The Analysis of Horticultural Diversification in Koto Tinggi Village, West Sumatera, Indonesia.

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Abstract

This study aims to examine the analysis of horticultural diversification in Koto Tinggi Village, West Sumatera, Indonesia. The first objective of the study is to analyze the factors influencing farmer for choosing their cropping pattern. We analyze it by qualitative analysis and the result is economic factors as the main driver for farmer choosing their cropping pattern. The second objective of study is to analyze factors contributing to diversification. The probit regression shows that gender, age and experience are significant factors contributing to diversification. Finally, for the third objective of the study shows that there is no significant difference between monocropping and diversification in terms of their farm revenue.

Chapter 1. Introduction

1.1 Background of Study

Agricultural sector has important roles in Indonesian economy. According to Soekartawi (2007), this sector contributes 22.3% of the Gross Domestic Product and able to provide about 54% of the labor source. It contributes to the food security so that it can affect nutritional intake and the community as a whole. Agricultural sector can support the industrial sector, both upstream and downstream industries and also contribute for foreign exchange.

Although agricultural sector is important to economic development but smallholder especially in rural area are often considered as a weakness in agricultural development in Indonesia. According to Mubyarto (1989) Referring to international standards, their productions are still considered as fluctuating and low quality products. Economically, the output is mainly to support family needs and most of the production factors and the capital are derived from its own farm. Therefore, improving the welfare of this smallholder is difficult to achieve.

Horticulture, one of agricultural sub sector, has a strategic position in the development of the agricultural sector. Horticultural sector improves in some of macroeconomic indicators, such as Gross Domestic Product (GDP). In 2008 the horticultural sub-sector accounted for about 18.55% of the total agricultural GDP. It also contributes to volume of exports and employment in Indonesia. Even though horticultural sector has contribution in Indonesian economy, but its production still has weakness that can prohibit development of this sector (Badan Penelitian dan Pengembangan Pertanian, 2012).

Horticultural production mostly carried out by smallholders in Indonesia. According to Badan Penelitian dan Pengembangan Pertanian (2012), its production is characterized as follows: cultivated in small scale, the production is depend on the nature, and usually for subsistence production. The production is often using traditional technology, resulting in low production and quality. The harvesting and post-harvest handling are not optimal. The location of production in general is in rural area and often produced in remote area with minimal facilities. Finally, often the farmer diversify their horticultural production in the farm.

Horticultural diversification existed in Indonesia since long time ago. It started with home garden carried out by women. Home garden results in crop diversity and create variety in

the food supply for household. According to Arumsari & Rini (2008) women especially in the rural area has an important role as to diversify the food and maintain food security for the household member. Moreover, Chambers (2007), argues that women plays important role in managing agriculture and are the primary savers and managers of seeds. In Mexico, for example, women cultivate home gardens, with staple crops for culinary processes, fruit trees, and plants that require special care. These women have a unique knowledge of many varieties of plants and their cultivation needs that is important for food security.

Diversification began to evolve in Indonesia since PELITA II[1] (Pembangunan Lima Tahun) in 1974. This program intended to enhance intensification and extensification program with aim to strengthening food self-sufficiency. This program was intended to integrate horticulture and pulses with rice cultivation. However during the implementation of PELITA II, there were a number of inconsistencies in policy and development as a result of rice politics that were dominant. Hence, the vision of diversification never existed (Rusastra, Saliem, Supriati, & Saptana, 2004).

Hoeper (1991) argues that diversification can reduce the probability of total crop failure in farm and enable the farmer use a greater variety of crops or vegetable for daily diet. Furthermore, diversification may reduce or avoid food shortage. By doing diversification, it also may reduce labor peaks and may lead to a labor requirement at farm household level. Finally, an appropriate crop rotation system may stabilize the yields and contribute to the conservation of soil fertility.

However, to the date there has been little agreement on monocropping associated with specialization. Kim, et al. (2012) pointed the reasons of farmer for doing monocropping, a practice of growing a single crop. Monocropping could be as economic incentives influenced by market conditions and government policy, technology and productivity. It can be very productive and sustainable in long term. Another major study from Chisholm (1962) argue the benefit of agricultural specialization asserting that specialization is best suited for climatic and soil conditions in different areas, and thus it could increase the production.

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[1] PELITA (Pembangunan Lima Tahun or Five Years Development) was a government program enhanced the people's lives by increasing production and incomes and changed the colonial economic structure into the structure of the national economy with the opening business opportunities across the economic and social field (Act 85 of 1958).

Based on these two issues, it is important to analyze the reasons of farmer to choose their cropping pattern. Moreover, it is also important to analyze whether their choice has impact on farm revenue.

1.2 Research Questions and Objectives

Koto Tinggi village located in Baso District, West Sumatera, is one of central horticulture. The main horticultural productions of this village are cabbage (*Brassica oleracea)*, Chinese mustard (*Brassica juncea*), and eggplant (*Solanum melongena*). Farmers in this village are doing both diversification farming and monocropping farming. In monocropping, farmers only produce one single crop per farm in a year, in this case, the farmer only produce orange (*citrus sp*). Contrarily, diversification farmer plants two or more crop in a year, in their farm. These farmer produced vegetables product and fruit product in their farm. Hence, in order to analyze horticultural diversification in Koto Tinggi, the research questions of this study are:

1. What are factors determining farmer to choose their cropping pattern in Koto Tinggi?
2. What are factors contributing to diversification in Koto Tinggi?
3. Whether diversification has the impact on farm revenue?

The objectives of this study are: first, to analyze existing cropping pattern. The second is to estimate factor contributing to diversification. The last is to calculat impact of diversification on farm revenue.

1.3 Hypotheses of The Study

According to research questions above, the hypotheses of this study are stated as follows:
1. The factors determining farmer to choose their cropping pattern are economic, socio and environment.
2. Gender, age, education, experience, type of land, type of capital, type of labor and type of fertilizer are contributing to diversity.
3. There is difference of farm revenue between monocropping and diversification farming.

