ACCELERATING THE GROWTH OF MANGOSTEEN (*Garcinia mangostana* L.) AT AGROFORESTRY SYSTEM IN DISTRICT OF KERINCI, JAMBI PROVINCE

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ABSTRACT

The objectives of this research were to accelerate the growth of mangostan at Agro-forestry System by optimizing various fertilizer applications and to study how to reduce the top soil erosion at the slant area of mangosteen agro-forestry system. The research was conducting by using Randomized Block Design with 4 replications and two treatments i.e. with fertilizer and without fertilizer. The variables observed were the growth of plant high, the sphere of the tree, and the branch development.

The study consisted of three activities: (1) collecting data by conducting survey and observation, (2) applying good practice techniques according to the environmental system of agro-forestry, and (3) evaluating the mangosteen improvement after applying the treatments.

The result of study showed the plant height and tree sphere are maximize increase at 2 to 4 years old plants and maximize improve the branch of the plants at 4 to 6 years old. The result also showed that the land was extremely responsive to fertilizer application because of the poor condition of the land, which indicated by low nitrogen, low phosphor and low pH. Even though the slope of the land was around 39%, the land erosion index was low because of low rain-fed and land covered.

Keywords: Mangostan, agro-forestry, fertilizer

INTRODUCTION

Mangosteen fruit (*Garcinia mangostana* L.) is one of the commodities of tropical fruits that have high potential to be developed. Mangosteen fruit dubbed as the queen of Fruits, which is a fusion of images reflecting the beauty of skin and flesh color of fruit and enjoyment of the fresh and distinctive taste of sweet and acid into one.

One of the mangosteen production centers in Jambi Province is the District of Kerinci. Mangosteen is planted in this region usually through a system of traditionally cultivated yard around the hills that have a high degree of slope (50% - 80%) and planted in between the annual crops with tight spacing, irregular and almost without maintenance. Such conditions affect growth, and productivity and quality of mangosteen. Although plantedas mix cropping as an agroforestry system, mangosteen is expected to be a source of income by farmers. Because of its high economic value, the mangosteen should be cultivated better.

Average productivity of mangosteen in the district of Kerinci is relatively low that is between 30 to 50 kgs/tree. According Poerwanto (2000) productivity mangosteen in Malaysia and India can reach 200 to 300 kgs/tree. While in other countries such as Thailand, Sri Lanka and Puerto Rico the productivity of mangosteen ranges from 15 to 120 kgs/tree.

Agroforestry is a new term given to the agricultural system that is already long practiced by farmers in Indonesia. Various definitions have been developed by researchers of agroforestry in accordance with the properties of their respective components of the system in its original place. Lundgren (1992) defines agroforestry as a collective name of the landuse system, with components of trees, seasonal crops, feed crops at the same time, rotation, or a mixture of both. In this system there is interaction between the tree with the other components which are ecologically form a multi-layered canopy.

Therefore, the existence of the mangosteen-based agroforestry system, which is one form of conservation farming systems need to be developed so that land resources can be ecologically

sustainable and economically profitable. Canopy closure properties and root interrelation in agroforestry system cause this this cropping system support the conservation of soil and water on the sloping site condition. Thus, this system plays an important role in enhancing the growth of the constituent components of plants including mangosteen.

MATERIALS AND METHOD

Time and Location of the Research

This research was conducted from January 2009 to November 2009 in the District of Kerinci of Jambi Province, specifically in the village of Koto Patah Semerap in Keliling Danau Regency. Soil analysis was conducted at the Laboratory of Soil Chemistryof Agricultural Faculty, University of Jambi in Jambi.

Method

This study consisted of three activities, namely (a) data collecting (preliminary surveys and field observations), and (b) the application of mangosteen cultivation technology with agroforestry systems, and (c) the evaluation of the treatment in the growth of mangosteen.

Data Collecting

The research began with a preliminary survey and continued with the collection and analysis of primary and secondary data. Agroforestry structure was observed descriptively intended to inventory the components of the mangosteen-based agroforestry consisting of agricultural crops, plantations and forests.

Observations are carried out on species, population and density as well as the layout of the preparation for the unit or a particular area. Data obtained from these activities were used as reference materials for the application of technology in mangosteen cultivation in agroforestry systems.

The application of mangosteen cultivation technology in agroforestry systems.

The cultivation technologies which applied in the mangosteen-based agroforestry system are erosion control, terrace technique, trimming, fertilization, pest and disease control, and weed control.

