Cocoa based agroforestry: An economic perspective in resource scarcity conflict era

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Abstract. Agricultural development towards food self-sufficiency based on increasing production alone has caused the occurrence of environmental disasters that are the impact of the exploitation of natural resources resulting in the scarcity of resources. This paper describes the optimization of land area, revenue, cost (production inputs), income and use of production input based on economic and ecological aspects. In order to sustainability farming by integrating environmental and economic consideration can be made through farmers' decision making with the goal of optimizing revenue based on cost optimization through cocoa based agroforestry model in order to cope with a resource conflict resolution.

1. Introduction

Agricultural development was proclaimed by the government no longer focus on the problem of production alone. However, the agenda of self-sufficiency sustainable is the main agenda apart from others such as diversification of food, increase of added value, competitiveness, export and improvement of farmer's prosperity. Program of income increasing and ability of farming and agribusiness management towards Good Agriculture Practices (GAP) and Good Farming Practices (GFP), science and technology application, and concern for conservation of resources both physical and genetic and environment become the main priority agenda. The agricultural and plantation sector not be separated from the utilization of resources has value to meet an increasingly diverse of human needs. Resources commonly used in agriculture are land resources, human resources and capital [1]. These issues should direct to resource conflict resolution based.

The problems of agricultural economic development related to the scarcity of the main resources are decline of quality and quantity of agricultural land resources, the weakness of human resources, that is farmers in adopting technology and innovation affecting the productivity, efficiency, the lack of access to business services, especially that affect farmers in financing their farms business so that the productivity achieved is still below of the potential productivity [2]. The various problems faced to need

the development of farming activities with the absorption of low production inputs as a form of sustainable agriculture [3].

The scarcity-resources era sweeping the globe also haunts Indonesia's famous country with abundant resources [4]. Agroforestry as a technique of land management that applying combination of forest trees with agricultural crops is an innovation model of land use that is more efficient in land use and production inputs which aim to optimizing the production and income of per unit area that refers to the principle of sustainable yields and addressed at which multipurpose, optimal and sustainable production under the positive influence of improved edaphic and microclimate conditions with imitating forest condition, and with the technique of management matching with cultural attitude of local communities [5].

Thereby, it is really necessary to conduct a study to know the excellence of agroforestry system application in bridging farmer importance from an economic perspective in resources-scarcity era as a global reality, which is also challenge for sustainable agriculture development. It is hoped that the application of cocoa-based agroforestry can maintain ecosystem sustainability, reduce the risk of harvest failure and price fluctuation caused by diversity commodities. On the other hand, high productivity can be maintained [6].

2. Method

The research was conducted in Balinggi Sub-district, Parigi Moutong District, Central Sulawesi Province, Indonesia. Sampling was done purposively by taking sample of 16 farmers who have a land area of 7 ha then simulated with the aim of optimizing cocoa-based agroforestry. The optimization of cocoa-based agroforestry farming in Parigi Moutong Regency was conducted quantitatively with the formulation of *Linear Programming* model formulated to as follows:
Maximize objective function (Revenue) Max:

$$Z_{Max} = \sum_{oe=1}^{n} C_o X_e \quad (1)$$

X_e = Decision Variable (optimum revenue) value of cocoa-based agroforestry production.
C_o = Parameter of objective function (cocoa based agroforestry farming income).
with constraint function

$$\sum_{j=1}^{bi} a_o X_e = b_o \quad (2)$$

$a_o X_e$ = Parameter of constraint function o for decision variable e
b_i = constraint capacity o [7].