1.4 Organization of The Study

This thesis is organized as follows: chapter 2 provides theoretical and empirical literature review. In this chapter, some horticulture, diversification definition and its measurement will be described. Chapter 3 presents the methodology of the study, for example the resources and different type of data, survey design, data analysis and limitation of the study. Chapter 4 presents descriptive statistics and estimation result as well as describing the factors that influence farmer choosing their crop pattern, factors contributing to diversification and impact of diversification to revenue. Finally, chapter 5 concludes with some policy implication.

Chapter 2. Literature Reviews

2.1 Agricultural Diversification

A considerable amount of literature has been published on diversification. One of them is Robison & Barry (1987) argue that diversification means to develop a larger number of crops or enterprises-mix in farm. It may be the response of subsistence farmers to risk arising from climatic, biotic, economic or seasonal factors. These uncertainties effect the variable returns (farm income) to decision farmers make in particular year. In this current study, we define diversification based on Robinson & Barry definition of diversification. We selected diversification farmers that produce more than one or two crops in their farm within a year.

Diversification according to Ilbery (1991), involve several of resources from production factor such as land, labor and capital which are previously committed to conventional farming activities. Ilbery also argues that regarding to diversification of farm production, it can be good solution for decline of commodity price by adding value to existing commodity export diversifying the same product or promoting. Moreover, diversification can be either structural, including activities oriented outward from the farm towards the public, or agricultural, including activities focused on farming and the various types of farm work (but which are different from traditional farming). While Hoeper (1991), said that diversification of agriculture is way for increasing food security by cultivating several different crop. Due to this condition, horticultural production can improve the yield in long run.

Limbong (1992) compared the advantages of monocropping and diversification, these are: the income of diversification is greater than monocropping and labor requirement in diversification farm is greater than monoculture per hectare due to maintenance of farm diversification is more intensive than the monocropping farming. Finally, the cost production of diversification farming is greater than the cost of monocropping.

Diversification should be followed by intensification of agriculture in order to improve food security at household level. Intensification means using more capital intensive inputs or work more on weeding, observing etc. Under this condition production technique will show result in long term. The low input strategy is considered in order to increase the yield of crop production. There is no contradiction in "intensifying crop production by diversification" (Hoeper, 1991).

According to Barbieri and Mahoney (2009), there are seven different types of diversification, these are: including non- traditional crops, livestock, and/or practices; alternative marketing schemes; tourism and recreation; lease and rental of resources; contract machine services; value-added processing; and preservation, education and consulting services.

There are several factors that need to be considered in diversification farming. Rusastra et al. (2004) in their study stated that the physical condition of the soil is one of the factors needed to be considered. These include the availability of water, soil condition, climate and weather conditions. The commodity sought according to the conditions of soil physical available. Farm conditions also become one of the considerations to farmer for choosing cropping pattern. Households conditions associated with the ability of capital, labor availability, contributions of income from farming, ownership of equipment (irrigation pump), as well as extensive and claim status. The availability of capital, equipment, and land ownership related to the success and sustainability of farming. The contributions of farm income have been implemented to increase farmer revenue.

At the beginning, the reason of farmers to diversify their farm production was to fulfill family basic needs. However, it began to growth over time, farmer more concern to increase their income through diversification. Diversification can reduce crop failure, may reduce labor peaks and may lead to a labor requirement at farm household level and the most important is to increase farm income. In terms of micro level, it is directed to fill demand with goal to reach production surplus (Rusastra et.al., 2004).

In Indonesia, there are two types of agricultural diversification. Horizontal diversification attempts to replace or improve the agricultural monoculture towards multicultural crops. It is on farm level, farmers demanded the freedom to allocate the available resources optimally in accordance with the existing conditions. Vertical diversification is effort to promote industrial agricultural product processing industry. It is primarily intended to increase the value added through processing and product quality improvement. Diversification is required in a linkage other activities both farm level and institutional level, while the regional diversification needs to be based on the principle of comparative advantage (Mubyarto, 1989).

Some studies have revealed about factors influencing farmers to diversify their farm, these are: (1) sustainable income, (2) availability of fertilizers and pesticides that are easy to obtain, (4) an appropriate soil conditions and climate / weather, and (5) reduce pest in the farm

(Tarigan, 1992). The other reason is to reduce production risk. Due to this condition, there are several factors that need to be considered for choosing cropping pattern such price of product, input and availability of resources.

There are some factors that influence farmers to maintain diversity such economic, ecological, political, social and cultural factors. These factors are consistent with those other studies and revealed that population structure and natural selection as an additional factors, come from surrounding environment that important and may themselves be influenced by farmer (Cox and Wood, 1999).

In most recent studies, diversity could determine by some factors. One of study from Rehima et al. (2013) used several variables to determine factors contributing to diversification by using Ordinary Least Square method such characteristic of sample (i.e age, gender, education etc) and the others variable such farms size, labor and also market access. They were some significant variables that contribute to diversity such gender, education that had a positive association with the level of diversification. Contrary to their expectation, the coefficient of trade experience was negatively related to diversification. Furthermore, the social organizations had significant probability to crop diversification. The last is land size that significantly and positively affected the crop diversification decision of the households.

In line with this study, another study of Benin et al. (2004), defined some variables to determine factors of diversity such household characteristics; age, sex of household head, education, household size, oxen ownership, exogenous income. They also adding with farm characteristics; slope of farmland, erosion of farm, fertility of farm, irrigation, farm size, farm fragmentation, number of farm plots, distance from house to farm. The result of this study is socio-demographic characteristics of the household such as the age and sex of the household head, the education of its members, and its size have no significant relation to the diversity. However, farm size have significant influence on diversity associated with greater diversity within as well as evenness in the extent of soil erosion on the. The last is market-related factors have effects to diversity that depend on both the measurement of the factor and the crop.

There are several methods to measure diversity in the farm, one of them is Hill's Diversity Number. It is corresponding to the 'effective species richness', in which rare species are given progressively less weight than common species (Hill, 1973).