Observed variables

The variable observed in this research is the growth of mangosteen (additional plant height, stem diameter increment and the development of secondary branches). Observations were taken at three growth stages i.e. at the age of 1 to 2 years, 2 to 4 year, and ages 4 to 6 years old. Observations were made with 4 (four) replications and each replication were observed in three plant samples.

In addition to plant growth, the research also observed the properties of the soil and the amount of erosion rate at both plants that received the treatment as well as on plants that did not get the treatment. Observation of soil characteristics were taken at three different altitudes (lower, middle and upper sites). Soil erosion was observed soon after the rain during the study (5 months). Observation and measurement of erosion were conducted by making two erosion reservoir units on the field permanently.

Erosion reservoir units created with size of 200 cm X 50 cm X 50 cm. The area catchments were 8 m X 2 m, with a slope of 25 to 30%. To support the observation of soil erosion rainfall during the study was also observed daily.

RESULTS AND DISCUSSION

Site Description

The site of the research situated approximately 10 kms to the south of the City of Sungai Penuh, Capital of the The district of Kerinci, Geographically, these areas are located around the coordinate 101°26'16" BT dan 2°9'10" LS (Figure 1).

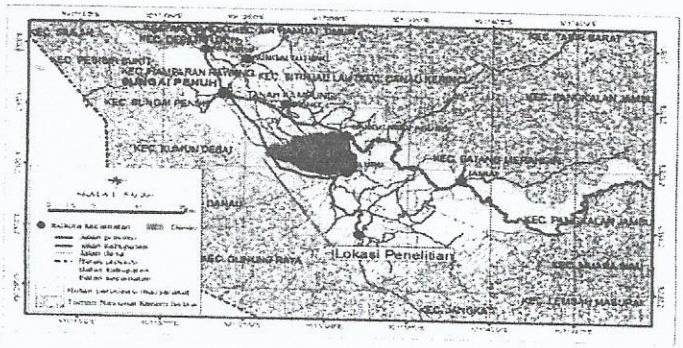

Figure 1. Map of the administrative area of research sites

Mangosteen cultivated area located on the hillside, which is part of the Bukit Barisan. The elevation of the site ranges from 830 to 1025 m above sea level. The highest peak of this hill is approximately 1.5 km from the westside of the site and is about 1580 m above sea level.

The slope of the site varied from a rather flat (8%) which is located in the valley or on top of a ridge, to very oblique (> 40%) which is located in the waist of the hill. But overall this plantation area can be categorized as hilly areas with slopes from 15% to 50%. The area with high slope is highly gravity resultant such that it has great potential to erode, if it is not synchronized with the efforts of conservative management (Figure 2 and 3).

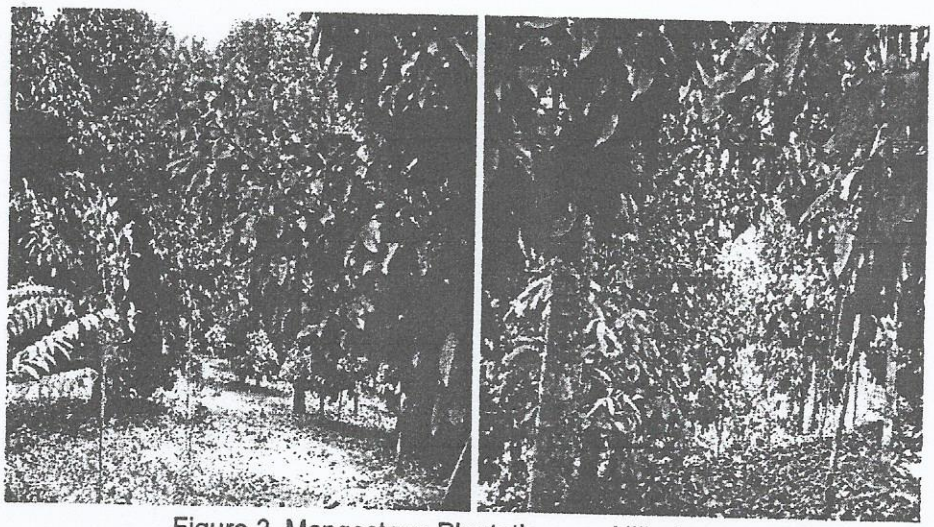

Figure 2. Mangosteen Plantations on Hilly Areas

The length of the slopes of mangosteen planted area is also another supporting factor for the subsistence of erosion that can not be neglected. Based on the elevation difference of highest peak (1580 m) and the lowest (800 m), and the flat distance on the map about 2 kms long, the average slope leght based on Pythagoras formula is 2147 m and the average slope is 780/2000 = 39%. These two factors are major contributors in the calculation of erosion prediction, especially if its