3. Results and Discussion

3.1. Optimization of Land Area

Indonesia has a land potential of 186.20 million ha which has been largely utilized for various purposes in both agricultural and non-agricultural sectors [8]. Parigi Moutong Regency in the last 6 (six) years has increased the area of 208.68 ha of seasonal crops, 49.43 ha of plantation and 6.27 ha of fish pond. Based on the Spatial and Regional Planning (RTRW), the plantation area is less than 1,766.01 ha from the expected target [9]. The increase of plantation area for farmers to adopt profitably and sustainably is by agroforestry. The recommended optimization of cocoa-based agroforestry farming area with the objective of maximizing the revenue on 7 ha of land is by applying a monoculture system of *nyatoh* (*Palaquium* spp) 2 ha, *palapi* 1 ha, cocoa 1 ha, agroforestry system of cocoa with *nyatoh* 2 ha and agroforestry cocoa with *palapi* 1 ha (figure 1).

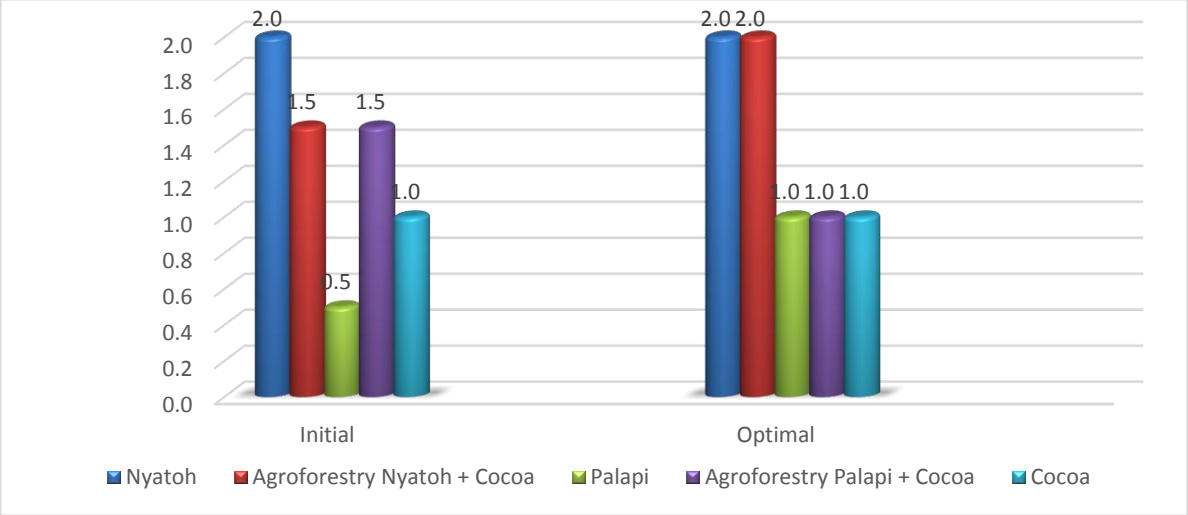

Figure 1. Optimizing of land area

3.2. Optimization of Revenue

Optimization of farm revenue on 7 ha of land can be achieved by increasing the revenue of agroforestry cocoa with *nyatoh* farming. This is because agroforestry cocoa with *nyatoh* farming can provide additional revenue because the production comes from two types of plants also reduces production costs. It can efficient allocation of production input. Thus, the optimum recommendation for farming revenue is to optimize the revenue from agroforestry cocoa with *nyatoh* farming with the increase of revenue from IDR 490.4 million to IDR 653.8 million with an increase rate of IDR 163.5 million (25%) (figure 2).

