AGROFORESTRY: ECONOMIC CONSIDERATION AND ECOLOGICAL PERSPECTIVES BASED ON FOREST FARMER IN CENTRAL SULAWESI, INDONESIA

S Jumiyati[1*], N Akkas[2], P Dua[3] and S.A. Rasyid[4]

[1,3]Department of Agricultural sciences, Faculty of Agriculture, Muhammadiyah University, Palu, 94118 Central Sulawesi, Indonesia

[4]Department of Agribusiness, Faculty of Agriculture, Muhammadiyah University, Palu, 94118 Central Sulawesi, Indonesia

[2]Department of Economic Management, Faculty of Aeconomics, Muhammadiyah University, Palu, 94118 Central Sulawesi, Indonesia

*Corresponding Author: S. Jumiyati, Muhammadiyah University, Palu, 94118 Central Sulawesi, Indonesia. Department of Agriculture Socio-Economics, Faculty of Agriculture, Hasanuddin University, Makassar 90245, Indonesia

https://doi.org/10.35410/IJAEB.2023.5848

ABSTRACT

In general, sustainable development has three dimensions, namely the economic, ecological and socio-cultural dimensions. The development of community activities especially farmers who need land is increasing very rapidly in line with the development of population and economic growth. To achieve high economic growth, the productivity of land is driven in such a way that it results in an increase in exploitation of natural resources which is reflected in the destruction of forests, land, water, air and biodiversity. The application of the concept of sustainable development faces various challenges because on the one hand economic development must continue to be encouraged while on the other hand cultural integrity, local wisdom and physical landscape must be maintained. This study aims to examine the economic, ecological and basic historical aspects of changes in forest land use and recommendations on land use models that provide the highest benefits and feasibility of farming. The results showed that farming that implemented cocoa-based agroforestry systems, especially cocoa and in fact gave the highest value of profit and feasibility based on economic considerations and an ecological perspective based on local wisdom for farmers around the forest.

Keywords: Cultivation system, profit of farming, conservation, society.

1. INTRODUCTION

The issue of climate change and management of agricultural land has a reciprocal relationship and a real impact on crop production and food availability. In conditions of climate change and high fluctuations in agricultural commodity prices, the global stock of agricultural products is relatively low. An increase in temperature of 20C and 7% rainfall results in a loss of 8% net revenue at the farm level. Based on studies, 18% of climate change occurs due to deforestation and 14% comes from farming activities. Related to this, efforts to minimize the impact of climate change and environmental preservation can be done through sustainable farming systems. The demand for sustainable agriculture has implications for the option of agricultural practices with characteristics: a) using local technology (local wisdom), b) integrated farming system, c) water-saving agriculture.

In general, sustainable development has three dimensions, namely the economic, ecological and socio-cultural dimensions. Specifically, the requirements for sustainable agriculture in farming systems are: plant and animal productivity, socio-economic feasibility and long-term maintenance of natural resources. Thus sustainable development must be able to strive for the achievement of economic goals (efficiency) in the form of increasing income, social goals (distributive) in the form of equity and minimizing disparities and environmental goals in the form of increasing environmental carrying capacity. Sustainability is interpreted as an effort to improve the welfare of the current generation without damaging the environment in order to continue to support the welfare of future generations.

Cocoa is a superior commodity of Central Sulawesi plantation besides coffee, cloves and oil palm. Since the monetary crisis, cocoa has been a prime commodity and is the biggest source of income for farmers in Central Sulawesi. Even now the largest cocoa producer is Central Sulawesi, replacing the position of South Sulawesi, which was previously the largest cocoa producer in Indonesia. Currently the area of cocoa plantations in Central Sulawesi Province is 289,274 ha with production reaching 158,278 tons / ha / year with a productivity value of 1.8 tons/ ha. This figure can still be increased to achieve a potential productivity value of 2.0 tons / ha. This increase will have a positive effect on farmers' income and welfare (Antara Sulteng.com, 2016). Some inhibiting factors for farmers in an effort to increase productivity are the extent of farmers' land ownership which is still below the scale of economic farming feasibility, which ranges from 0.66 - 1.00 ha. While the scale of economic feasibility of cocoa farming is around 4 - 7 ha.

