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Model Optimization Planting Pattern Agroforestry Forest Land Based on Pine Tree

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Abstract
This study aims to determine cropping patterns in class slopes 0 - <15% and the grade slope slopes 15% - <30% and the slopes> 30%. The method used in this study is a description of the dynamic system approach using a software power sim. Forest areas where the research, which is a type of plant that is cultivated by the people in the study area, namely coffee, vanilla plantation crops / horticulture fruit and chili sauce for food crops / horticulture vegetables. Research results prove that the slope grade 0 - <15%. Cropping pattern of this slope is a combination of plant species are pine-vanilla-chili sauce with vanilla density of 712 stems and stem cayenne 1940, with revenues of wages pine + Rp 79,183,734 / ha. b) On the slope grade 15% - <30% and 30%. Cropping patterns on the slopes of this combination of plant species are pine-coffee-vanilla. On the slopes of 15% - <30% density of 277 coffee and vanilla stem rod 547, while for slopes of 30% with a density of 279 coffee and vanilla stem rod 545, with revenues respectively: wages pine + Rp 58.33.144 / ha and wages pine + US $ 55.40225 million / ha.
Keywords: Optimization, cropping, agroforestry, forest, pine trees

Introduction

Sumedang regency which has forestry land area of about 51 927, 45 ha. In Perum Perhutani management unit III West Java involve forest communities, which allows the farming community in forest land, by planting crops together with forest trees (agroforestry). How this is done with the intention to participate in building the socio-economic forest communities, and preserving the forest as well as the quality of the environment. This is done to reduce socio-economic disparities in the communities around the forest. Socio-economic conditions of low public will put pressure on forests resulting in disruption of forest resources concerned.

Forest benefits is undoubtedly the Indonesian economy but, according to statistics from the Ministry of Forestry (1994) turned out of 27.2 million people residing in and around forest areas are 34% low-income communities dependent on forest resources. The causes of poverty are among others due to the increase in population as well as the uneven distribution, it is having an impact on the provision of food and shelter needs to be able to guarantee a decent life. Socio-economic disparities in the communities around the forest may cause interference to forest resources, the socio-economic conditions of low public will put pressure on forests. The pressure may be the theft of forest products, illegal cultivation, illegal grazing, which will lead to the destruction of forests. This is done to meet the needs of life. According Soemarwoto (1991) meeting the needs of human life have meaning to enhance the dignity and social status. Therefore, the success of forest management should be followed by an increase in the welfare of the surrounding community so as not to cause conflict.

The government's efforts in improving the welfare of communities around the forest of which is done by allowing the public to participate in work / processing forestry land, by planting crops together with forest trees (agroforestry). Agroforestry has an important economic function for society as a source of income. Based on the calculation Foresta and Michon (2000) various agroforestry in Indonesia capable of supplying 50% - 80% of the agricultural rural income through direct production and other activities related to the collection, processing, and marketing results. As a producer of cash, agroforestry can be regarded as "bank" true, which can cover the daily needs of family farmers. In addition, the diversification of existing plants, agroforestry is able to ensure the security and peace so that farmers will always make a profit. However, the activities during the process over land use often affects the soil surface. Felling trees and land treatment resulting in the surface of the soil to be open, so that if it rained blows rainwater directly. Various kinds of direct interference can also damage the surface of the soil, as a result of the traffic of vehicles, animals and humans in a variety of activities such as cutting and transporting trees, preparing the land and planting trees. This occurs when the cultivation of crops not think of environmental rules, think how to get the maximum economic benefit.

To avoid such circumstances is necessary to find alternatives to the direction of the management model of forestry development combined with efforts to fulfill the needs, income generation and welfare of communities around the forests are also forest conservation and environmental quality. According Darusman (1993) issue of development of forest communities, which are generally traditional, in addition to adhere to the norms and traditional values, requires a thorough understanding and deep about the condition and dynamics of socio-

