Contribution of agroforestry on farmers' income in Mapilli Polewali Subdistrict, West Sulawesi Province

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Abstract. Changes in land use from forests into agricultural land raises many problems such as land to be limited so that people use agroforestry patterns as sources of income. This study aims to determine the pattern of agroforestry management and calculate the contribution of agroforestry to the total income of farmers. This research is located in Landi Kanusuang Village, Mapilli Polewali District, West Sulawesi. The method of data was done thought using purposive sampling on 30 respondents and making a plot sample size of 20mx50m as much as 10 plots. Data is processed and analyzed with descriptive and quantitative methods. The results showed that the composition of the type of agroforestry system consists of 8 types of plants with agroforestry system where the vertical structure of the agroforestry garden stands 3 strata. Strata A with a height of > 15 m, Strata B with a height of 5-15 m and strata C with a height of 1-5 m. In addition, the average income was Rp. 18,831,743.743/year with agroforestry contribution to the total income of farmers of 76.14%.

1. Introduction
Forests are natural resources that are crucial and beneficial for life and livelihood, either tangible or intangible. The tangible benefits of the existence of forests include wood, non-timber forest products and animals, while the intangible benefits are in the form of environmental services, both as water regulators, aesthetic functions, as well as oxygen providers and carbon sinks [1]. Changes in land use from forests to agricultural areas are a reality that occurs with an increase in population. The conversion of forest land into agricultural land is realized to cause many problems such as decreased soil fertility, erosion, extinction of flora and fauna, floods, droughts and even changes in the global environment. This problem is exacerbated by the increasing area of forest that is converted to other business land. In dealing with these problems, the community utilizes limited land by implementing an agroforestry system. Agroforestry is one of the land management systems that can be offered to overcome problems that arise due to land conversion and at the same time to overcome food problems [2].

One of the agroforestry systems that can increase farmers' incomes that is widely known and practiced by the community is mixed gardens, namely gardens that are planted with forestry and agricultural crops simultaneously on the same plot of land [3,4]. Agroforestry is developed to improve the welfare of the community, mainly it is expected to help optimize the results of a form of sustainable land use in order to guarantee and improve the needs of people's lives and can increase the carrying capacity of human ecology, especially in rural areas [5,6].
One of the villages in Polewali Regency that uses agroforestry as an economic source. Although agroforestry gardens are managed traditionally, their contribution to the fulfillment of primary and secondary needs is felt by farmers. The farming community in Landi Kanusuang Village manages their land with a mixed cropping system aimed at optimizing land use. In general, farmers try to take advantage of the land by cultivating crops of high value and fast yielding. The selection of these types of plants in order to get a greater yield or income. The area of land owned by farming communities also affects the desire of farmers to implement agroforestry systems. The main crop commodities in Landi Kanusuang Village are cocoa plants and types of fruits. Meanwhile, forestry plants such as gamal trees are used as interludes or inserted between the main commodity crops. The interesting thing about community forest management is that the harvest time is known by the community or community forest farmers and they can predict it. According to Pratama et al. (2015) [7] in the study of community forests, besides having wood forest products, they also have non-timber forest products, from these two types of commodities, the community can determine the harvest time based on the harvest season and based on needs. This potential can then be used as the basis for community forest management to obtain productive and sustainable sources of income for farmers. Based on the description above, it is necessary to conduct research on “The Contribution of Agroforestry to Farmers’ Income in Landi Kanusuang Village, Mapilli Polewali District, West Sulawesi”

2. Research methods

2.1. Study site
This research was conducted in February-March 2020 with the locations 03°24’14.8 latitude and 119°10’52.3 east longitude at an altitude of 21 masl in Landi Kanusuang Village, Mapilli District, Polewali Regency, West Sulawesi.

2.2. Research tools and materials
The tools used in this study include a compass, GPS, roll meter, rope, stake, Abney level, tape meter and camera. The materials used in this study were tally sheets, questionnaires and writing instruments.

2.3. Method of collecting data
There are two methods used in this study, namely using primary data and secondary data. Primary data is data obtained through field observations and then interviews with the farmers concerned using a list of questionnaires, while secondary data is data obtained through agencies related to this research and various other literature.