The cultivation of cocoa plants in Central Sulawesi Province, especially Sigi Regency in general is almost the same as other areas outside Java, namely by monoculture and mixed gardens. This is inseparable from the characteristics of farmers in this region who have diversity in farming patterns. Most of the cocoa plants in Sigi Regency are cultivated in the form of smallholders by local farmers on a small scale and the management is still traditional, because nothing has been done in the form of PBN or PBS (Sri Jumiyati, 2018).

Efforts to increase productivity along with unavoidable population growth while on the other hand the existence of land has not increased, causing increased pressure and exploitation of agricultural land. The solution to these problems, in addition to intensification of agricultural land, is the use of forest land and marginal land to support increased productivity of agricultural land. In such conditions, the application of agroforestry systems is a solution based on the idea that the conversion of forest land into agricultural land can cause many problems such as decreasing soil fertility, erosion, extinction of flora and fauna, flooding, drought and even changes in the global environment (Lahjie, 2003 and Rianse, 2010). Agroforestry as a land management technique that applies a combination of forest trees to agricultural crops is an innovation model of land use that is more efficient in land use and production inputs which aims to optimize production and income perunit area that refers to the principle of sustainable yields and is aimed at production multipurpose, optimal and sustainable under the positive influence of improving the conditions of edapik and micro climates created by imitating forest conditions,

Vol. 08, No. 04; 2023

ISSN: 2456-8643

and with management techniques that are in accordance with the cultural attitudes of local communities (Subadi, 2010).

In this regard, the formulation of the problem in this study is as follows:

1. What are the basic economic considerations that affect the profitability and feasibility of farming and can optimize the management of agroforestry systems in various cropping patterns?
2. What ecological perspective is the objective of implementing the agrofor system in various cropping patterns?
3. How are forest land uses carried out by forest farmers based on local wisdom?

Description of the Study Area

Determination of the location of research in this study was conducted intentionally (Purposive), by selecting the research area based on specific objectives that are in accordance with the research objectives. The research location chosen was Sigi District, Palolo Subdistrict which is located at an altitude of 200-2610 meters above sea level, with the highest peak being Mount Rorekatimbu (2610 masl). It has a varied topography ranging from a flat, rather steep slope, steep to very steep with soil layers in mountainous areas that are sensitive to erosion. Geographically TNLL is located in a position with 199 ° 90 '- 120 ° 16' BT and 1 ° 8 '- 1 ° 3' LS coordinates.

Based on the Schmidt and Fergusson rainfall classification, the northern part of the LLL area has a C / D climate type with annual average rainfall ranging between 855-1200 mm / year. The eastern part of type B with rainfall ranges from 344-1400 mm / year and the western part is climate A with an average annual rainfall of 1200 mm / year. Overall rainfall in TNLL varies from 2000-3000 mm / year. Temperatures range from 22 ° -34 ° C with 98% air humidity and average wind speeds of 3.6 km / hr. TNLL has an important water catchment function, supported by two large rivers namely the Gumbasa river in the north which joins the Palu river in the west and the Lariang river in the east and south. The hydrological function is very beneficial for the people around the region and the population of Central Sulawesi in general. There are 117 villages around the forest, 70 villages including physically directly adjacent and 1 village located within the TNLL area consisting of the Bada tribe, Behoa tribe, Pekurehua (Napu) tribe and Kaili tribe which are divided into 7 based on their dialects namely: Kaili Ledo, Kaili Ija , Kaili Ado ', Kaili Moma', Kaili Tohulu, Kaili Uma and Kaili Da'a. In general, the community around the forest has a dependence on forests and considers their territory as an ancestral heritage that must be managed wisely and sustainably as has been done by previous generations.

