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

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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 03º24´14.8 latitude and 119º10´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

$$V = LBDS\ x\ TT\ x\ F$$

Information:
V = Tree Volume (m^3)
LBDS = Base Area (¼πD²)
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.

$$MAI = Vt/t$$

Information:
MAI = Mean Annual Increment
Vt = 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 =Variabel Cost (IDR/ha/ year)

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

$$\boldsymbol{TR} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} (\boldsymbol{Y}.\boldsymbol{Py})$$

Information:
TR = Total *Revenue* (IDR/ha/year)
Y = 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:

$$\overline{Kr} = \frac{\bar{R}}{\overline{Pt}} x\ 100\%$$

Information :

$\overline{Kr}$ = Contribution of agroforestry
$\bar{R}$ = Farmers' income from agroforestry
$\overline{Pt}$ = 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 cepium* 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. Prunning***.** 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)

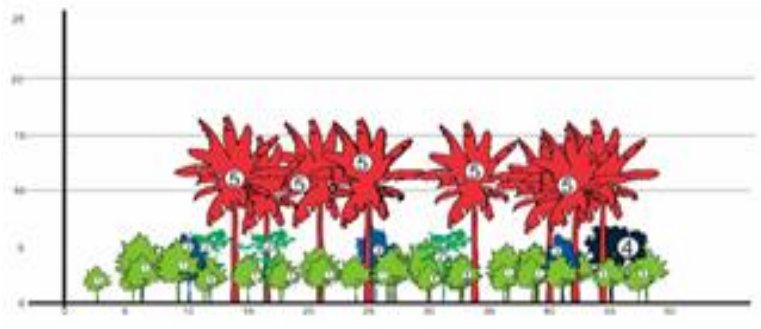

Figure 1. Vertical Structure

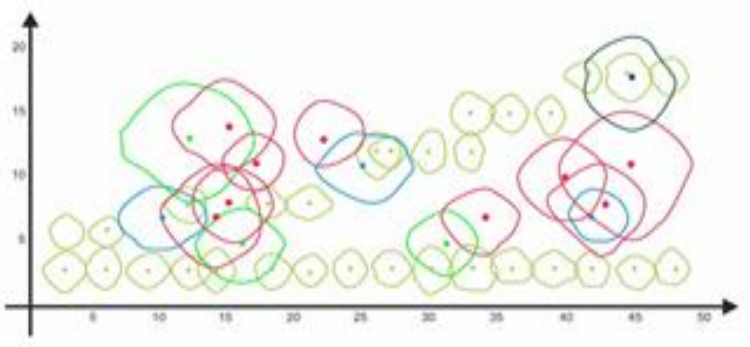

Figure 2. Horizontal Structure

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

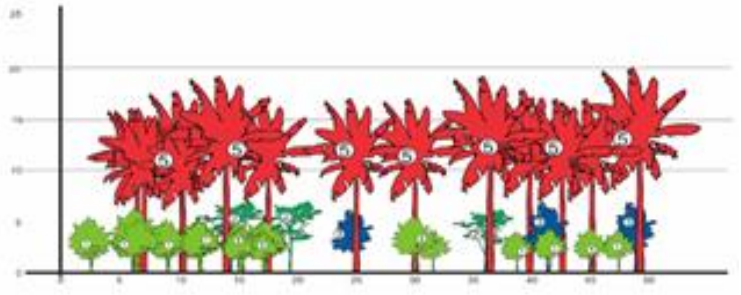

Figure 3. Vertical Structure

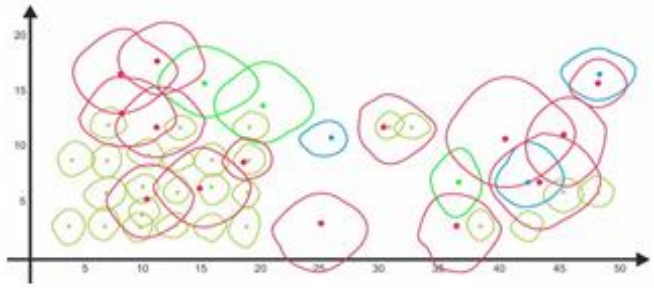

Figure 4. Horizontal Structure

3) Vertical and Horizontal Structure on land classification (Plot 5)

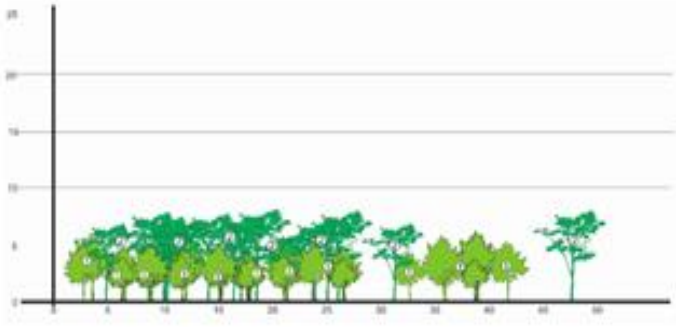

Figure 5. Vertical Structure

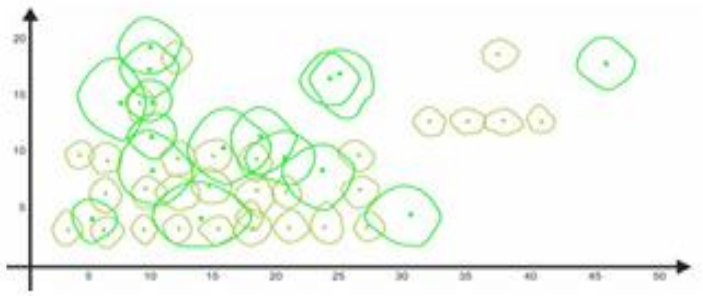

Figure 6. Horizontal Structure

3.3. Analysis of costs, revenues, and revenues in agroforestry systems

3.3.1 Cost Analysis

Table 2. Cost Analysis of Agroforestry Farmers

Respondent	Land area	Fixed cost (IDRyear)		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