2.4. Research procedure
The research procedures carried out in this study are as follows:

a. Selecting respondents using the purposive sampling method as many as 30 people, namely farmers who apply mixed agroforestry patterns in Landi Kanusuang Village, Mapilli Polewali District, West Sulawesi.

b. Conducting interviews with respondents using a questionnaire that has been selected based on the questionnaire

c. Making plots measuring 20 m x 50 m as many as 10 plots, making plots on land that applies agroforestry patterns

d. Measure the tree circumference, tree height, and branch-free height.

e. All types of plants contained in the plot were recorded in terms of type and number

f. Then the data from interviews and observations are collected in the form of notes or tally sheets and then recapitulated according to the objectives to be achieved.
2.5. Data analysis
Primary and secondary data that have been collected are processed and analyzed to calculate land productivity. The data analysis used in this research is descriptive analysis and quantitative analysis.

2.5.1. Tree Volume. The measurement results of tree growth dimensions are analyzed to determine the actual condition of tree potential by calculating the volume of wood on the land to be studied

\[ V = LBDS \times TT \times F \]

Information:
- \( V \) = Tree Volume (m\(^3\))
- \( LBDS \) = Base Area (\( \frac{1}{3} \pi D^2 \))
- \( D \) = Rod Diameter (tall = 1.30 m)
- \( TT \) = Total Height
- \( F \) = Bar Shape Number (0.8)

2.5.2. MAI (Mean Annual Increment). MAI is the average increment (per year) that occurs over a certain period of time.

\[ MAI = \frac{V_t}{t} \]

Information:
- \( MAI \) = Mean Annual Increment
- \( V_t \) = Tree volume at age \( t \) (m\(^3\))
- \( t \) = Age (year)

2.5.3. Cost analysis. Cost analysis is the cost incurred which can be valued in money during the production period, starting from the planting, maintenance to harvesting stages in this agroforestry business. In other words, total cost is the sum of fixed costs and variable costs.

\[ TC = TFC + TVC \]

Information:
- \( TC \) = Total Cost (IDR/ha/year)
- \( TFC \) = Fixed Cost (IDR/ha/year)
- \( TVC \) = Variable Cost (IDR/ha/year)

2.5.4. Revenue analysis. Revenues are all yields from each agroforestry component expressed in rupiah.

\[ TR = \sum_{i=1}^{n} (Y_i \times Py) \]

Information:
- \( TR \) = Total Revenue (IDR/ha/year)
- \( Y_i \) = Production obtained in a farm
- \( Py \) = Price \( Y \) (IDR)
- \( n \) = Number of types of plants cultivated
2.5.5 *Income Analysis.* Revenue is the difference between revenue and all costs incurred in production.

\[ Pd = TR - TC \]

Information:
- Pd \(=\) Income (IDR/ha/year)
- TR \(=\) Total Revenue (IDR/ha/year)
- TC \(=\) Total Cost (IDR/ha/year).

2.5.6 *Agroforestry Contribution.* Contribution of agroforestry to farmers' total income. The formula used is:

\[ \bar{K}f = \frac{\bar{R}}{\bar{P}t} \times 100\% \]

Information:
- \(\bar{K}f\) = Contribution of agroforestry
- \(\bar{R}\) = Farmers' income from agroforestry
- \(\bar{P}t\) = Total income of farmers.

3. Results and discussion

3.1. *Description of agroforestry system management*

3.1.1. *Land preparation.* Land preparation is the initial stage of managing an agroforestry system. From the results of interviews with 30 respondents, all respondents carried out land preparation by clearing the land from grass or shrubs. During land clearing, respondents use machetes or sickles to cut grass or shrubs that grow around the land, after which the farmers dig holes in the cleared land to plant.

3.1.2. *Nursery.* Nursery is an initial activity in the field which aims to prepare ready-to-plant seeds. The origin of cocoa seeds used by cocoa agroforestry farmers in Landi Kanusuang Village is the result of government subsidies and their own seeding, while for coconut, *gliricidia ceptium* or gamal, durian tree, rambutan and longkong (langsat in Bahasa) seeds, farmers generally get them from wild seeds and or wild shoots that grow around the garden. The planted seeds must meet the requirements, both in terms of age and size. Good and quality seeds are one of the determinants of success in any plant cultivation business.

3.1.3. *Planting.* The stages and methods of planting are carried out from generation to generation in accordance with what their predecessors did, where the first planted is the shade then after that the shade (cocoa) and is applied to date includes seeding, making planting holes and planting. The spacing used by farmers is generally 3m x 3m while other plants are planted in a random pattern.