Determination Method of Respondents

Determination of respondents was carried out using the Snow Ball Sampling technique to determine the history of changes in forest land use patterns based on local wisdom and Purposive Sampling techniques, namely the determination of 45 monoculture cocoa farmers and 25 cacao-based agroforestry farmers to calculate profits and feasibility and optimization of farming

2. DATA ANALYSIS

Based on the formulation of the problem, the data analysis will be used to answer the following problems:

1.Economic Aspects of Cocoa Based Agroforestry Systems

Furthermore, comparing the receipt of farming with cocoa-based agroforestry systems with monoculture Cocoa farming. Calculations are carried out using descriptive methods to determine the level of profitability and feasibility of farming based on the formula of Farming Acceptance Structure (Soekartawi, 2014) as follows:

(1) I = TR – TC

I = Income/Provit TR = Total Revenue TC = Total Cost

(2) TR = Y.Py

TR = Total Revenue Y = Yields

Py = Price of Yields

(3) TC = FC + VC TC = Total Cost FC = Fixed Cost

VC = Variable Cost

ISSN: 2456-8643

The analysis of farming profits was then continued with the Cost of Ratio (R/C) analysis to find out the farming feasibility index, which is an analysis by comparing farm income with the total farming costs. This analysis uses the equation model as follows:

R/C = TR/TC

R/C = Index of Farming Feasibility TR = Total Revenue

TC = Total Cost With the criteria, if:

R/C = 1, farming is not profitable and does not lose /break even point R/C < 1, the farm is lost

R/C > 1, farming is profitable.

Comparison of the results of the analysis of the average income of cocoa and maize monoculture farming with cocoa and maize agroforestry for 1 year is presented in the following table:

No.	Farming System	Production (kg)	Price (IDR/kg)	Revenue (IDR)	Cost (IDR)	Income (IDR)
1.	Maize Monoculture	5.600	3.500	19.600.000	6.996.000	12.604.000
2.	Cocoa Monoculture	480	23.000	11.040.000	5.754.000	5.286.000
3.	Agroforestry cocoa+maize					
	- cocoa	510	23.000	11.730.000	5.235.700	6.494.300
	- maize	3.800	3.500	13.300.000	4.200.000	9.100.000

The table above shows that maize farming provides higher income than cocoa farming if it is done in monoculture, even though the selling price is lower and the farming costs are higher. The large amount of income is caused by the high revenue caused by the large amount of maize production compared to the amount of cocoa production. On the other hand, farming with an agroforestry system with a combination of cacao and maize crops provides higher income compared to maize and cocoa monoculture farming systems. This is because the total production of cocoa and maize is higher than the total production of cocoa and maize in the monoculture farming system.

Pruning cacao trees provides an opportunity to grow corn between cocoa rows. Compared to when cocoa farmers try to clear shrubs using pesticides, there are many types of productive food

ISSN: 2456-8643

that are also useful as land cover, produce organic matter, and build a conducive environment for the growth of cocoa plants. So within four months maize will generate additional production and income for farmers while creating a good microclimate for cocoa growth. In addition, farmers can use maize cobs, leaves and stems as ingredients for making organic fertilizer to increase soil fertility.

Comparison of the results of the analysis of the average income of cocoa and taro monoculture farming with cocoa and taro agroforestry for 1 year is presented in the following table:

No.	Farming System	Production (kg)	Price (IDR/kg)	Revenue (IDR)	Cost (IDR)	Income (IDR)
1.	Taro Monoculture	7.052	3.500	24.682.000	9.989.655	14.692.345
2.	Cocoa Monoculture	480	23.000	11.040.000	5.754.000	5.286.000
3.	Agroforestry cocoa+taro					
	- cocoa	572	23.000	13.156.000	5.135.700	8.020.300
	- taro	7.165	3.500	18.077.500	8.231.322	9.846.178

The table above shows that the agroforestry pattern shows a higher income value which is a combination of income from the two farms compared to a single income from the monoculture pattern. Taro is a plant that can grow well under cocoa stands. This is because taro has the ability to grow in the shade. The research results show that taro is more technically feasible to be developed with an agroforestry system. In agroforestry systems, taro leaves adapt to light stress resulting in leaf expansion. The ability of taro to grow under stands is an opportunity in the development of agroforestry systems.