economic and local culture, including the pattern of life and livelihood ,

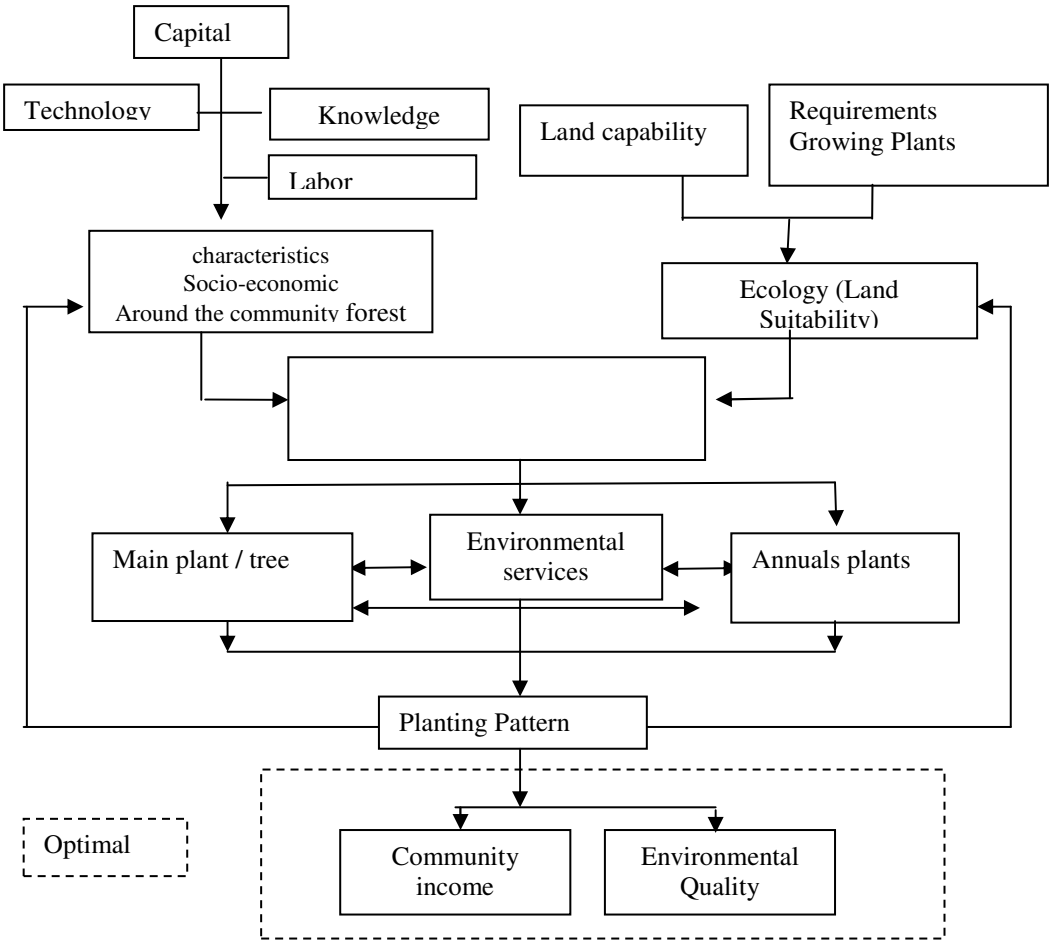
Sumedang regency which has forestry land area of about 51 927, 45 ha. In Perum Perhutani management unit III West Java mengikitsertakan forest communities, which allows the farming community in forest land. How this is done with the intention to participate in building the socio-economic forest communities, and preserving the forest as well as the quality of the environment.

Based on interviews with residents in the area of pine forests Cipadayungan Sumedang Regency cultivated plant community is (a) coffee, pepper, vanilla for horticultural crops and fruit plantations, and (b) of cayenne pepper to the vegetable crops and horticulture. Relating to the situation, then through this study the authors wanted to assess the optimization of suitable cropping patterns to be developed in the research area so that land use is able to improve the local economy and ensure the sustainability of forest resources efficient and effective, both for productivity and for environmental sustainability.

Theoretical Framework

The conceptual framework in this study mainly refers to the basic theory of Rambo (1984) where human activity, social institutions and cultural elements are in one integral whole, the social system. Social systems interact with ecological systems or natural ecosystems (forests and its potential as an ecosystem). Schematically depicted flow of conceptual research, as in Figure 1.

Figure 1.
Conceptual Framework



In the relationship between social systems with natural ecosystems there are issues that are very complex, the problems related to the environment. When poured into the model, nature is very complex dependency model. To be able to take the right decision, it must first be familiar with the intricacies of the model. Ideally component modeling a decision support system must be able to support any decision-making activities which include the analysis of system problems, projections of future situations, alternative planning, comparison or alternative

selection, optimization and simulation through application of models that are relevant (Suryadi, 2000).