3.1.4. *Plant maintenance*

3.1.4.1. *Pruning.* Pruning activities in Landi Kanusuang Village are generally carried out on cocoa plants only with the aim of maintaining/preventing pest and disease attacks, forming plants, maintaining plants and increasing production. There are several kinds of pruning techniques, namely shape trimming, maintenance pruning and production.
3.1.4.2. Fertilization. Fertilization is carried out to improve plant conditions and resistance to environmental changes, maintain production stability, and meet nutrient needs for plants. In general, fertilization is done twice a year, namely the beginning and the end of the rainy season.

3.1.5. Harvesting and post harvesting. Harvesting activities carried out by farmers in Landi Kanusuang Village for various types of crops are generally carried out by themselves or in collaboration with the farmer's family, but there are also some farmers who employ other people to assist in the harvesting process. Harvest time varies by plant type. Cocoa and coconut are harvested twice a year, while bananas, rambutan, langsat and durian are harvested once a year. The harvest is used directly by farmers to meet their daily needs. This is in accordance with the statement of Olivi et al (2015) [8] that some of the harvested crops from forestry or agricultural crops are used alone to meet their daily needs for building houses and other.

3.2. Composition of plant types, vertical and horizontal structure of agroforestry systems

3.2.1. Composition of plant species. The composition of plant species found in this agroforestry land were 8 types of plants. These types can produce different products, both wood and non-wood.

Table 1. Composition of Plant Types

| No | Plant Type              | Number of Respondents who Plant | Percentage (%) |
|----|-------------------------|---------------------------------|----------------|
| 1  | *Theobroma cacao*       | 30                              | 100            |
| 2  | *Gliricidia sepium*     | 25                              | 83             |
| 3  | *Cocos mucifera*        | 23                              | 77             |
| 4  | *Nephelium lappaceum*   | 22                              | 73             |
| 5  | *Lansium domesticum*    | 25                              | 83             |
| 6  | *Syzygium aqueum*       | 1                               | 3              |
| 7  | *Durio zibethinus*      | 18                              | 60             |
| 8  | *Musa paradisiaca*      | 18                              | 60             |

3.2.2 Vertical and horizontal structure of agroforestry systems

Based on the division of the strata of the canopy, the strata of the canopy at the research site can be seen in Figure.

1) Vertical and Horizontal Structure on land classification (Plot8)
2) Vertical and Horizontal Structure on land classification (Plot 10)

3) Vertical and Horizontal Structure on land classification (Plot 5)
3.3. Analysis of costs, revenues, and revenues in agroforestry systems

3.3.1 Cost Analysis

| Respondent | Land area (ha) | Fixed cost (IDR/year) | Variable cost (IDR/year) | Total cost (IDR/year) |
|------------|----------------|-----------------------|--------------------------|-----------------------|
|            |                | Land Tax               | Tool Shrink              | Fertilizer            | Labor Wages          |                      |
| 1          | 0.5            | 30000                 | 170000                   | 270000                | 400000               | 870000               |
| 2          |                | 30000                 | 105000                   | 240000                | 0                    | 375000               |
| 3          |                | 30000                 | 115000                   | 260000                | 0                    | 405000               |
| 4          |                | 30000                 | 110000                   | 160000                | 0                    | 300000               |
| 5          |                | 30000                 | 170000                   | 160000                | 400000               | 760000               |
| 6          |                | 30000                 | 115000                   | 240000                | 0                    | 385000               |
| 7          |                | 30000                 | 105000                   | 280000                | 0                    | 415000               |
| 8          | 1              | 50000                 | 170000                   | 285000                | 400000               | 905000               |
| 9          |                | 50000                 | 175000                   | 265000                | 800000               | 1290000              |
| 10         |                | 50000                 | 115000                   | 265000                | 0                    | 430000               |
| 11         |                | 50000                 | 175000                   | 285000                | 400000               | 910000               |
| 12         |                | 50000                 | 170000                   | 220000                | 400000               | 840000               |
| 13         |                | 50000                 | 245000                   | 320000                | 800000               | 1415000              |
| 14         |                | 50000                 | 120000                   | 385000                | 0                    | 555000               |
| 15         |                | 50000                 | 245000                   | 285000                | 800000               | 1380000              |
| 16         |                | 50000                 | 175000                   | 260000                | 800000               | 1285000              |
| 17         | 1.5            | 75000                 | 175000                   | 315000                | 800000               | 1365000              |
| 18         |                | 75000                 | 115000                   | 185000                | 500000               | 875000               |
| 19         |                | 75000                 | 125000                   | 380000                | 800000               | 1380000              |
| 20         |                | 75000                 | 175000                   | 450000                | 800000               | 1500000              |
| 21         |                | 75000                 | 255000                   | 270000                | 800000               | 1400000              |
| 22         |                | 75000                 | 255000                   | 240000                | 0                    | 570000               |
| 23         | 2              | 90000                 | 110000                   | 325000                | 0                    | 525000               |
| 24         |                | 90000                 | 180000                   | 265000                | 800000               | 1335000              |
Based on Table 2 shows that the average cost incurred is greatest in the area which has a land area of 2 ha of IDR 1,497,500,-/year, while the lowest average cost is found in a land area of 0.5 ha, which is IDR 501,429,-/year. This is influenced by the use of fertilizers and labor wages because fertilizers and labor wages are very important in land management. This statement is in line with Tulus (2001) [9] which states that labor wages and the use of fertilizers have a major influence on cost expenditures because according to Dewanto et al (2013) [10] that fertilization aims to replace lost nutrients and increase the supply of nutrients needed by plants to increase plant growth, crop production and quality. Expensive labor costs result in much higher production costs so that it can affect farmers' income. This is in line with the opinion of Suratiyah (2015) [11] which states that the use of labor is one of the important factors whether the available family labor can meet various needs. The workforce needed is greater than the potential, so it must budget for the needs for labor outside the family needed. This will affect the cost of farming because workers outside the family must be paid wages.