The ability of taro to produce higher leaf sizes under stands indicates that the growth factor in the form of sunlight intensity is a factor of positive interaction between stands and taro plants. Meanwhile, one of the negative interactions of the agroforestry system is competition between plant species. However, the possibility of competition for nutrients between cocoa and taro plants can be anticipated by adjusting the spacing and fertilizing inputs. Fertilization will provide additional nutrient input so that it is sufficient for the needs of two or more constituent plants.

2.Ecological Aspects of Cocoa Based Agroforestry Systems

The ecological perspective that is the goal of implementing the agroforestry system in various cropping patterns is assessed through factors that include: a) Hydrological functions (rainwater interception, water infiltration and landscape drainage), b) Land and Water Conservation, and c) Biodiversity.

Hydrological Function

The existence of trees (Nyatoh and Kemiri) can intercept and store rainwater on the surface of leaves and stems that will experience evaporation before falling to the surface of the soil. Surface flow is a portion of rainwater flowing above the ground. Tree plants function to reduce rain erosivity and surface flow by intercepting rain falling on it. The presence of litter in the form of organic waste in the form of piles of dry leaves, trees originating from trees and various other remaining vegetation on the surface of the soil accompanied by changes in soil porosity due to the development of root systems allows infiltration capacity and rate to increase. This condition besides increasing soil moisture also reduces volume and surface flow rate. Thus the management of farming with a cocoa-based agroforestry system is very suitable with the topographical conditions of the land in the Lore Lindu National Park forest area which is in a mountainous area with a slope of 15-45%.

Land Conservation

The role of agroforestry aims to overcome the criticality of land, among others by: 1) Increasing groundwater infiltration, 2) Reducing surface flow, 3) Preventing floods in the downstream, 4) Reducing the rate of evapotranspiration,

5) Increasing nutrients and improving soil structure, 6) Maintaining base flow in the dry season, 7) Protection of upstream ecology, 8) Reducing soil surface temperature, 9) Reducing soil erosion. The benefit of the existence of trees for land conservation is the occurrence of an efficient nutrient cycle so that it will support land productivity through soil enrichment by the development of soil microbes.

Biodiversity

The diversity of cultivated plants between perennials and agricultural crops allows for a longer food and energy chain. This condition will support the creation of high biodiversity (biodiversity). The implementation of the agroforestry system is expected to guarantee the ongoing ecological role of biodiversity in both plants, animals and microorganisms on land owned by farmers.

3. History of Changes in the Pattern of Utilization of Forest Land Based on Local Wisdom

Communities around the forest are dominated by the indigenous Kaili tribe who are indigenous to the Central Sulawesi region (> 80%) and the rest (± 20%) are from Bugis, Toraja, Manado and Java. The main livelihood is as a farmer. In addition there are also people who work as traders and gold miners. Based on oral history information and documentation tracking local communities have been using forest land since before the area was designated as a National Park area (in 1982). The use of forest land by the Kaili indigenous people is carried out as needed for basic needs not for the accumulation of land and extractive and exploitative interests. Local communities open fields communally and work collectively in the practice of subsistence based on experience and knowledge (local wisdom). In the belief that indigenous people clearing land for cultivation cannot be done on any land. In the process of opening new fields, they must conduct a series of preparations and surveys before determining the location. If the adat process is found in several trees and also animals, then the forest that is the candidate for the field location will not be opened. According to their beliefs, these fields will not produce results and will cause havoc to their families. Each stage of production has traditional rituals and is carried out by deliberations led by Customary Leaders and Farmers. They cleared the land then left without questioning who would process it later. Over time, land clearing has been carried out individually with rituals that are still carried out by each family. This happens because some people are familiar with individual or family-based land-processing techniques.