The general formula is:

$$N_a = 1 \sum -\sqrt{(a-1)} p_{ai}$$

The second is Simpson's Index. It devises a measure of dominance which could be applied to a large population, and which could be estimated without bias from a sample. This is an unbiased estimator of the dominance index of the population (Magurran, 2004). Two versions of Simpson's index of diversity have been used: either the complement or the inverse of the index of dominance:

$$I_{CompSimp} = 1 - D_{Simpson} \quad \text{or} \quad I_{InvSimp} = 1 / D_{Simpson}$$

In this study we used Margalef's index. Although it does not include any component of evenness, however it easy to maintain and still appropriately used in this study. This index attempts to estimate species richness independently of the sample size. The index will be independent of the number of individuals in the sample only if the relationship between S (or S - 1) and $\ln(N)$ or $\sqrt{N}$ is linear. The indices are:

$$I_{Margalef} = (S - 1) / \ln(N)$$

$$I_{Menhinick} = S / \sqrt{N}$$

Diversification existed since long time ago in Indonesia, as we stated before in introduction part. It began with home garden produced by woman. Arumsari & Rini (2008) argue that in home garden, rural women grow vegetables that are important to household nutrition. Women's roles in crop production are expanding: the out-migration of young men from rural areas in some regions has led to permanent changes in women's responsibilities and tasks.

World Bank in its recent sourcebook on gender and agriculture points out that rural women and men play important roles in biodiversity management. Women and men, depending on their cultural and social backgrounds, perform different roles and have varying responsibilities in agriculture – in crop production as well as crop management. Hence, they have different needs, priorities, and knowledge about diverse crops, plants, and animals. Women are typically involved in the selection, improvement, and adaptation of local plant varieties, as well as seed exchange, management, and saving. They often keep home gardens where they grow

traditional varieties of vegetables, herbs, and spices selected for their nutritious, medicinal, and culinary advantages.

In 1974, Indonesian government promoted agricultural diversification through Pelita II and Pelita IV, in order to increase the supply of various agricultural commodities by improving and expanding commodity diversification for smallholder farming. This program intended to increase the diversity of commodities, especially cultivated horticultural and farming combined with existing farming (BAPPENAS, 2001).

2.2 Horticulture

Horticultural crops are part of the agricultural sector, which includes all types of commodity coverage of non timber plants. It is harvested in short season which has a high economic value and very useful for food security at household level. Horticulture crops cover all types of vegetables, fruits, flowers or ornamental plants, and medicinal plants (Badan Penelitian dan Pengembangan Pertanian, 2005). Horticulture, in a broad definition, according to Acquaah (2002), is activities that involve cultivating, processing, and marketing of fruits, vegetables, nuts, and ornamental plants. In Latin, horticulture derived from *hortus* (garden) and *cultura* (cultivation) means garden cultivation.

Definition of horticultural crops, more specifically, is refers to the understanding of the business world. According to Badan Penelitian dan Pengembangan Pertanian (2005), horticultural crops have highly prospective future such as supply domestic and international markets given the potential market demand both within and outside of the country and a high economic value. Besides, the diversity of soil and agro-climatic characteristics and distribution of a wide area of Indonesia become strength in the development of tropical and sub-tropical horticulture.

The main functions of horticultural crops is not only for food but also related to health and the environment. This simple function can be divided into four, as follows: (1)food supply function; especially in the provision of vitamins, mineral, fiber, energy and other compounds for nutrition, (2) economic function; horticulture, in general, has a high economic value such as source of cash income of farmers, trade, industries, and others, (3) health function; fruits and vegetables can be used to prevent and treat diseases, and (4) socio-cultural functions; the field

can be an element of beauty or environmental comfort, ceremonies, tourism and others. (BAdan Penelitian dan Pengembangan Pertanian, 2005)

There are several horticultural categories that can be divided into some activities. The first is fruit culture, where it is long term operation involved growing, harvesting, processing and marketing. The second is vegetable culture with short duration plants that need to be restarted each growing season. Ornamental culture, usually called ornamental horticulture, is an integral part of branch in horticulture. The last is landscape architecture where the landscape is used for ornamental plants in conjunction with other elements to beauty a given area (Acquaah, 2002).

Horticultural sector in Indonesia, contributes to the national income, as we stated before. The GDP of horticulture from 2004- 2009 period was increasing from over the year. From four horticultural commodities such as vegetables, fruits, medicinal plants and ornamentals commodity, fruits gave higher contribution. Fruits have the greatest production volume in amount of 12,656,031 tons in 2009 (Direktorat Jenderal Hortikultura, 2009).

In Indonesia, There are some of horticultural production systems existed, these are;

1. Home garden; the fruit trees are planted only a few along with other plants such as vegetables, flowers, and medicinal plants in the home garden. Because of the relatively narrow yard and diverse array of existing plants in the yard, then each planted species only grow with few numbers. In the home garden, the fruit trees are usually not reliable as a primary source of income. Therefore, it is often cultivated with less management.

2. Mixed between forest and garden system; fruit trees cultivated outside the village together with other plants. In this system there are usually one or two dominant varieties. This system has less management, so that the production quality usually low.

3. Monoculture systems; one type of horticultural production is cultivated in farm, upland area or wetland drained intensively and well management.

4. Intercropping system between the fruit trees with other crops; the fruit trees are planted accompanied with annual crops in the farm. Indramayu Village in java island, for example, the farmers grown mango in the farm together with rice.

(Zulkarnain, 2010)

Chapter 3. Methodology

3.1 Study site, Data, and Survey Design.

Koto Tinggi Village is the second largest of central horticulture in West Sumatera. This village honored 8 awards from Indonesian government for the national talented horticultural farmers' group. Moreover, Koto Tinggi is one of prospective locations to grow horticultural crops, especially upland horticultural production. It has longitude of 100°29′04′ and latitude 0°17′51′, and the temperature is around 17 - 25°C (Kenagarian Koto Tinggi, 2012).

Koto Tinggi has six *jorong[2],* namely; Koto Gadang, Kubang Pipik, Koto Tinggi, Batu Taba, Sungai Sariak, and Ladang Hutan. The research conducted in these six *jorong* . We selected the sample from the list of population data taken from the UPT (Unit Penilaian Teknis), a government extension agriculture departement. Forty five samples of diversification farmer and forty five samples of monocropping farmers were randomly selected.