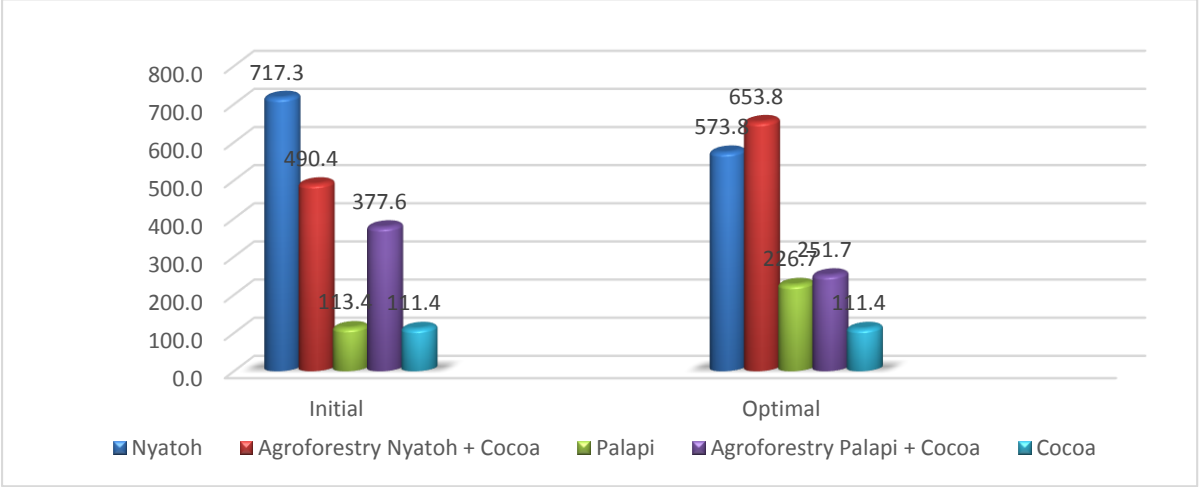

Figure 2. Optimization of revenue

3.3. Optimization of Cost

Costs required are the production cost in annual crops and annual crop maintenance. Various agroforestry farming costs with different cropping patterns depend on the type of cultivated plant [10]. The cost optimization recommendation is to increase the production cost at the agroforestry of cocoa with *nyatoh* farming with the initial cost of IDR 137.5 million to IDR 183.4 million up by IDR 163.4 million (25%) (figure 3).

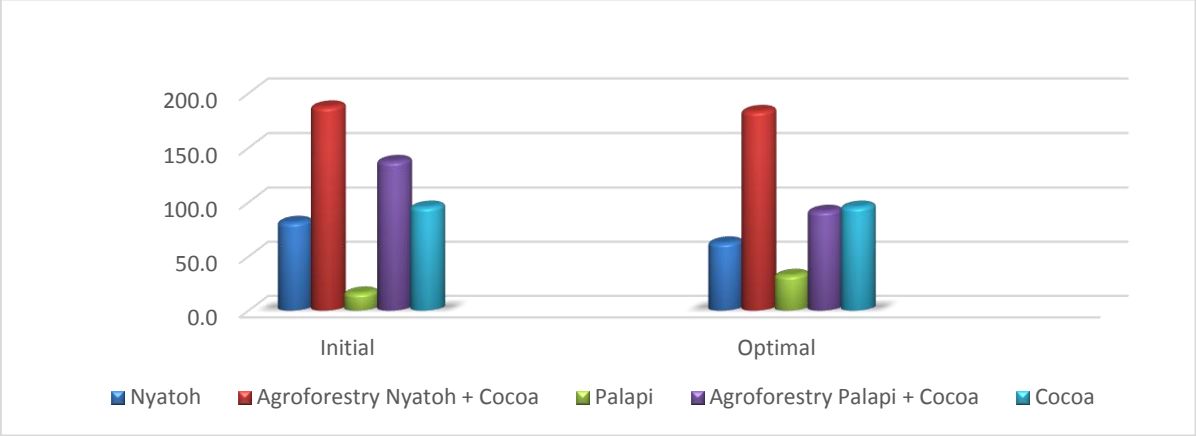

Figure 3. Optimization of cost

3.4. Optimization of Income

Economic factor is the priority of farmers in the selection of crops in cultivating of agroforestry land. For farmers, economic factors directly affect farmers' incomes then ecological factors become a priority after economic factors [11]. Total farm income increased from the initial income of IDR 1.341.4 million to IDR 1.348.9 million with an increase of IDR 7,500 million. The contribution of agroforestry income was IDR 630.4 million (46.7%) of the total optimum revenue. This shows that agroforestry farming has a prospect for increasing of farmer's income compared to monoculture farming (figure 4).