In the social system there is a potential human resources, while in the forest ecosystem there is the potential of forest resources. In between there is a relationship of interaction in terms of utilization of forest resources by the forest communities. The value of forest product utilization will determine the pattern of utilization of forest resources, both for the purposes that have been necessary in the development of national and specific purposes.

Rural communities around the forests exploiting the potential of forest resources, either commercially or for fulfilling the needs of everyday life with the knowledge capital and technology is. However, a fundamental question to be answered is how the pattern of forest use that can meet the criteria of sustainable use to ensure the preservation of forest resources in accordance with the characteristics of the community. Such patterns of forest use is what should be developed as a basis of development of rural communities around the forest in an integrated manner with environmentally sound capable of guaranteeing the preservation of forest resources.

Methodology

Based on this conceptual framework, the methods used in this study is a description of the dynamic system approach using a software power sim from Muhammadi (2001), which quickly can see the behavior of the model created. Forest areas where the research, which is a type of plant that is cultivated by the people in the study area
(a) coffee, vanilla plantation crops / horticulture fruit
(b) cayenne pepper to crops / horticulture vegetable

References and field results are input to the simulation model of Power sim, with a sub-sub-system is as follows.
1. submodel Erosion
Erosion submodel is based on USLE method of Arsyad (2000) with the formula Erosion (A) = RKLSCP adapted to the study area. The slope is divided into three classes, namely slope 0 - <15%, 15 - <30%, and ≥ 30%. Flowchart of erosion submodel arranged along its effect on crop productivity. According to Sudirman et al. (1986) in Arsyad (2000) at the rate of erosion of 10, 20, 40, and 60 cm decline in production to respectively 48, 65, 79, and 86% of production without erosion.

Flow diagram erosion submodel was formed from the following equation

A = RK (LS) CP ..... (1)
from the equation Arsyad (2000)
R = Rainfall in tonnes / ha / yr

$$K = 1,292\left[2,1M^{1,14}\left(10^{-4}\right)(12-a)+3,25(b-2)+2,5(c-3)\right] \text{.....} \quad (2)$$

M = percentage of very fine sand and dust (diameter 0.1 to 0.005 and 0,05-0,02mm) x (100-percentage of clay);
a = percentage of organic material; b = Code of soil structure;
c = Class permeability soil profile

$$LS = \sqrt{x}\left(0,0138+0,00965s+0,00138s^2\right) \text{.....} (3)$$

L = length of the slope; S = slope; C = Factor vegetation ground cover
P = Factor soil conservation measures
F = p (fx) ..... (4)
p = Depletion of soil
fx = function decline in production

2. Sub Model Plant Growth

For the development and success of agroforestry systems, the type of crop to be planted must meet several requirements, not only increase the income of farmers but also social, physical, and biological. Therefore on crop growth submodel inputs include growth factors, factors plant death, and the probability of harvest. Factors of growth / death of plants obtained from the various information and data directly from the field. The amount of the harvest is determined by the probability of success and decline.

Flowchart Sub crop growth model is formed from the equation:
P = Pp (1-FKR) .... (1)
Pp = Tt (Fk) .... (2)
P = Harvest;
FKR = Fraction density;

Pp = Probability of harvest; Tt = Plants grow;
Fk = Fraction harvests
Kt = Lp - Lk ..... (3)
lp = Bb ..... (4)
bb = Th (fb) .....(5)
Lk = Lp (fk) .....(6)
lp = The rate of growth plant; Lk = The rate of death of the plant; Bb = Seedlings Th = area of land for the development of the plant; fb = fraction of crop seeds and plant death fk = Fraction

3. Sub Economic Model
Sub economic model is to describe the income of farmers from planting crops results in the research area. Income is the excess of the income generated by the sale of all activity costs incurred to produce the plants concerned.
Flow diagram of the economic submodel was formed from the equation:

$$H = \sum_{i=1}^{n} Q_i - \sum_{i=1}^{n} C_i$$

Where:
H = Profit / net revenues from the development of all the plants
Qi = Sales crops i
Ci = Expenses / cumulative cost for the development of i

Results and Discussion
Types of plants that were analyzed is a plant cultivated by the people in the study area
(a) coffee, vanilla plantation crops / horticulture fruit
(b) cayenne pepper to crops / horticulture vegetable
Of the three types of plants can be made a combination of cropping patterns as follows:
1. pinus- coffee-vanilla,
2. pinus- coffee-chili sauce,
3. pinus- coffee,
4. pinus- coffee-vanilla-cayenne,
5. pinus- coffee-vanilla,
6. pinus- coffee-vanilla-cayenne,
7. pinus- vanilla-cayenne,
8. pinus- vanilla, and
9. pinus- vanilla-chili-pepper.
If seen from the results of the laboratory on soil structure and the growing requirements according Djaenudin (2000), all combinations of these crops can be planted in the area of research. The following requirements grow these plants.