Table 1. Type and Source of Data

Detail	Source
a. Respondent Characteristic (age, gender, education, and experience) b. Horticultural production (number of product per farm, capital source, type of landownership, type of capital, type of fertilizer) c. The socioeconomic and environmental factor of farmer.	a. Primary data: • Interview with farmer in Koto Tinggi • Interview with key informan in Koto Tinggi b. Secondary data: • Socioeconomic data • Geography and Demography data

This study used both primary and secondary data. The primary data based on survey by interviewing 90 farmers in Koto Tinggi. Furthermore, interview also conducted for key informant such as government of Koto Tinggi and some experts. The secondary data were taken from Koto Tinggi administration office and some literatures such relevant journals as references for the study. The detail about the data can be seen in the Table 1.

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[2] *Jorong* is the lowest administrative zone under village level in Indonesia, but it does not included in the official division of Indonesian government administration.

3.2 Data Analysis

The first research objective was analyzing qualitative descriptive statistics. This part is intended to explore the factors that influence farmer for choosing their cropping pattern. The interview is done through open question. Then, the raw data was input in the Microsoft Excel. We grouped the result into three factors; economic, social and environmental reasons.

The probit model was used to analyze the second objective of study, identify the factors contributing to diversity in Koto Tinggi. We used a binary choice model based on the method of maximum likelihood is specified. The dependent variable of these models was Farm diversity. Since the dependent variable was dichotomous, OLS cannot be used. The raw data from the survey were processed using Microsoft Excel and Stata 11. The following type of Probit model was used for this study.

$$Y_i^* = \beta X_i + u_i, \tag{3.2.1}$$

Where : $u_i \sim N(0, 1)$, i $\;= 1,.....n$

$Y_i^*\;$ = Farm diversity (if diversification farming = 1; other = 0)

$X_i\;$ = Independent variables (described in the Table 2)

The independent variables were organized into two groups, i.e. household characteristics and Production Factors. The definitions of all independent variables are presented on Table 2.

Table 2. Independent Variables

Name of Variable	Description	Definition
1. Household Characteristics		
Gender (gen)	1 = Women 0 = Men	Gender of respondent
Age (age)		Age of respondent in years
Farmers' Education (edu)	1= High school 0= Elementary	Education of the respondent was measured on the basis of grade.
Farmers' Experience (exp)		Respondent experience in horticultural production in years
2. Production Factors		
Type of Land Ownership (typow)	1= Communal land only 0= Others	The ownership of land used by the respondent to produce horticultural production
Type of Labor (typlab)	1= Family Labor only 0= Others	Labor used by the respondent in farm
Type of capital (typcap)	1= Own Capital only 0= Others	Source of capital to produce horticultural production
Type of Fertilizer (typfer)	1= An organic only 0= Others	Fertilizer used by the respondent in farm

To calculate the level of diversity, we used Margalef index;

$$D_i = \frac{S-1}{Ln\ A_i} \qquad (3.2.2)$$

Where D_i represents the Margalef index of richness, S represents number of horticultural crops grown in the farm, A_i stands for the total area planted to horticultural product (m²) in a year. Margalef richness index (D_i) has a lower limit of zero if the farmer grown only one type of crop.

The last research objective was analyzed by using two independent t-test. This test is used to describe whether there is difference between diversification and monocropping system in terms of farmers' revenue per hectare. This is done by calculating two means (revenue of diversification and monocropping farmer) and compared them to see if one is greater than the other, and by how much.

To calculate the revenue of the farmer we used formula below;

$$Revenue = Production\ (kg)\ x\ Price\ (Rp) \qquad (3.2.3)$$

The hypotheses of the t-test were:

H_o= There is no difference between diversification and monocropping in influencing farm revenue.

H_1= There is difference between diversification and monocropping in influencing farm revenue.

The form of t test can be seen below;

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{S_{\bar{x}_1 - \bar{x}_2}} \qquad (3.2.4)$$

The null hypothesis, will be accepted if the t-statistic is less than the tabulated value. On the other hand, the null hypothesis will be rejected if the t-statistic is greater than the tabulated value at 5% level of significance.

3.3 Limitation

Horticultural activities in this research focus on farm activities, from cultivation preparation to harvest activities. In order to determine diversification famer and monocropping farmer, we only looked to their production from August 2012 to August 2013. Other limitation is we do not calculate the cost of production due to time constraint. Hence, we cannot inform any information about farmers' welfare. This study will use recall method for several horticulture production variables to provide information about the factor that determine the diversity. So, it does not have baseline survey for more accurate result.

Chapter 4. Results and Discussions

4.1 Research Location Description
4.1.1 Geography and Demography Description

Koto Tinggi village is located in Baso district, West Sumatera. It is located on upland area which has altitude of 800 to 1.400 meter above the sea level. Koto Tinggi is in longitude 100°29′04′ and latitude 0°17′51′. The temperature range between 20 to 27 °C and the average exposure per day is between 6 to 8 hours. The average rainfall is 3105.4 mm per year with an average rain a day is 237 mm.

Total area of Nagari Koto Tinggi is about 18.62 km². The Flat with a slope of 0% to 30% is about 8.5 km² (45.8%). Moreover, the choppy with a slope of 30% to 80% is 6.5 km² (39.9%) and the wavy with a mountainous slope of 80% to150% is 2.6 km² (13.9%). Finally, the hilly and mountain with slope more than 150% is 1 km² (5.4%). The detail about topography in Koto Tinggi village can be seen from Figure 1.

This village has latosol and andosol type of soil. The colors of soil are red, yellow and black. Furthermore, the soil pH ranges from 5 to 7 located at an altitude of 900 to1500 meters above sea level with high humidity.

Figure 1. Topography pictures

There are 1920 households in Koto Tinggi. From this numbers, 2.402 men were listed in the population data, while women are 2.342 persons. Most of the household in Koto Tinggi are farmers with number of 1657 farmer households. Their average income percapita is Rp 485.000,-. The main production in this village is horticultural product such as cabbage, eggplant, Chinese mustard, chives and orange.