Date	Replication	Measured water volume (Liters)	Measured sediment (Grams)	The mean of erosion per day rainfall (Kgs/ha)
September 13, 2009	2	30	30,00	
October 15, 2009	1	60	120,00	79,69
October 15, 2009	2	45	135,00	
		TOTAL		326,68

Data in Table 2 shows that the rainfall during the research has resulted in soil loss amounted to 326.68 kgs per ha. This value is smaller than the estimates of soil loss per year because the research was conducted during the dry season, where rainfall and number of rainy days is very small. In addition, agroforestry system with a layered canopy reduced the enormity of erosion.

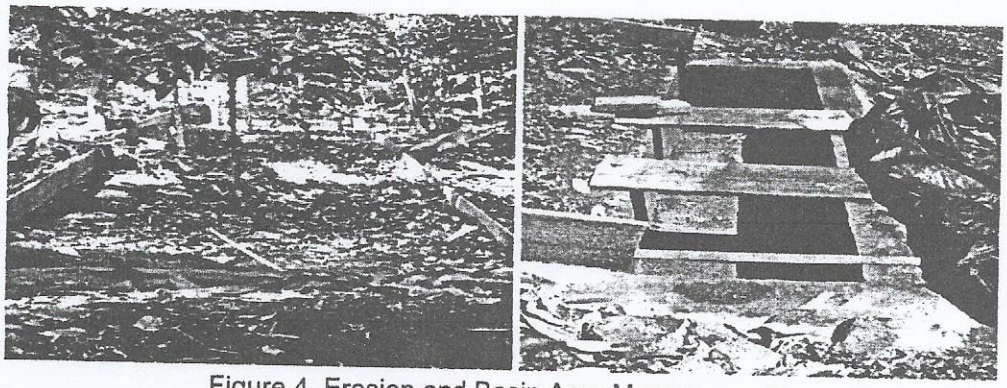

Figure 4. Erosion and Basin Area Measurements

Based on the data of monthly rainfall that occurred during 10 years as shown in Table 3 and the daily rainfall observation, the amount of erosion per year can be predicted by comparing the amount of rainfall during the months of May to October (766.3 mm) of annual rainfall (2046.7 mm), ie 326.68 times 2046.7 devided by 766.3 equal to 872.5 kgs/ha/year.

Table 3. Average rainfall data for 10 years (1995-2004)

No.	Month	Rainfall (mm)
1	January	241,5
2	February	197,9
3	March	230,9
4	April	227,7
5	May	116,5
6	June	103,2
7	July	97,8
8	August	116,1
9	September	109,9
10	October	222,8
11	November	213,0
12	December	236,7
	TOTAL	2.046,7

Erosion hazard index (EHI) is a ratio of the amout of erosion occurred to the amount of the erosion allowed. Based on data from this study, the EHI in the site of study was 0.872 /30 = 0.02 which is categorized as low erosion rate.

Plant Height Growth

The observation of plant height growth was conducted on plant with ages of 1 to 2 years, 2 to 4 years and 4 to 6 years old. The result of the study is illustrated on the table below.

Table 5. The Mangosteen Height Growth (Cm)

Treatment	Age of plants		
	1-2 years	2-4 years	4-6 years
With Fertilizer	11,50 a	10,75 a	43,25 a
Fertilization as Recommendation	18,25 a	23,64 b	36,13 a

Notes: The numbers followed by the same letter do not differ at level of 5% LSD

Fertilizer treatments on mangosteen plants cause changes in plant growth, especially in plants between the ages of 2 to 4 years old. Effect of fertilization on the plant height was significantly different in plants aged 2 to 4 years, whereas in plants aged 1 to 2 years and aged 4 to 6 years showed no significant difference.

On plants aged 1 to 2 years showed that in conditions without fertilizer, the plant height was only increase by 11.50 cms and with added fertilizer reached 18.25 cms. Although statistically not show differences, but based on relative values, the relative plant height was 148.69%, which meant there was an increase in plant height of 48.69%. In 2 to 4 years plants, the height of the plant without fertilizer increased about 10.75 cm, while applying the recommended fertilizer increased the plant height of about 23.64 cm, which meant there was an incremental of plant height about 119.90%.