Table 1.
Suitability conditions in the area of Forest Land Cipadayungan with Plant Growing Requirements

Plant	Factor	Growing Requirements		Description
		Reference	Field	
Coffee	climate	temperatures 10 – 32^o	19 – 23^o	corresponding
		Rainfall 800 - 3000 mm/year	913.47	corresponding
		Height ≥ 700 m dpl	± 700	corresponding
	Land	The minimum depth 50 cm.	120 cm	corresponding
		pH 5,2 - 7,8	5,5 – 6,3	corresponding
		C-organic ≥ 0,8	3 – 12,49	corresponding
vanilla	climate	temperatures 20 – 35^o	19 – 23^o	corresponding
		Rainfall <1500 - 2000 mm/year	913.47	corresponding
		Height 400 - 700 m dpl	± 700	corresponding
	Land	The minimum depth > 75 cm.	120 cm	corresponding
		pH 5,5 - 7	5,5 – 6,3	corresponding
		C-organic	3 – 12,49	
Cayenne pepper	climate	temperatures 14 – 28^o	19 – 23^o	corresponding
		Rainfall 600 - 1200 mm/year	913.47	corresponding
		Height ≥ 700 m dpl	± 700	corresponding
	Land	The minimum depth 30 cm.	120 cm	corresponding
		pH 5,2 - 8,2	5,5 – 6,3	corresponding
		C-organic ≥ 0,8	3 – 12,49	corresponding

Data source: Djaenudin (2000) data and laboratory results Puslittanak Lembang, Bandung Based on simulation results obtained optimal plant density as follows.

Table 2.
Density Combination Type Plants

No.	Class tilt Slope (%)	The combination of plant density		
		K (stems /ha)	V (stems /ha)	C (stems /ha)
1	(0<15)	-	712	1.940
2	(15<30)	277	548	-
3	≥ 30	279	545	-

Description; K = Coffee, V = Vanilla, C = cayenne pepper

Judging from the root system of a combination of pine trees, coffee, vanilla and chili sauce did not give a picture of the level of competition of nutrients that may arise. Hairy roots of coffee plants is about 60% contained in the layer between 0-20 cm from ground level, while to the side are mostly found at a distance of between 60-90 cm of the main stem. Vanilla plant root system is fibrous roots, the development side to reach 20 to 50 cm. Coffee took nutrients from the deeper horizon of the vanilla plant, and cayenne take nutrients from shallower horizon of vanilla. So a combination of pine and pine-coffee-vanilla-vanilla-cayenne provide benefits through increased efficiency of uptake

In the high-growth vanilla plant is lower than the coffee plants. Vanilla plant is a plant that is tolerant of shade and economically valuable. Vanilla plant can be grown in between or under the coffee plants, so that light escapes from the coffee tree will be utilized by the vanilla plants, and the light that escapes from a vanilla shade will be used by cayenne. Thus, a combination of pine and pine-coffee-vanilla-vanilla-cayenne meets the principles for maximizing space utilization efficiency of light. According Suharjito et al. (2003) in terms of space agroforestry closely related to nutrient availability, use, and saving natural resources. For example the presence of coffee in the shade of which, according to research Jalid (2004) that alternate with shade coffee production systems Gliricidia can improve productivity and soil moisture, lowers the rate of erosion, maintain biodiversity and create forest conditions. So the combination of pine-coffee-vanilla and pine-vanilla-chili sauce is a combination of the most suitable to be applied in the research area.