4.1.2 Samples' characteristics

We interviewed 90 farmers in Koto Tinggi village. From these farmers, more than 40% are in age between 41 to 50 years old as depicated in the Figure 2. This number followed by age between 51 to 60 years old with 30%. The samples dominated by female with percentage of 63% (figure 3).

Figure 2. Percentage of Farmers' age
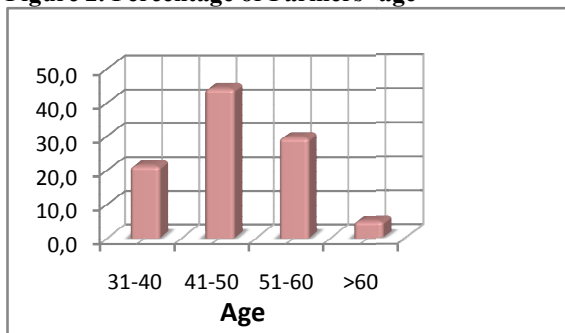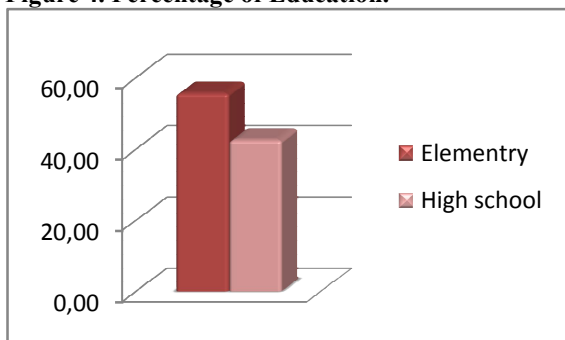

Source: Own calculation

Figure 3. Percentage of Gender
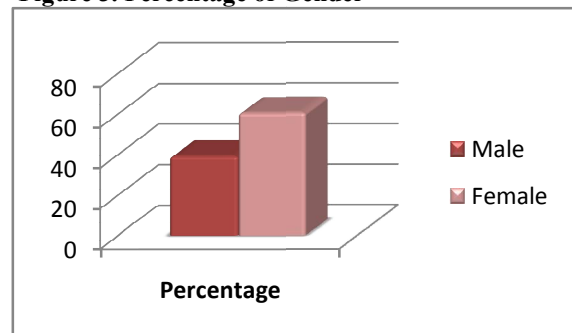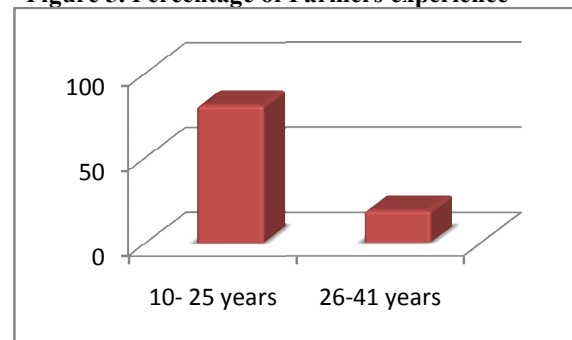

Source: Own calculation

More than 50% of the farmers in Koto Tinggi finished their study in elementary school (figure 4). Furthermore, 43% of the farmers finished their study in high school. Most of the farmers in Koto Tinggi village have experience in horticultural farming for 10 to 25 years. Only 18 % of the farmers are having experience more than 26 years.

Figure 4. Percentage of Education.

Source: Own calculation

**Figure 5. Percentage of Farmers experience**

Source: Own calculation

Most of the farmers in Koto Tinggi having land size between 0,1 hectare to 0,25 hectare dominated by woman (figure 6). In Koto Tinggi village, the agricultural lands are using communal land (figure 7). This land is belongs to the tribes in Koto Tinggi. The leader of the tribe distributes the land to each family. The owner of the land is the woman. The distributions of

the land depend on the number of woman in the family. The woman will get 2 types of communal land, the first is land that they got from their mother. It belongs to the family called *Pusako Tinggi*. The second called *Tanah Kaum* belongs to the tribe, however, men could also be used *Tanah Kaum*.

Figure 6. Percentage of land size
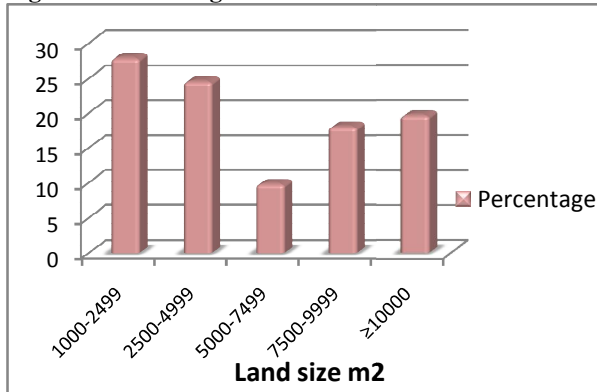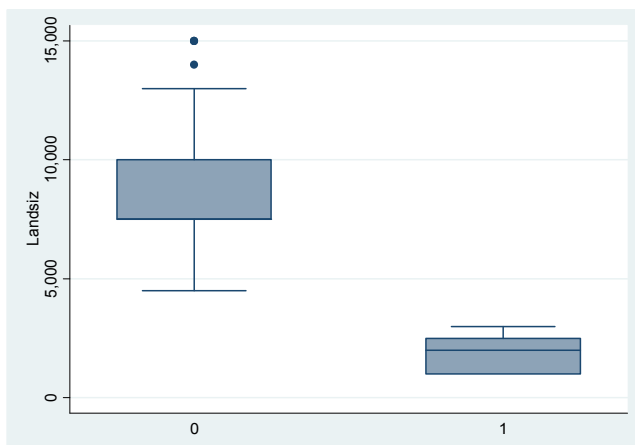