In the group of plant aged 4 to 6 years, the plant height was increase by 43.25 cms with added fertilizer treatment, while without fertilizer the increase on the plant height was 36.13 cms. This means that the incremental of plant height is about 16.47%, less than that of other group of aged.

From the above enlightenment, it can be conluded that the group of plants of aged 2 to 4 years is relatively more responsive to fertilization. This condition is assumed that the plant with the age of 2 to 4 years is in active vegetative state. While in the age group of 4 to 6 years, the plant had allegedly entered the reproductive phase. This conjecture is supported by information obtained in Thailand reported that the mangosteen only takes 5 to 6 years to reach reproductive phase. Since the agroclimate and land condition in Indonesia is originated from a very fertile volcanic soils, so that the growth rate can be relatively quick (Sunaryono, 1987).

Stem Perimeter Growth

Observation of the mangosteen stem perimeter growth to the plant of age 1 to 2 years, 2 to 4 years and 4 to 6 years presented in Table 6. The data in this table shows that the plant aged 2 to 4 years more responsive to fertilizer in term of the growth of the stem perimeter. The increment of stem perimeter on the plant of the age group 1 to 2 years without applying fertilizer is about 0.90 cms which is no significantly different from those with fertilizer that is 0.96 cms. In the age group of 4 to 6 years without fertilizer, the increment of stem perimeter was about 0.98 cms, and was not difference from those which are fertilized that is 1.35 cms.

Table 6. Plant Stem Fringe Growth (cm)

Treatment	Age of plants		
	1-2 years	2-4 years	4-6 years
With Fertilizer	0,90 a	2,91 a	0,98 a
Fertilization as Recommendation	0,98 a	4,69 b	1,35 a

Notes: The numbers followed by the same letter do not differ at level of 5% LSD

The relative values of each plant age groups are 108.88%, 161.16% and 137.75% respectively for 1 to 2 years, 2 to 4 years and 4 to 6 years. These data indicated that the age group of 2 to 4 years is an age group where the state of the plant was in active vegetative growth period, where the treatment of fertilization could increase stem perimeter greater than the other two age groups of plants, and the highest stem perimeter was 4.69 cms, which was significantly different from those without fertilizer treatment which only increased by 2.91cms.

The Branch Length Growth

Observations on the branch length of mangosteen for plant age of 1 to 2 years, 2 to 4 years and 4 to 6 years are illustrated in Table 7. Fertilizer treatment on the mangosteen plant showed no significant differences to the length of branches in the age group of 1 to 2 years and 2 to 4 years, while in the age group of 4 to 6 years, the length of branches provide a larger and significantly different. In the age group of 1 to 2 years showed that the branches length was not significantly difference between the plant without fertilizer and with fertilizer, that is 5.50 cms compared to 5.63 cms.

Table 7. Added branch plants Length (cm)

Treatment	Age of plants		
	1-2 years	2-4 years	4-6 years
With Fertilizer	5,63 a	2,50 a	4,83 a
Fertilization as Recommendation	5,50 a	3,90 a	11,43 b

Notes: The numbers followed by the same letter do not differ at level of 5% LSD

In the age group of 2 to 4 years, although the difference was not statistically significant but showed no tendency to give the length of branches is higher at plants with fertilizer treatment, ie without fertilizer was 2.50 cms and with fertilizer was 3.90 cms. In this age group there was an increment length of the larger branches on which fostered the improvement of 156% increment.

The length of branches is significantly different between the plants with fertilizer and without fertilizer at the age group of 4 to 6 years. The increment difference between those plants is 136.64%. This difference is supposedly due to fertilizer tends to increase the number of leaves on the plants with the age of 4 to 6 years. Moreover, with the canopy covering each other generates relatively small light intensity on the branches. Consequently, it was expected that the plant would try to adapt to these circumstances by increasing the elongation of branches toward the direction of light, caused by the action of hormones auxin.

CONCLUSIONS

Based on the above discussions, it can be concluded some points as follows:

1. Soil fertility levels at the study sites were low, mainly because of poor nutrient elements of N, P, K, Ca, Mg, and high acidity level of the land.
2. The slope of the land in the study site was 39% on average. Nevertheless, the erosion hazard index of the soil in the study site is low due to low rainfall and lofty land covered.
3. Proper fertilizer application on young plant could increase plant growth. It increased plant height and stems peerimeter at the age of 2 to 4 years, and increased the length of branches on plant at the age of 4 to 6 years.

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