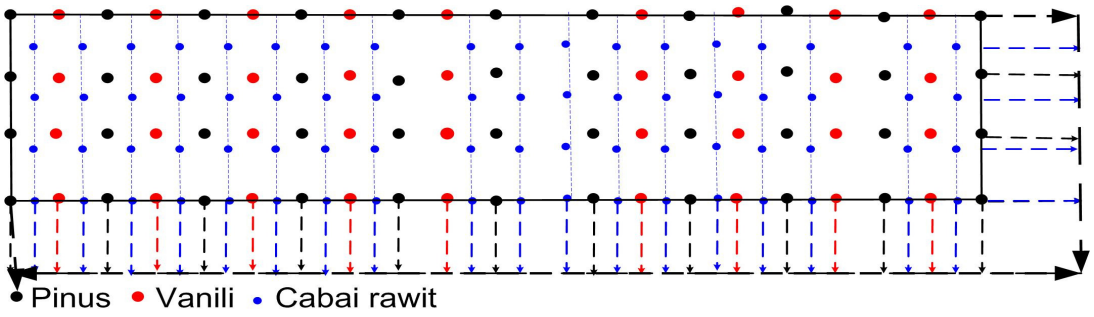
Match between the physical properties of the forest environment with growing requirements of plants will give

you an idea that the land potential to be developed, which means that by paying attention and taking into account the inputs necessary for planting the plants will be able to deliver the results as expected. According Subagjo et al. (1995) when an agricultural commodities planted on suitable land environment, the plant will demonstrate maximum genetic capabilities, in terms of both quantity and quality.

Coffee plants including tropical plant that grows at an altitude of 700 meters above sea level which is able to adjust to varying environmental conditions. Although coffee including tropical plants, but coffee does not require high temperatures and require shade plants. Temperature suitable to grow coffee well is 10 - 32o C. The temperature is above 35o C and cold-freezing temperatures can damage crops, even turn it off. Rainfall is suitable for growing coffee is between 800 - 3000 mm / year. Coffee is a species that can live well in the shade of other trees. These plants classified as medium sun-loving and can perform photosynthesis activity from morning till evening, both on sunny or cloudy conditions. However, when it gets too hot, it will close the plant stomata, thereby decreasing the rate of photosynthesis (Wrigley, 1988). Limit the availability of light for coffee by shade trees is 40-70%, in detail can be seen in Table 1. The pepper plants are also plants that live in the shade of other trees. Pepper plants growing requirements are generally the same with coffee, for more detail can be seen in Table 1.

Vanilla plant is a climbing plant that can grow well in the shade of other trees. Vanilla plant is not resistant to sunlight, too much light causes the leaves yellowish vanilla (Bank Rakyat Indonesia, 1986). Cayenne pepper crop mostly grown in the upland / rainfed areas, or areas that have not received technical irrigation. Cayenne grow anywhere, and is known as the easiest plants to adapt to the environment where they grow and flexible plants to be cultivated.
According to the simulation results can be implemented cropping patterns in the field with optimal hasi as follows.
a. On the slope grade 0 - <15%
Pokon vanilla plant, cultivated plant communities vanilla and cayenne pepper. Combinations of plant species are pine-vanilla-chili sauce. The distance between plants pine 20 x 20 m. Cropping patterns that allow can be done with optimum results are: 1) The distance between the plant and vanilla vinus 4 x 3 m. The number of rod 712 vanilla plants. 2) the distance between the cayenne pepper plant 2 x 2.5 m. The amount of cayenne pepper plant 1,940 trees.

Figure 2.
Pinus mapping Planting Pattern (P) -Vanili (V) - Cayenne pepper (C) on the Slopes 0 - <15%



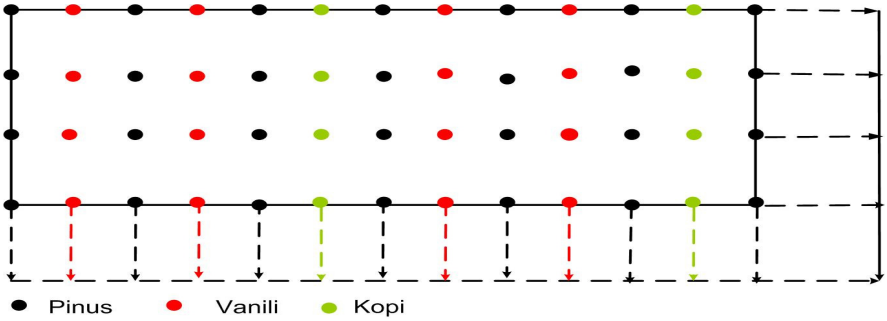
According to the simulation results using the program powersim with input cropping pattern as shown in Figure 2, namely, the amount of vanilla plants 712 rods and cabae cayenne 1,940 trees and take into account costs incurred for cultivation include the cost of seedlings, labor and fertilizer are then deducted the cost of sales, income to total income and the effects of erosion can be seen in Table 3.

