ TC \] = total cost
\[ P \] = price output
\[ Q \] = total output
\[ TFC \] = total fixed cost
\[ TVC \] = total variable cost
Household expenditure using the tabulation method with the household expenditure equation model then analyzed descriptively [9]:

\[ Ct = Ca + Cb ... + Cn \]

Note:
- \( Ct \) = Total expense of household
- \( Ca \) = expense for consumption foods
- \( Cb \) = expense for consumption non foods
- \( Cn \) = others

The contribution of the cashew plant to household expenses analyzed by calculating the percentage of cashew farming income to household expenses

\[ K_{jm} = \frac{\pi}{Ct} \times \% \]

Note:
- \( K_{jm} \) = cashew contribution

2.2. Potential biomass and C-stock

Measuring tree diameter is carried out following [6] by measurement the girth of the trunk at breast height of 1.3 m from the ground (diameter at breast height or dbh), then calculated by the equation:

\[ D = 2r \]
\[ r = \frac{K}{2\pi} \]

Note:
- \( D \) = diameter
- \( K \) = circumference
- \( r \) = trellis
- \( \pi \) = Constanta (3.14)

Tree biomass can be carried out in several ways [10]. In this study, biomass was calculated using an allometric equation in which the volume of the tree was represented in the square of the trunk multiplied by tree height (D2.H). In the carbon measurement, variations in numbers were found, some researchers used the figure of 50% [7]. Therefore, in this study, carbon calculation uses an assumed figure of 50% of the biomass of the cashew plant. \( B_t = 0.0240 \times (D2.H)^{0.7816} \) while the carbon stock was estimated at 50% of the total biomass (ibid).

3. Results and discussion

3.1. Plant management

Cashew farmers have a productive to less productive age, low to medium education, the number of families consists of couples with one to four sons or followed by their elderly parents. In addition to the main livelihood of farmers, some of them have a side job as a mason, laborer. For farmers who do not have a side job everyday work on the land to prepare for future cultivation activities such as cultivating the land, arranging the land, looking for firewood, maintaining cassava cuttings as well as homework and social work. Ownership of farmers' land is generally narrow, especially ownership of yards (Table 1).

Cashew plants are cultivated in gardens and/or dry land. The intercropping cropping pattern for farmers who feel capable of management and limited land, while monoculture occurs the opposite. Cashew plantations are planted on land ownership boundaries, plot boundaries so that the spacing
between rows is irregular. Generally, cashew plants are poorly maintained, soil processing and fertilization are the effects of food plants grown as intercrops. Shape pruning, maintenance, rejuvenation is not done, in some cases, some of the branches are even pruned if they are seen as shading the intercrops. Harvesting is done with poles so that the fruit falls and is damaged so that it is not allowed to rot, it is used for feed, partially squeezed and the pulp is sold.

**Table 1. The Farmers and Condition of Cashew Plantation in Wonogiri**

| No | Farmers and Cashew Plantation          | Description           | Note                          |
|----|----------------------------------------|-----------------------|-------------------------------|
| 1  | Age                                    | 40-68 years           |                               |
| 2  | Education                              | ES-SHS                |                               |
| 3  | Number of families                     | 2-6 person            |                               |
| 4  | Profession                             | Farmer and services   |                               |
| 5  | Land tenure                            |                       |                               |
|    | a. Rice field                          | 0.300-0.600 ha        |                               |
|    | b. Dry land                            | 0.500-1.000 ha        |                               |
|    | c. Garden (P)                          | 0.015-0.250 ha        |                               |
| 6  | Land use                               | Dry land and Garden   |                               |
| 7  | Cropping pattern                       | Multiple cropping     | Cassava, corn, peanut         |
|    |                                        | Monocropping          | Phytofarmaka, grasses or      |
|    |                                        |                       | not cultivation               |
| 8  | Plant age                              | 2-47 years            |                               |
| 10 | Ground area                            | minimum 3.5 x 6.6 m;  |                               |
|    |                                        | maximum 6 x 12 m      |                               |
| 12 | Plant condition                        | Not maintenance       |                               |

This condition is also found in the cashew plantation center in NTT and Southeast Sulawesi [2,11-13]. However, some farmers in the area have changed their behavior to make cashew nuts a commodity through participatory assistance.

3.2. Cashew farming acceptance

Cashew products and their derivatives are abundant [5], but in this study, the fact is that farmers sell cashew products in the form of logs, some of them have started selling the dregs of pseudo fruit juice. This income was obtained from the reduction of TR - TC to obtain a net income of Rp. 6019101.04, (Table 2). So that B / C ratio = > 1.

Therefore the average log revenue was Rp. 5,456,666.67, / year, and fruit pulp of Rp. 562,434,38, / year. When compared to revenue from NTT, Southeast Sulawesi, and others, this income is still low. The causes of low income include less intensive cultivation, some old trees, attacks by plant pests, low soil fertility so that productivity decreases. The strategies found by [4] to develop cashew nuts in Wonogiri include increasing plant cultivation by utilizing available facilities.

The calculation of the family members of the farmer household is 3.5 so that the income from cashew nuts per person is Rp. 1,719,742.15, / year (Table 2). This calculation presented to know how much cashew plant contribution (contribution) is to the expenditure each year so that it can be used to predict how many trees the farmer household should plant to meet its expenses.