Source: Own calculation

Figure 7. Percentage of Land Ownership
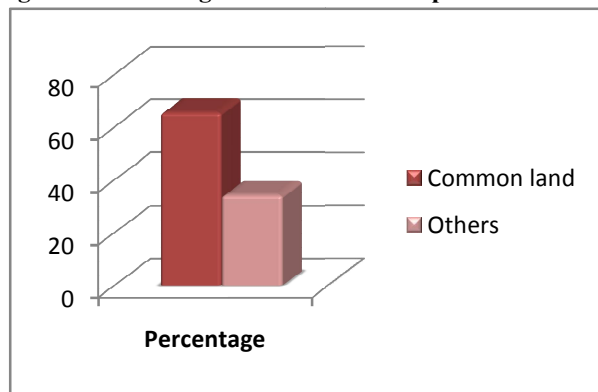
Source: Own calculation

According to figure 8, diversification farmers (one) are having land size below 0,5 hectares. The average land size of the diversification farmers is 0.3 hectares. Monocropping farmers (zero) have land size larger than diversification farmer. The average land size of monocropping farmer is 0.7 hectares. The description about this situation will be presented in the result sub chapter.

Figure 8. Boxplot of land size

Where : 1 = Diversification Farmer
0 = Monocropping Farmer

Source: Own calculation

4.1.3 Horticultural Diversification

The farmer in Koto Tinggi produces vegetable and fruit products. They produced vegetables such as eggplant (*Solanum melongena*), chinese mustard (*Brassica juncea*), snap peas (*Pisum sativum*), chilly (*capsicum annuum*), cabbage (*Brassica oleracea)*, chives (*Allium schoenoprasum)* and the only fruit that they plant is orange (*citrus sp*). Diversification farmers usually diversify their production with some type of the vegetables and some of them diversify their farm with vegetables and fruits. For example, the farmer cultivated cabbage, chinese mustard and chives in their farm within a year. Monocropping farmer only produced orange in their farm.

Diversification farmers produce 3 or 4 products in a year. The main product having more than 4 or 6 month of production period, will be planted first. Then, the crop with short time of production period is planted beside the main product. For example, the farmer cultivates Chilly first, then after two month farmer cultivates chinese mustard accompanied with cabbage. The Chinese mustard will be harvested within 25 days, while cabbage is in 4 month. The productive period of the chilly paper is 6 month, then the farmer changes it with eggplant. Chives are also planted around the Chinese mustard and eggplant. In this farm, Chinese mustard will be cultivated ten times in a year, and cabbage two times in a year. While chilly and eggplant is only one time in a year.

**Figure 9. Level of diversity**
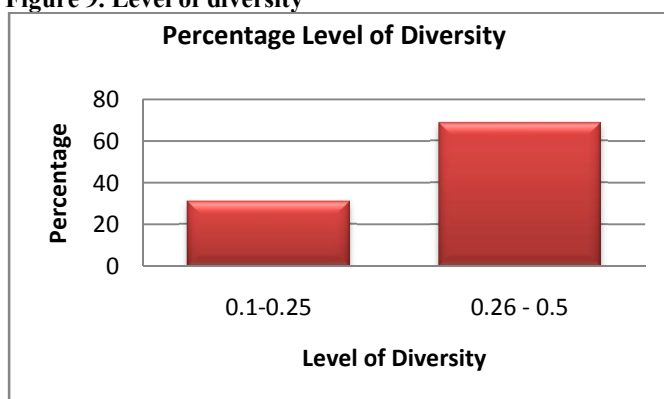
Source: Own calculation

According to Margalefs' formula, level of diversity in Koto Tinggi is between 0.2 to 0.4. The lowest level of diversity is 0,237, while the highest level is 0,434. Most of the farmer is having index between 0.26 to 0.5 with percentage of 69% (Figure 9).

4.2 Results
4.2.1 Factors influencing farmer for choosing cropping pattern

The economic factor is the main factor that influence farmer for choosing their cropping pattern. All of monocropping farmer only answered the economic factor such price and demand of the orange product as the main factor. The price of the orange is quite high in the local market. The price of Grade A, the highest quality, is about Rp. 15.000 per kg, then the Grade B is Rp.12.000 per kg and Grade C is Rp.8.000 per kg. Monocropping farmer also answered technology as the factors to do monocropping farming. The monocropping is easy to obtain than diversification farming.

Figure 10. Percentage of Factors influencing farmer for choosing diversification farming
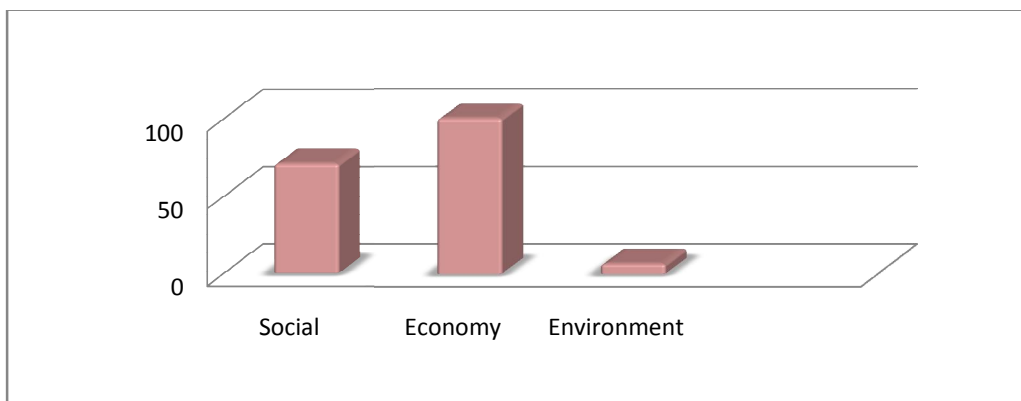
Source: Own calculation

We interviewed 45 diversification farmers. They can answer more than one factor for choosing of their cropping pattern. All of them choose economic factor as main factor for choosing diversification farming. Most of them said that it can increase their income, sustain income all over the year and also as capital source for the next farming.

Some farmers were adding their answer with social factor. They said that diversification farming existed in Koto Tinggi since long time ago. This kind of farming was handed from generation to generation or we can say that it was tradition in their family.