Table 3.
Farmer income of Agroforestry Systems on the Slopes 0 - <15%

Year Production	Commodities revenues		
	Cayenne pepper (Rp/ha)	Vanilla (Rp/ha)	Total (Rp/ha)
1.	2.938.339	-	wages pine + 2.938.339
2.	2.938.339	-	wages pine + 2.938.339
3.	2.938.339	29.040681	wages pine + 31.979.020
4.	2.938.339	76.245.395	wages pine + 79.183.734

b) For the class of slopes 15% - <30% and 30%
Vanilla tree crops, crops cultivated society vanilla and cayenne pepper. Combinations of plant species are pine-vanilla-chili sauce. The distance between plants pine 20 x 20 m. Cropping patterns that allow can be done with optimum results are:
1) The distance between the coffee and the coffee plants 3 x 12 m. The number of coffee plants 277 trees.
2) the distance between the vanilla plant with vanili3 x 4 m. The number of rod 547 vanilla plants. Mapping the plants on slopes of 15% - <30% and 30% the same, namely pine-coffee-vanilla.

Figure 3.
Pinus mapping Planting Pattern (P) - Coffee (K) - Vanilla (V) on the Slopes of 15 - <30% and ≥ 30%



According to the simulation results using powersim program with input cropping pattern as shown in Figure 3, namely, the number of coffee plants 277 547 trees and vanilla sticks. and take into account the costs incurred for the cultivation covers the cost of seedlings, labor and fertilizer are then deducted the cost of sales revenue and total revenue impact of erosion can be seen in Table 4

Table 4.
Farmer income of Agroforestry Systems on Slopes 15 - <30

Year Production	Commodities revenues		
	Coffee (Rp/ha)	Vanilla (Rp/ha)	Total (Rp/ha)
1.	-	-	-
2.	-	-	-
3.	-	21.958.167	wages pine + 21.958.167
4	24.470	58.314.674	**wages pine + 58.33.144**

Total revenues slope ≥ 30% and the impact of erosion can be seen in

Table 5.
Farmer income of Agroforestry Systems on the Slopes ≥ 30%

Year Production	Commodities revenues		
	Coffee (Rp/ha)	Vanilla (Rp/ha)	Total (Rp/ha)
1.	-	-	-
2.	-	-	-
3.	-	19.991.280	wages pine + 19.991.280
4.	9.583	55.392.667	wages pine + 55.402.250

Farmers in the study sites had a tendency to cultivate their lands into monoculture farming system. However, due to limited capital, the majority of land used for crops during the rainy season and the dry season allowed back overgrown shrubs. There is approximately 75% (49 people) of respondents stated that farmers lack the capital to cultivate their lands, therefore in many research areas gained vegetable crops and horticulture. Of the many horticultural crops and vegetables grown in the area of research, shows that people concerned in terms of economics than the environment. This happens because the community to prioritize the needs of short-term private consumption.

Cost-benefit analyzes conducted in this study is a systematic assessment of all the benefits and all the costs that

would arise from an action or some actions or alternatives. The so-called benefits here are the benefits obtained from agroforestry management, while the cost is the lost benefits are sacrificed to obtain these benefits. The costs and benefits arising from agroforestry activities calculated on the basis of received / issued at this time (calculated value at this time). Thus, the comparison between the benefits to the cost of a comparison between the present value of the benefits by the present value of costs.

Based on market information, marketing coffee and vanilla different nature to the marketing of food crops, when viewed from the angle of costs in general the price of crops at harvest are relatively down and famine price will go up. For coffee and vanilla crop conditions in the country was more influenced by the demand for export, which is largely determined by the prices in foreign markets. Thus the prices that occurred during the harvest season may be higher than when no harvest, especially at the same time happened in export demand rises.

Conclusion

a. On the slope grade 0 - <15%. Cropping pattern of this slope is a combination of plant species are pine-vanilla-chili sauce with vanilla density of 712 stems and stem cayenne 1940, with revenues of wages pine + Rp 79,183,734 / ha
b. On the slope grade 15% - <30% and 30%. Cropping patterns on the slopes of this combination of plant species are pine-coffee-vanilla. On the slopes of 15% - <30% density of 277 coffee and vanilla stem rod 547, while for slopes of 30% with a density of 279 coffee and vanilla stem rod 545, with revenues respectively: wages pine + Rp 58.33.144 / ha and wages pine + US $ 55.40225 million / ha

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