**Table 2. Cashew Farming Acceptance (Rp/year)**

| No | Total Revenue (TR) | Total Cost (TC) | π household | π every soul | B/C ratio |
|----|--------------------|-----------------|-------------|-------------|-----------|
| 1  | Fruit              | 592434.38       | 300000      | 562434.38   | 160695.54 |
|    | Pick and squeeze   |                 |             |             |           |
| 2  | Chestnut           | 5666666.67      | 150000      | 5456666.67  | 1559047.62|
|    | Drying             |                 |             |             |           |
|    | Total              | 6259101.05      | 450.000     | 6019101.04  | 1719743.15|
|    |                    |                 |             |             | 13.9      |
This revenue can be increased if the cashew plant is cultivated according to Good Agriculture Practices (GAP), then the production converted into products and their derivatives with higher economic value. During this research, the cashew fruit, which was previously underutilized, has been squeezed and the pulp is sold for food with a selling value of Rp. 2,000-3,000, - / kg, it is said that the juice has not been processed into syrup. Calculated the add value of the household scale economy from the form of logs to cashews and CNSL earns income. then peeled into cashew nuts, the added value of the change in form of sale is Rp. 9,000,000 to Rp. 12,000,000, - so that the net income is Rp. 6,000,000 to Rp. 9,000,000, -. Furthermore, 5,000 kg of cashew skin processed into CNSL, the added value of the change in the form of sale is Rp. 2,016,000,- [5].

3.3. Household expenses
The Central Bureau of Statistics shows how to calculate household expenditure by classifying expenditure on food, non-food, and others [1]. Based on the calculation, the cashew farmer household expenditure is Rp. 20,625,625, - / year for some family members of 3.5 people (Table 3). This calculation shows that consumption expenditure is 87.71%, non-food 12.22%, and others 0.07%, indicating that cashew farmers are still subsistence. The causes of this subsistence include the condition of farmers as previously stated so that the perspective on "modern" farming is still limited. This limitation is probably due to lack of capital and coaching because based on a Bank Indonesia report (?) With assistance in the utilization of small business financing (PPUK Program) in the cashew nut processing industry in Wonogiri, there is a significant increase in revenue. If the program can be carried out on farming, the same benefits can be obtained.

Table 3. The household expense of cashew farming

| No | Type of expenses          | Household (Rp/year) | Person (Rp/year)  |
|----|---------------------------|---------------------|-------------------|
| 1  | Foods consumption         | 18090312.50         | 5168660.71        |
| 2  | Nonfoods consumption     | 2520312.50          | 720089.29         |
| 3  | Others                    | 15000.00            | 4285.71           |
|    | Total                     | 20625625.00         | 5893035.71        |

When compared with the rice farmer household expenditure of Rp. 33,540,000, - / year with some family dependents of 3-4 people, the cashew farmers are lower [9]. So, if the cultivation of cashew plants can be increased, the chances of acceptance will increase even though the consumption pattern will also change. The contribution of cashew nuts to household expenses is 29.18%.

3.4. Biomass potential and C-Stock
The biomass potential of cashew plants increases with the increase in plant age (Table 4). Trees aged 0-5 years produce average biomass of 15,751 kg, increasing to the age of 31-40 years as much as 339,383 kg, then decreasing at the age> 40 years. Cashew nuts have sympodial branches, a parabolic canopy shape resembles an umbrella, the leaves are located at the end so that the canopy is covered with leaves but in old plants, the branching is damaged. In old plants regenerating very slowly, meristem tissue is difficult to develop [14]. However, if compared to other timber plants (cashew plants in it) in community forest stands of 22462.780 kg (without knowing the age of the stands) [7], in the study was still higher.

Carbon stocks increase with the age of the plant until the age of 31-40 years, in line with the biomass potential. Based on the existing criteria, up to the age of 20, the C-stock is still in the low category, after the age of 21 it increases. However, cashew nuts have contributed to soil fertility related to organic C. Measurement of C-stock should be done by adding up the above-ground biomass, below ground, litter/litter, dead biomass, and soil carbon, but in this study limiting it to cashew plants where in the field the plants grow together with other plants.
Table 4. Biomass Potential and C-Stock of Plant Cashew

| Old plants | Total tree/farmer | lbsd (m²/ha) | Bt (kg/tree) | C-stock (kg/tree) | C-stock (ton/ha) | Criteria |
|------------|-------------------|-------------|--------------|------------------|-----------------|----------|
| 0-5        | 27                | 6.729       | 15.751       | 7.875            | 1.650           | low      |
| 6-10       | 48                | 38.596      | 65.893       | 32.947           | 6.903           | low      |
| 11-20      | 50                | 76.771      | 161.306      | 80.653           | 16.900          | low      |
| 21-30      | 72                | 191.931     | 353.187      | 176.594          | 37.002          | moderate |
| 31-40      | 23                | 362.002     | 678.766      | 339.383          | 71.112          | moderate |
| > 40       | 10                | 179.140     | 335.721      | 167.860          | 35.172          | moderate |

4. Conclusion
The contribution of cashew farming to the expenditure of each member of the Farmer Household is an average of 29.18%. Cashew tree carbon stock increases until the age of 40 years then decreases. The optimum C-stock is thought to occur at the age of 31-40 years, namely as much as 339,383 kg / tree or 71,112 tons / ha.

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