The last factor is environment, only 6 % of the respondent answered this factor. These farmers said that, diversification can reduce the pest during the production period and it can increase their soil nutrition (Figure 10).

4.2.2 Factors contributing to diversification

After we input the raw data into Microsoft Excel and analyzed it with Stata 11, the result for the Pseudo R square was 0.4529. So that, 45% of the variation was explained by the model and the rest was explained by the error. This R square is relatively low because we collected cross sectional data.

Table 3. Factors Contributing to Farm Diversity

Variable	Coefficients	Std.Error	Marginal Effect	z
Gender	.28858	.4742899	.4805275	2.72*
Age	.2948146	.0729777	.1162698	4.04*
Education	.2898879	.4983219	.1134583	0.58
Experience	-.2490215	-.0801263	-.0982098	-3.11*
Land Ownership	.3027462	.4054035	.1191286	0.75
Type of Labor	-.1330817	.4049087	-.0524116	-0.33
Type of Capital	.5184049	.378671	.2016881	1.37
Type of Fertilizer	.317164	.3898475	.1245736	0.81
	-9.31073	2.173372		

Summary Statistics
Number of obs =   90
LR chi2(8)   =   56.51
Prob > chi2   =   0.0000
Pseudo R2   =   0.4529
Log likelihood = -34.127406

Source: Own calculation
Notes: Significant at 10% level

The result from the probit model (table 3) showed that there were 3 independent variables that contributed to the diversity in Koto Tinggi. These three variables are belongs to the characteristic household, gender, age and experience had contribution to farm diversity. The result from gender showed that the probability of women to diversify their farm is 48% on average, *cateris paribus*. This means woman intent to choose diversification farming than man. The age variable showed that if farmer age changes to higher level, *cateris paribus*, then there will be an increasing in the probability to diversify the farm. Moreover, experience had negative coefficient. It means that if experience of farmer in horticultural production changes to higher level, *cateris paribus*, then there will be a decreasing in the probability to diversify the farm.

4.2.3 Diversification impact to farmers' Revenue

T-test for 2 independent samples taken from the Stata result showed that the test is 0.3980. Hence, we cannot reject H_0 hypothesis. There is no difference between diversification revenue and monocropping revenue (Table 6).

Table 4. Independent t-test

Variable	Obs	Mean	Std.Err	Std.Dev	(95% Conf.Interval)	
Revenue of Diversification (per hectare)	45	1.89E+07	165604.2	1110907	1.86E+09	1.92E+07
Revenue of Monocropping (per hectare)	45	1.84E+07	612159.9	4106493	1.71E+07	1.96E+07
diff		5405582.4	634164.4		-732920.2	1814085
Summary Statistics						
t		0.8524				
Satterthwaite's degrees of freedom	50.4058					
Ha: diff !=		0				
Pr(|T| > |t|)		0.3980				

Source: Own calculation

However, according to t-test by Stata 11, the mean of two revenues per hectare is different. The diversification revenue mean is Rp.18.876.000 per hectare. It means that diversification farmer had higher revenue than monocropping farmer, although the range is quiet small (Table 7).

Further analysis for crop combination in Table 5 shows that average revenue for combination of vegetables and fruit is higher than combination of vegetables. The average revenue per hectare of combination between vegetables and fruit is Rp 42.258.723

Table 5. Average Total Revenue for each combination of Horticultural diversification per hectare

Combinations	Average Revenue
Vegetables	17.527.692
Vegetables and fruit	42.258.723

Source: Own calculation

4.3 Discussion

The economic factor is the main factor that influence farmer for choosing their cropping pattern. Both farmers, monocropping and diversification farmers, have economic reasons to choose their cropping systems. Although the specific factors are different each other, for example monocropping farmer answered that price of the orange have strong influence for farmer to do specialization in one crop.

The diversification farmers, intend to choose sustain income all over the year. By doing diversification, the farmer can get additional income while they are waiting for their main crops harvested. The finding of current study is consistent with one of Barbieri & Mahoney (2009) result that the reasons of farmer to diversify their horticultural production are to generate additional farm income and to continue farming, and to enhance their own and families quality of life.

Environmental factor has lower percentage from all the factors, 6% of the farmer answer environmental factors such diversification can reduce pest in farm and also enrich nutrients in the soil. This finding further support the idea from Sidle et al. (2006) that diversification has an impact on environment. Fruits diversify with vegetable grown in upland have limit soil erosion and land degradation.

In terms of their social background, these farmers have more than 25 years of experience in horticultural farming. Furthermore, some of them finished their study in the high school. Although in this study, education is not one of significant variable for diversification, but it could be influence farmer for more care about environment. In other study of Rehima (2013), stated that education is contributing to the farmers' capital enhances the ability to hold new production techniques more rapidly, to seek new information on technology and to meet more complex management requirements of crop diversification.

Turning now to the second objective of study, there are 3 variables contributing to diversification. Regarding farmers' characteristic, women are intent to produce diversification product. We interviewed some key informants and they said that diversification farming often done by women due to the culture. Woman often grow some kind of horticultural product in their home garden. Most of them applied it in their farm. So, they called diversification farming is women's job. The men intend to grow tree product because they said that it is more challenging than vegetables product. This current study is consistent with other study from Kimhi & Chiwele

(2000), indicated that female-headed households adversely affected the crop and barley variety diversification in Zambia and Tigray.

The second variable is age that has a positive influence on diversity. The older is intent to have diversification farming than the younger. This finding further support the idea of Anderson & Gugerty (2013), that the head of household and plot decision-makers were slightly older in diversification households compared to monocropping households, although the magnitude is not very large, but it has contribution to diversity. Similar result also revealed by Gauchan, et al. (2005), age had significant factors explaining rice diversity. The result had positive sign that older farmers are more likely to allocate rice area more equally among varieties. This might be due to their experience in farming and they are not as receptive to adopting and specializing in a single modern variety.

The results of the experience variable revealed that the increasing of farming experience will decrease the probability to farm diversity. It means that experienced farmers more likely to do monocropping farming as compared to less experienced farmers. Contrary result with the finding of Ashfaq et al. (2008), experience has signififant influence to diversity. The coefficient result showed positive sign. Hence, the experienced farmer intended to do diversification farming in their farm.