Historically indigenous peoples have Kapongo local wisdom which is almost owned by all indigenous peoples in Central Sulawesi which underlies the concept of shifting cultivation with certain rules and times to rotate back to the initial fields. This system has proven successful in maintaining the fertility of the land and supporting indigenous peoples for centuries without the threat of environmental damage. Even the indigenous people around the forest ve the concept of forest and land use with the following distribution:

• Pangale; space that must not be managed because it is located on a high and steep plateau. In addition, this area usually has a very high biodiversity so it must be protected and protected. In this region there are usually ancestral spirits that are highly respected by indigenous peoples.

• Jurame / ulate; space that is commonly managed by indigenous people as a field for planting food crops such as rice, sweet potatoes and corn with shifting cultivation.

• Pinojo'ong / jo’ong, is a space for managing agricultural crops or commodities for plantation crops such as cloves, coconuts and cocoa.

In the early 1970s, it was in line with changes in farming objectives that were no longer subsistence but also to get income to meet needs that could not be self-produced, so farmers built houses and cleared permanent land with forest garden planting patterns. Utilization of forest land with a pattern of forest gardens in addition to having economic value can also maintain ecological aspects, especially protection against soil fertility and prevent erosion. Forest gardens (mixtures) are an early form of agroforestry which is an embodiment of the ecological and economic processes of traditional communities. At the location of forest plantations farmers cultivate tree crops (nyatoh, teak, durian, rambutan and langsat) which are done intentionally or not with irregular spacing around dwellings or former rotational farming (farming) in the past that begins with plants grains, pulses and medicines. Thus local farmers with their local wisdom have combined dynamic agricultural and forestry principles in a traditional social, economic, ecological and cultural process of society as a model of sustainable natural resource use patterns.

In the 1980s, it was in line with the presence of migrants from various regions such as South Sulawesi (Bugis and Toraja), North Sulawesi (Manado) and Java who introduced plantation crops of high economic value such as cloves, nutmeg and cocoa, forest gardens (mixed) turned into a monoculture garden. With the potential for development and marketing that is more likely, most farmers prefer to change their land use patterns from forest gardens (mixed) to farming with cocoa monoculture planting patterns.

In the period 2000-2010 along with population growth and declining cocoa production caused by plant age, pest infestation and reduced cropping area due to land conversion, farmers changed the land use pattern with monoculture crops (maize). peanuts, cassava and sweet potatoes), for more stable market opportunities and prices while farmers who implement monoculture vegetable cropping patterns (cabbage, beans and tomatoes) are more likely to get higher prices.

Since the period of the 2000s, land use patterns of farmers who still depend on cocoa farming have begun to plant cocoa on their planting land for the purpose of improving the microclimate and the conditions of the planting land while increasing farmers' income. However, the combination of practices carried out by farmers with limited knowledge is still carried out without a scientific approach (Patilaiya, 2022). Although farmers already know about cocoa and candlenut plants individually, the interactions between these plants and how to optimize the positive interactions between the two plants or the interactions between these plants and their environment have not been clearly understood. Land use with agroforestry patterns that aim at the absence of a decline in crop production over time and the absence of environmental pollution are expected to be sustainable and sustainable (Jumiyati, 2021).

3. CONCLUSIONS

The results of the study it can be concluded that:

1. Cocoa-based agroforestry systems provide higher income generation than cocoa monoculture systems. In an agroforestry system the profits come from the cocoa plant and from the plants under the stand. Whereas in the monoculture system the profits only come from the cocoa plant.
2. The ecologically based cocoa agroforestry system can make the cropland environment more adaptable to support growth and production compared to the cocoa monoculture system. This can be seen from the productivity of more diverse land so as to produce higher profits and ensure the sustainability of farming.
3. Cocoa-based agroforestry system is a concept of land use that follows a rotation cycle based on the history of changes in land use patterns through economic and ecological perspectives and is a modern scientific approach to religiomagic indigenous wisdom.

ACKNOWLEDGEMENTS

Acknowledgments to forest farmers, traditional community for their contribution and active participation during the data collection process. Thank you to the Rector of the Muhammadiyah University of Palu for his support and deepest gratitude to the Majelis Diktilitbang PP. Muhammadiyah which has supported this research activity through the Muhammadiyah Research Grant Program.

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