3.3.2 Revenue analysis

| Respondent | land area | Agroforestry Revenue | Total Revenue/Land Area (IDR/year) |
|------------|-----------|----------------------|-----------------------------------|
|            |           | Forestry Plant | Agricultural Crops | Agroforestry Revenue |                       |                      |
| 1          | 0.5       | 900000         | 7250000            | 16250000                | 815000                |
| 2          | 1         | 1800000        | 6950000            | 24950000                | 875000                |
| 3          |           | 1200000        | 7450000            | 19450000                | 865000                |
| 4          |           |               | 7320000            | 18320000                | 732000                |
| 5          |           | 1400000        | 6560000            | 20560000                | 796000                |
| 6          |           |               | 7750000            | 18750000                | 775000                |
| 7          | 1         | 1800000        | 6950000            | 24950000                | 875000                |
| 8          |           | 1800000        | 10100000           | 11900000                | 10675000              |
| 9          | 1         | 2100000        | 9500000            | 30500000                | 11600000              |
| 10         |           |               | 12950000           | 25950000                | 12950000              |
| 11         |           | 2200000        | 10640000           | 32640000                | 12840000              |
| 12         |           | 3600000        | 12350000           | 16050000                | 15950000              |
| 13         |           | 1800000        | 11270000           | 29270000                | 13070000              |
| 14         | 1.5       | 1800000        | 10670000           | 28670000                | 12470000              |
| 15         |           | 3600000        | 11000000           | 47000000                | 14600000              |
| 16         | 1.5       | 3600000        | 14550000           | 18150000                | 18150000              |
| 17         | 1.5       | 2100000        | 16650000           | 37650000                | 18750000              |

Table 3. Revenue Analysis of Agroforestry Smallholders
Based on Table 3 shows that the average revenue issued is greatest in the area which has a land area of 2 ha of IDR 22,495,000,- per year, while the lowest average value of revenue is on a land area of 0.5 ha, which is Rp. 8,190,000, per year. This is influenced by the type and number of plants found on the farmers' agroforestry land. Income is strongly influenced by the selection of the type and number of plants developed on the land of the farmer's agroforestry system.