25	90000	125000	480000	750000	1445000
26	90000	195000	435000	1200000	1920000
27	90000	235000	525000	750000	1600000
28	90000	175000	265000	1000000	1530000
29	90000	180000	335000	1200000	1805000
30	90000	240000	290000	1200000	1820000
Total	720000	1440000	2920000	6900000	11980000

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

Table 3. Revenue Analysis of Agroforestry Smallholders

Respondent	land area	Agroforestry Revenue		**Total Revenue/Land Area (IDR/year)**
		Forestry Plant	Agricultural Crops	
1	0.5	900000	7250000	8150000
2		1800000	6950000	8750000
3		1200000	7450000	8650000
4			7320000	7320000
5		1400000	6560000	7960000
6			7750000	7750000
7		1800000	6950000	8750000
8	1		10675000	10675000
9		1800000	10100000	11900000
10		2100000	9500000	11600000
11			12950000	12950000
12		2200000	10640000	12840000
13		3600000	12350000	15950000
14		1800000	11270000	13070000
15		1800000	10670000	12470000
16		3600000	11000000	14600000
17	1.5		18600000	18600000
18		3600000	14550000	18150000
19		2100000	16650000	18750000

20		1600000	17275000	18875000
21		2700000	15115000	17815000
22		1600000	14625000	16225000
23	2	2700000	21300000	24000000
24			22075000	22075000
25		1600000	19120000	20720000
26		2800000	20220000	23020000
27			21030000	21030000
28		1800000	19675000	21475000
29		1800000	22990000	24790000
30		1400000	21450000	22850000
Total		12100000	167860000	179960000
Average		2016667	20982500	22495000

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

Table 4. Income Analysis of Agroforestry Farmers

Respondent	Land area	Revenue	Cost/year (IDR/year)	Total income/ Land area/ Year (IDR)	Total Income /Ha/Year (IDR)
1	0.5	8150000	870000	7280000	14560000
2		8750000	375000	8375000	16750000
3		8650000	405000	8245000	16490000
4		7320000	300000	7020000	14040000
5		7960000	760000	7200000	14400000
6		7750000	385000	7365000	14730000
7		8750000	415000	8335000	16670000
8	1	10675000	905000	9770000	9770000
9		11900000	1290000	10610000	10610000
10		11600000	430000	11170000	11170000
11		12950000	910000	12040000	12040000
12		12840000	840000	12000000	12000000
13		15950000	1415000	14535000	14535000
14		13070000	555000	12515000	12515000
15		12470000	1380000	11090000	11090000
16		14600000	1285000	13315000	13315000
17	1.5	18600000	1365000	17235000	11490000
18		18150000	875000	17275000	11516667
19		18750000	1380000	17370000	11580000

20		18875000	1500000	17375000	11583333
21		17815000	1400000	16415000	10943333
22		16225000	570000	15655000	10436667
23	2	24000000	525000	23475000	11737500
24		22075000	1335000	20740000	10370000
25		20720000	1445000	19275000	9637500
26		23020000	1920000	21100000	10550000
27		21030000	1600000	19430000	9715000
28		21475000	1530000	19945000	9972500
29		24790000	1805000	22985000	11492500
30		22850000	1820000	21030000	10515000
Total		**179960000**	**11980000**	**167980000**	**83990000**

Table 4 shows the income of the agroforestry system on several land areas in Landi Kanusuang 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.

Table 5. Income Analysis of Non-Agroforestry Farmers

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

15	0	0	0
16	10000000	120000	9880000
17	12000000	70000	11930000
18	0	0	0
19	10000000	250000	9750000
20	10000000	3405000	6595000
21	0	0	0
22	8000000	70000	7930000
23	0	0	0
24	0	0	0
25	12000000	3465000	8535000
26	0	0	0
27	12000000	4095000	7905000
28	0	0	0
29	0	0	0
30	1000000	350000	650000
Total	152000000	17217700	134782300
Average	9500000	1076106	8423894

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:

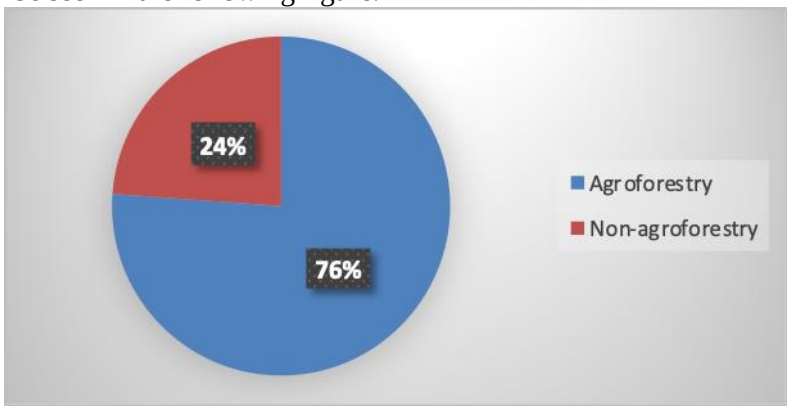

Figure 7. The value of the contribution of agroforestry to farmers' total income

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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