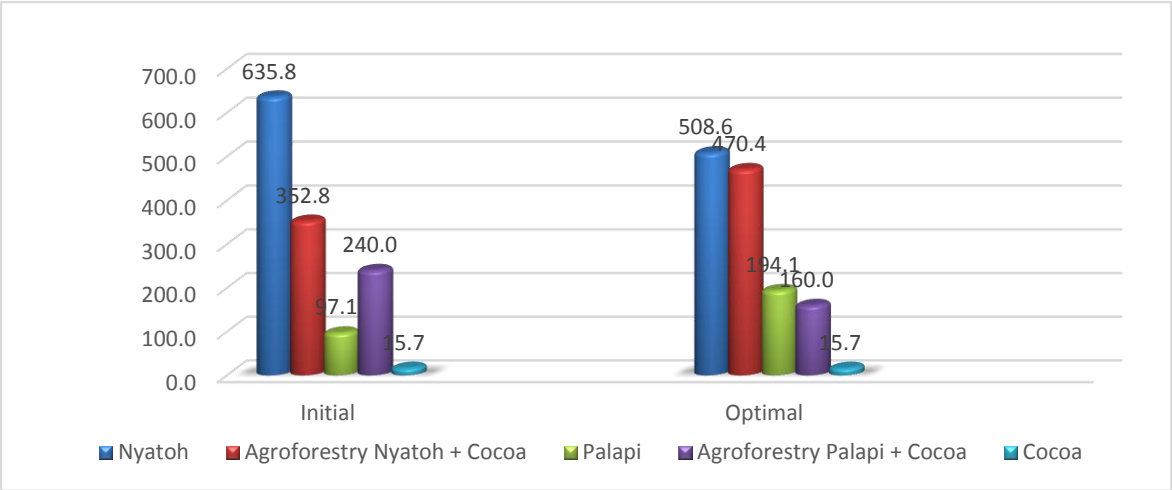

Figure 4. Optimization of Income

3.5. Residual Value of Production Input and Income Increase at Optimization

At the time of farming optimization, the input production used is all used up. This shows that the application of agroforestry techniques by farmers leads to efficiency and effectiveness of input production use. Thus. It is not necessary to add input because it will not cause an increase in income but result in residual value which can increase production cost. On the other hand, if the farmer adds 1 unit of tree seedlings there will be an increase of IDR 52,000 (table 1).

Table 1. Residual value of production input and increase revenue at optimization of cocoa based agroforestry

No	Production inputs	Residual value	Increase revenue (IDR)
1	Land area	0	0
2	Seed of tree	0	52,000
3	Seed of cocoa	0	0
4	Hole of planting	0	0
5	Planting	0	0
6	Manure	0	0
7	Insecticide	0	0
8	Maintenance 3x a year	0	0
9	NPK	0	0
10	Urea	0	0
11	KCL	0	0
12	TSP	0	0
13	Pruning	0	0
14	Harvesting of cacao	0	0
15	Harvesting og cocoa	0	0

4. Conclusion and Suggestion

It can be concluded that (1) optimization of optimum land use is by applying monoculture of cocoa 1 ha, *nyatoh* 2 ha , *palapi* 1 ha, agroforestry of cocoa with *nyatoh* 2 ha and cocoa with *palapi* 1 ha; (2) The optimum revenue, cost and income came from the agroforestry of cocoa with *nyatoh* farming with the increase of revenue (25.0%), cost (25.0%) and income (46.7%); (3) The application of cropping pattern of cocoa-based agroforestry in the management of farming can minimize the use of production inputs and optimize income and competitiveness.

Some possible suggestions are: (1) Site-specific land management as one solution to handle gap between government policy and community based land model with local wisdom value owned: (2) Changes in land use patterns as a form of economic adaptation must also be in line with ecological adaptation in the framework of efficiency, optimization and competitiveness so that sustainability can be guaranteed; (3) The need for government appreciation that not only supports increased production but also creates market opportunities for farmers who apply environmentally friendly and sustainable cultivation techniques.

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