### 3.3.3 Income analysis

| Respondent | Land area | Revenue (IDR/year) | Cost/year (IDR/year) | Total income/ Land area/ Year (IDR) | Total Income /Ha/Year (IDR) |
|------------|-----------|--------------------|----------------------|-------------------------------------|---------------------------|
| 1          | 0.5       | 8150000            | 870000               | 7280000                             | 14560000                  |
| 2          | 0.5       | 8750000            | 375000               | 8375000                             | 16750000                  |
| 3          | 0.5       | 8650000            | 405000               | 8245000                             | 16490000                  |
| 4          | 0.5       | 7320000            | 300000               | 7020000                             | 14040000                  |
| 5          | 0.5       | 7960000            | 760000               | 7200000                             | 14400000                  |
| 6          | 0.5       | 7750000            | 385000               | 7365000                             | 14730000                  |
| 7          | 0.5       | 8750000            | 415000               | 8335000                             | 16670000                  |
| 8          | 1         | 10675000           | 905000               | 9770000                             | 9770000                   |
| 9          | 1         | 11900000           | 1290000              | 10610000                            | 10610000                  |
| 10         | 1         | 11600000           | 430000               | 11170000                            | 11170000                  |
| 11         | 1         | 12950000           | 910000               | 12040000                            | 12040000                  |
| 12         | 1         | 12840000           | 840000               | 12000000                            | 12000000                  |
| 13         | 1         | 15950000           | 1415000              | 14535000                            | 14535000                  |
| 14         | 1         | 13070000           | 555000               | 12515000                            | 12515000                  |
| 15         | 1         | 12470000           | 1380000              | 11090000                            | 11090000                  |
| 16         | 1         | 14600000           | 1285000              | 13315000                            | 13315000                  |
| 17         | 1.5       | 18600000           | 1365000              | 17235000                            | 11490000                  |
| 18         | 1.5       | 18150000           | 875000               | 17275000                            | 11516667                  |
| 19         | 1.5       | 18750000           | 1380000              | 17370000                            | 11580000                  |
Table 4 shows the income of the agroforestry system on several land areas in Landi Kanusung Village. In some of the observed land areas, the average value of farmer’s income was IDR 12,257,029,-/ha per year. The highest income is found on a land area of 0.5 ha of IDR 15,377,143,-/ha per year, while the lowest income is on a land area of 2 ha of IDR 10,498,750,-/ha per year. The difference in farmers’ income on land area is due to differences in the type and number of plants cultivated by each farmer on their land. The area of land owned by farmers and the selection of plant types by farmers affect the size of the income obtained by farmers. The wider the land owned, the higher the income obtained, but a small land area can also get high income if farmers are able to manage it well. From the table above, it can be concluded that agricultural land is a potential that needs to be utilized properly by farmers in order to obtain large profits.

3.4 Income analysis in non-agroforestry systems

Types of non-agroforestry commodities are livestock and lowland rice farming.

| Respondent | Income (IDR/year) | Cost (IDR/year) | Total Income (IDR/year) |
|------------|-------------------|----------------|------------------------|
| 1          | 0                 | 0              | 0                      |
| 2          | 10000000          | 417700         | 9582300                |
| 3          | 12000000          | 480000         | 11520000               |
| 4          | 10000000          | 120000         | 9880000                |
| 5          | 0                 | 0              | 0                      |
| 6          | 10000000          | 410000         | 9590000                |
| 7          | 0                 | 0              | 0                      |
| 8          | 0                 | 0              | 0                      |
| 9          | 0                 | 0              | 0                      |
| 10         | 0                 | 0              | 0                      |
| 11         | 12000000          | 400000         | 11600000               |
| 12         | 8000000           | 380000         | 7620000                |
| 13         | 7000000           | 2655000        | 4345000                |
| 14         | 8000000           | 530000         | 7470000                |
Table 5 shows the average non-agroforestry income with an average lowland rice farming income of IDR 6,845,000, per year while the average income of farmers is IDR 8,950,192,- per year. The income of lowland rice farming and breeders is obtained from the revenue minus the total production cost. The smaller the total costs incurred and the greater the amount of production, the greater the income earned [12].

3.5 Agroforestry contribution

The contribution of agroforestry to farmers’ income is the ratio between the income of agroforestry farmers to the total income of non-agroforestry farmers. The following value of the contribution of agroforestry can be seen in the following figure:

![Figure 7. The value of the contribution of agroforestry to farmers’ total income](image)

Figure 7 shows the contribution of income from agroforestry systems managed by farmers to the total income they receive of 76.14%. In general, the contribution obtained from agroforestry products is very helpful in meeting daily needs. If the contribution given by agroforestry is 10% of the total income, it is very helpful in meeting needs [13]. But in reality, in Landi Kanusuang Village, the contribution obtained from agroforestry products is above 10%. This proves that agroforestry land is the main source of income for farmers and its role is very important and can be used sustainably.
4. Conclusion
The agroforestry system applied by farmers in Landi Kanusuang Village, Mapilli Polewali District, West Sulawesi is an agricultural system. The average income earned by farmers in Landi Kanusuang Village, Mapilli Polewali District, West Sulawesi is IDR 18,831,743 per year. From this result, it is obtained from the difference between the overall receipts of agroforestry and non-agroforestry. The contribution of agroforestry obtained by farmers is 76.14%. This large contribution proves that agroforestry has an important role to fulfill the welfare of farmers in Landi Kanusuang Village, Mapilli Polewali District, West Sulawesi.

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