We did not include land size into the variable of Probit model due to some problem with during the analysis. However, if we analyze more detail from the Figure 8. The diversification farmers were having smaller land size than monocropping farmers. This finding do not support the previous research from Benin et al. (2004) and Abay et al. (2009), said that farm size has a positive impact in diversity. The large farm may enable farmer to multiple their crops. This current result might be implied that probably because of sizable farm land demands more management skill and inputs, due to this condition farmer may not be able to produce multiple crops.

Koto Tinggi village has a matrilineage system as most people in West Sumatera. "Descent and descent-group formation are organized according to the female line. A lineage possesses communally owned properties, including agricultural land, houses, fish ponds, heirlooms, and miscellaneous adat. In principle, ancestral property (*harta pusaka*) is inalienable and there is no individually owned property, particularly property of an immovable nature"(Tsuyoshi, 1978).

Most of diversification farmers are using communal land. Communal land in Koto Tinggi called *Babingkah Tanah* means all lands in the Koto Tinggi had been divided for each tribes that exist in these villages. Based on the principle of communal land, the communal land only owned and used by the people in each tribe and it will owned by women who had been married. Due to this condition, land size owned by each farmer is quite small. As you can see before in farmers' characteristic sub chapter, more than 50% of diversification farmers have land size below 0,5 ha. Regarding this problem, monocropping farmers that want to increase their production have to rent the land from others.

If we now turn to the third objective of study, the result shows that there was no different of revenue between monocropping farmer and diversification farmer. However, if we focused on the mean result, the revenue of diversification farmers is higher than monocropping. We did not calculate the cost of production, hence we cannot conclude anything about farmers' welfare. However, some studies revealed about the comparison of diversification and monocropping in term of their benefit. Kim et al. (2012) stated in their study that diversification benefits are positive but it is not significant for Korean rice farmers. The other study is from Anderson & Gugerty (2013), there is a difference between diversification and monocropping in terms of their productivity per hectare although statistically it is not significant. The land productivity of Intercrop plots was $436 per hectare, higher than monocropping plots at $383 per hectare.

Based on the result of Table 8, the highest revenue of diversification farming is vegetable and fruit combination. There are many factors that influence this result. Vegetable crops have shorter period production than tree product. So, the farmer could harvest it several times in a year. While orange fruit only have two harvest seasons in a year but the price of this product in market is quite high. From this result we can imply that vegetable and fruit combination is one of the best ways to increase farmers' revenue. The careful choice of the crops is essential to provide maximum exploitation advantages in diversification farming.

Chapter 5. Conclusions and Policy Implications

5.1 Conclusions

Based on the result of this research, we can conclude that;

1. Economic factor is the main driver to farmer for choosing their crop pattern. Monocropping farmer choosing to produce orange because of its price in the local market is quite high. While diversification farmer intended to have sustain income all over the year.

2. There are three factors contributing to diversity. The first was gender, women intended to produce diversification product than man. The second is age, the increasing of age level will increase the probability to diversify the farm. The older farmers have more diversification level than younger farmer. Finally, the experience, the increasing of experience level will decrease the probability to diversify the farm.

3. There was no different of revenue between monocropping and diversification farming. However if we look up to the mean result, diversification revenue was higher than monocropping revenue. The higher combination of diversity is between vegetables and fruit.

5.2 Policy Implications

1. In order to increase diversification crop pattern practices, economic incentives may be offered to farmer in Koto Tinggi Village.

2. The contribution of females on crop diversification needs policy attention on promotion and empowerment of females in order to increase their diversity in the farm.

3. Although there is no deference between monocropping and diversification in terms of their revenue. But, the combination of fruit and vegetables product has higher revenue among others, so that we need to promote this combination for development of diversification farming. However, it still need further research in order to give positive impact on farmers' welfare.

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Appendices

Appendix 1. Stata Output of Factor Contributing to Farm Diversity

a. Probit Model

```
Probit regression                              Number of obs   =         90
                                               LR chi2(8)      =      56.51
                                               Prob > chi2     =     0.0000
Log likelihood = -34.127406                    Pseudo R2       =     0.4529
```

div	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
gen	1.28858	.4742899	2.72	0.007	.3589887	2.218171
age	.2948146	.0729777	4.04	0.000	.1517809	.4378483
edu	.2898879	.4983219	0.58	0.561	-.6868051	1.266581
exp	-.2490215	.0801263	-3.11	0.002	-.4060661	-.0919769
landow	.3027462	.4054035	0.75	0.455	-.4918301	1.097322
typlab	-.1330817	.4049087	-0.33	0.742	-.9266882	.6605247
typcap	.5184049	.378671	1.37	0.171	-.2237767	1.260586
typfer	.317164	.3898475	0.81	0.416	-.4469231	1.081251
_cons	-9.31073	2.173372	-4.28	0.000	-13.57046	-5.050998

b. Marginal Effects

```
Marginal effects after probit
     y  = Pr(farmdiv) (predict)
        = .56025852
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
gen*	.4805275	.15296	3.14	0.002	.180729	.780326	.633333
age	.1162698	.02773	4.19	0.000	.061922	.170617	47.2111
edu*	.1134583	.19307	0.59	0.557	-.264944	.49186	.411111
exp	-.0982098	.0307	-3.20	0.001	-.15839	-.038029	23.6222
landow*	.1191286	.15892	0.75	0.453	-.19235	.430607	.533333
typlab*	-.0524116	.15926	-0.33	0.742	-.364558	.259735	.533333
typcap*	.2016881	.14402	1.40	0.161	-.080583	.483959	.466667
typfer*	.1245736	.15135	0.82	0.410	-.172068	.421215	.5

Appendix 2. Pictures of Horticultural Diversification in Koto Tinggi

a. Hortikultural Diversification

b. Monocropping

c. Interview with farmers in Koto Tinggi

Statutory Declaration

I herewith declare that I composed my thesis submitted independently without having used any other source or means than stated therin.

Date: Signature: