Muresk Institute of Agriculture
Curtin University of Technology

Farm Productivity and Farmers' Welfare in West Timor, Indonesia

Fredrik Lukas Benu

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DECLARATION

I hereby declare that this submission is my own work and, that to the best of my knowledge, contains no material previously published or written by another person, or material which to a substantial extent has been accepted for the award of any other degree of a university or other institute of higher learning, except where due acknowledgment is made in the text. I certify that, to the best of my knowledge, any help received in preparing this thesis and all sources used have been acknowledged.

ABSTRACT

This study examines agricultural productivity and farmers' welfare in West Timor, Indonesia. The driving force behind this study is to understand why the welfare of farmers has lagged behind others despite significant growth in the agricultural sector. The main research problem in this study is that while agricultural production has increased significantly in West Timor, the welfare of farmers has not increased as fast as that of non-farmers. To reduce the gap in income between farmers and non-farmers, the growth of income of West Timor's farmers, as the indicator of their welfare, has to accelerate at least as fast as the growth of non-farmers' income. This target might be achieved if there is an appropriate policy of agricultural development implemented by the government. For this reason, evaluation of the structure of agricultural production, as well as the welfare of the farmers of West Timor, is an important issue that needs to be addressed.

This study analyses the structure of agricultural production and the welfare of farmers in West Timor An econometric method (Three Stage Least Squares) was used in modelling the agricultural system to evaluate the structure of the agricultural production as well as farmers' welfare in West Timor. A simultaneous equations model which consists of eight structural and four identity equations was constructed for the analysis of the structure, the estimation of elasticities from the regression coefficients and the subsequent policy analysis. The data used for the analysis are secondary data published by the Indonesian government. All data used in the model were time series data from 1979 to 1998 and gathered in the period between January and July 1999.

The results of this research found that technical factors such as water availability, pasture capacity and irrigation channels influence the production of agriculture more than economic factors such as the price of products and cost of inputs. Too, population growth and the availability of socio-economic institutions such as cooperatives at the village level, have a significant influence on the agricultural production. Although technical factors influence the production of agriculture more than economic factors, subsequent policy analysis shows that an increase in agricultural credit as well as a reduction in the cost of production will still have a

positive impact on the production of agriculture. A policy to increase the price of agricultural commodities at the farm gate, especially the price of live cattle and rice, will increase the profit of farmers, further motivating them to increase their overall production. There are six scenarios of the policy alternatives that are simulated in this study. These are: (1) the scenario of a 10 per cent increase in the size of irrigated areas, (2) the scenario of a 10 per cent increase in the amount of credit, (3) the scenario of a 35 per cent decrease in total cost per hectare of maize cultivation, (4) the scenario of a 10 units increase in the number of cooperatives, (5) the scenario of a 10 per cent increase in the price of live cattle at the farm gate, and (6) the scenario of a 10 per cent increase in the price of rice at the farm gate.

The results of the policy analysis found that the largest positive impact on the agricultural sector output as well as farmers per capita income is derived from the scenario of a 10 per cent increase in the size of irrigated area. The scenarios of increasing amount of agricultural credit and the number of co-operatives have also generated a large positive impact on the agricultural sector output, but with a high increase in farmer population growth. Two other scenarios that have a large impact on the agricultural sector output as well as farmers' per capita income are the scenario of a 10 per cent increase in the price of live cattle and the price of rice.

Based on the results of the policy analysis, two main policies that might be undertaken by the government to promote the growth of the agricultural sector and farmers' per capita income are expansion of irrigated areas and improving farmers' access to agricultural credit.

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CHAPTER 1

INTRODUCTION

This chapter outlines the background, the objectives, and the significance of the research. Section 1.1 presents the role of agriculture in economic development in general, especially in Indonesia, and also presents the role of the agricultural sector in the macro-economic development of West Timor. At the end of this section, some issues with respect to both the agricultural practices and the welfare of farmers in West Timor are presented.

Section 1.2 outlines the main objectives of this research, while section 1.3 presents some outcomes that are expected be derived from the research, especially with regards to the contribution to knowledge, local people (farmers) and the regional government of East Nusa Tenggara (NTT) province The chapter ends by presenting some conclusions with respect to the background goals, and significance of the thesis. The final section also outlines the structure of the whole thesis.

1.1. Background

1.1.1. The role of agriculture in economic development

Since the beginning of the regime of president Soeharto (1969), the Indonesian government has adopted a Five Year Development Plan (*Pembangunan Lima Tahun*) as the basic short-term development strategy. For the long term, the government decided on the 25 years from 1969 to 1993 as the first long-term development strategy. This means the economic development of Indonesia is now in the second period of its long-term development strategy. According to Falcon (1996) the consistency of the policy of economic development resulted in a decline in the incidence of poverty from 70 per cent to 15 per cent between 1970 and 1995. Contributing factors during that period were: (i) a high level of political support from a president who was concerned about farmers and food policy; (ii) a good and predictable macroeconomic environment, where there were continuity of policy and personnel; and (iii) Indonesia concentrated on the right kind of growth for the countryside, with technology incentives and investment in roads, irrigation, rural health and education.

At the beginning of the second long-term development phase (1994), a new direction on the development strategy for Indonesia was put forth. According to Saragih and Krisnamurti (1993), the structure of the economic development of Indonesia could be changed from an emphasis on the agricultural sector to one based on the industrial sector supported by a significant increase in the agricultural sector. According to De Rosa (1995), despite the steady pace of its industrialisation and some significant reserves of mineral fuels and ores, Indonesia is still a heavily agrarian-based economy, with cultivation and exports devoted in large measure to tropical agricultural commodities and related products. Saragih (2000) predicted that the agricultural sector would still provide a great contribution to economic growth in Indonesia. This prediction was based on the fact that; (i) agro-industry (i.e., industry in agriculture) has good potential for development in Indonesia because it can be supported by a steady supply of raw materials; (ii) agricultural commodities have better competitive advantage than the other commodities of Indonesia in the global market, (iii) the agricultural sector still covers a large proportion of the labour force, so it will make a significant contribution to the Gross Domestic Product of Indonesia (GDP); and (iv) the development of agro-industry is expected to reduce the income inequality between farmers and non-farmers.

There are five important guidelines for the economic development of Indonesia as stated in the guidelines for the direction of the state of Indonesia (*Garis Besar Haluan Neragara* 1999-2004). These are: (i) global-oriented economic development in accordance with the development of technology to create competitive advantage based on the comparative advantage of an agrarian country; (ii) development of a policy of industry, trade and investment to create global competitive power and equal opportunity employment either for all regions or for all labour forces; (iii) to endeavour to improve the efficiency and productivity of small and medium enterprises as well as cooperatives; (iv) to improve the food security system for the people, based on the biodiversity of the food resources, institutions and the local culture; and (v) to accelerate the effective regional economic development by providing good opportunities for the local economic actors. El-Said *et al.* (1999) in their simulation analysis of three alternative policies for Indonesia, found that an agricultural demand-led industrialisation policy is associated with a larger Gross Domestic Product (GDP) increase than the other development strategies. This policy emphasis is based on the assumption that the demand for agricultural products is the driving factor in the industrialisation process in agriculture. This industrialisation process will bring some new entrants either to the lower-end of agriculture (production and distribution of seeds, fertilisers, pesticides, machineries, etc.) or to the upper-end of agriculture (i.e., post harvest and marketing industries). The two other alternative policies for Indonesia are the food processing-based policy and the labour-intensive light manufacturing-based policy (Said *et al.* 1999).

The unfavourable agro-climatic and edaphic conditions in some regions in Indonesia will hamper the implementation of the industrialisation policy in agriculture (Djoeroemana *et al.* 2000). One of these regions is West Timor, which is a part of East Nusa Tenggara (NTT) province of Indonesia.

According to Djoeroemana *et al.* (2000), with agriculture as the basis of NTT's economy, the most appropriate strategy for the development of NTT's economy is to make agro-industry the major motor of growth. KEPAS (1986) presents case studies from around the province that show increasing market orientation. A better communication system and improved access to consumer goods and services have increased the demand for cash crops. However, the intensive management of major cash crops is a new phenomenon in much of the region and problems both in their cultivation and marketing are common.

Agricultural and rural development objectives can be met by a wide variety of policy instruments which can be imposed directly at the farm level (production subsidies, food procurement), the national border (trade instruments, exchange rate), or at some other point in the market (price instrument, public investment).

According to van Kuelen *et al.* (1998), agriculture was regarded in most developing countries during a substantial part of the post-war period, as instrumental for and subordinate to urban and industrial development. Although van Kuelen *et al.* (1998) mentioned the role of agriculture, especially "on-farm" agriculture as an important sector in economic development, they did not mention the contribution of "off-farm" agriculture neither upper-end nor lower-end in the economic development of developing countries. Off-farm agriculture can be identified as all of the agricultural activities before and after the cultivation process. Off-farm agriculture covers the process of production and distribution of seed, fertiliser, pesticides, tractors, etc. at the lower-end of agriculture, as well as the post harvest and marketing at the upper-end of agriculture. According to von Braun *et al.* (1994), commercialisation of the rural sector is considered a cornerstone of successful economic development (see also Rola-Rubzen and Hardaker 1999, Djoeroemana *et al.* 2000 and Saragih 2000)

According to Kuyvenhoven *et al.* (1998), although the rate of expansion of agricultural output is usually lower than for most other economic activities, a rapid increase in productivity is required in order to improve rural incomes and maintain food supply for the urban population, raw material supplies for agro-industrial development, and cash crop production for export earning and taxes. A rapid increase in agricultural productivity can be achieved if there is a proper policy framework that offers appropriate incentives to farmers to improve productivity in a sustainable manner.

Rola-Rubzen and Hardaker (1999) cited reasons why agriculture should be made an integral part of a development strategy in less developed countries (LDCs). These are (i) the agricultural sector provides the supply of raw materials that may be used in industry; (ii) the agricultural sector provides food for a rapidly increasing population, (iii) higher rural incomes raises the demand for manufactured goods; (iv) a buoyant and secure agricultural sector increases the demand for non-farm goods and services and helps create jobs in non-farm activities; (v) non-farm activities in agricultural regions expand quite rapidly in response to agricultural development; (vi) non-farm activities supply a range of goods and services to agriculture and the rural population, thereby contributing to the growth of agricultural output and the improvement in living conditions in rural areas; (vii) income is generated, which can be invested in the farm or non-farm sectors and (viii) rising agricultural productivity allows labour to be released gradually for employment elsewhere as industrialisation proceeds without the negative effects on food production or price.

1.1.2. The role of agriculture in the economic development of West Timor

Agriculture is the sector which absorbs most of the labour force in West Timor. The average proportion of people employed by this sector was about 81.7 per cent in 1985, decreasing to 77.9 per cent in 1996 (Statistical Office of East Nusa Tenggara Province of Indonesia 1997). This means that the proportion of people who work in the agricultural sector has decreased by approximately 0.34 per cent per year on average between 1985-1996. However this proportion increased again in 1997 (79.1 per cent) because of the economic crisis. Although the proportion of people working in the agricultural sector decreased, it still covers a significant proportion of the labour force, as the rate of decrease (proportion of labour force) is slow. Meanwhile the agricultural sector output of West Timor (based on the constant price 1993) had increased from Rp. 96.70 billion in 1985 to Rp.380.85 billion in 1996. This means the output of the agricultural sector of West Timor increased by approximately 24.48 per cent per year on average between 1985-1996. The productivity of food crops increased from 2.7 tonnes per hectare in 1985 to 3.4 tonnes per hectare in 1996, while the productivity of tree crops also increased from 0.4 tonnes per hectare in 1985 to 0.6 tonnes per hectare in 1996 (East Nusa Tenggara in Figure 1985-1996).

West Timor has a dryland type of agriculture. Rainfall in this region is limited to three or four months of the year. Although the agricultural activity in West Timor is limited by a long dry period (eight or nine months of the year), the agricultural sector of West Timor provides a large contribution to the economic development of this region. According to the statistical report published by the local government (Statistical Office of East Nusa Tenggara Province of Indonesia 1998), the contribution of the agricultural sector to the Gross Domestic Regional Product (GDRP) of West Timor is about 43 per cent in 1998. Almost all regencies (except Kupang where the agricultural contribution is 18 per cent) still contribute significantly to the agricultural sector of the total GDRP of West Timor. Sub-regencies that have a large agricultural sector contribution to the total GDRP are Timor Tengah Selatan (54.8 per cent in 1998), and Timor Tengah Utara (51.3 per cent in 1998). This description shows that the agricultural sector still makes a significant contribution to the economic growth of almost all regencies in West Timor.

An important question is what is the economic position of the actors in this sector (farmers), who have given a large contribution to the economy of West Timor? What is the difference between the welfare of the farmers and the other economic actors (non-farmers) of West Timor?

One of the economic indicators that might be used as a proxy of welfare is income. The distribution of this indicator represents the distribution of welfare among economic actors. According to Basu (1994) income distribution may be justified as a measure of welfare distribution if one assumes that income represents welfare (IRW) and equal income between individuals means equal welfare. In the period 1980 – 1998, the average growth of farmers' per capita income (real income) was about 11.4 per cent per year. At the same time the average growth of non-farmers' per capita income (real income) was approximately 20 per cent per year (East Nusa Tenggara in Figure, 1980-1998).

Sutomo (1995) in his study of poverty and economic development in East Nusa Tenggara Province of Indonesia (West Timor is a part of East Nusa Tenggara province of Indonesia) found that there is a change in the economic structure of this province from the primary sector to the secondary sector, so that employment opportunities have moved from the agricultural sector to the non-agricultural sector. Labour in the non-agricultural sector (urban areas) has a higher wage/salary than that of the agricultural sector (rural areas) because of skill differentiation. Furthermore, although there is an increase in the income of labour in the non-agricultural sector as well as in the agricultural sector, there is a big difference in the rate of increase, so that the distribution of income is still very unequal.

Benu *et al.* (2002), in their research of the agribusiness development in rural area of NTT (including West Timor), found that there were a huge difference between the price of some specific agricultural products at the farm gate and the price at the consumers level. The margin of price of maize was about 20 per cent, while peanut was more than 50 per cent, and orange was about 20 per cent. At the same time, Barlow *et al.* (1990) found that the cost of the marketing operation of cattle estimated in the early 1980s was approximately 28 per cent (including 5 per cent taxes) of the Jakarta price for a 300 kg beast prior to slaughter. According to this source, a farmer producing a fat beast in West Timor accordingly receives some 72 per cent of the Jakarta return. The difference between the price of the agricultural products at the farm gate and at the consumers level indicates the difference of income between farmer and non-farmer.

If level of education is a proxy for peoples' welfare, it might be understood that the farmers' welfare is lower the non-farmers' welfare. Data published by the central bureau of statistic shows that there are 20.4 per cent

1.1.3. Agriculture and the welfare of farmers of West Timor

Shifting cultivation and free grazing of livestock have been practiced for generations and are still extensively practiced today in West Timor. These agricultural systems may cause environmental degradation that now needs attention, but they are also the only sound alternatives for a region where topography, soil and rainfall limit the development of permanent agriculture. According to Mudita (2000), the solution of the problem of environmental degradation is not as simple as forcing peasant farmers to adopt some sort of intensification without a clear understanding of the underlying ecological principles. Furthermore, Mudita (2000) stated that despite much criticism, it seems that the policy of agricultural development in the region still lacks understanding of the ecological principle.

Research conducted by the Canadian International Development Agency (CIDA 1980), found that farmers in West Timor, from generation to generation, have carried out a traditional agricultural production system of shifting cultivation. This system is mostly at the subsistence level where the main orientation is to provide food for the family. Ataupah (1991) stated that the productivity of shifting cultivation is generally very low and fluctuates from year to year depending on the precipitation and the level of fertility of the cultivated area. Furthermore, the chief concern of farmers in this production system is with subsistence rather than the level of productivity.

The welfare of farmers can be evaluated using several criteria, such as per capita income, the level of education, life expectation, purchasing power, and calorie consumption. Even the amount of public transportation and hospitals accessed may be used to evaluate the welfare of farmers. However, this study only deals with per capita income as the indicator of welfare since it faces the problem of the availability and continuity of the other indicators at the regional level. Some of these indicators are published either at the provincial level or at the national level only. For example, the indicator for the level of education is published for the last five years only. In addition the indicator for life expectation is published based on the census data collected every five years, and the indicator for calorie consumption, as well as the amount of public transportation are published either at the province level only or without a classification for urban and rural communities. Section 4.4 of this study presents some information on the indicators for welfare, as well as the techniques that have been used by the Indonesian government to draw the poverty line as an indicator of the living standards of Indonesia. This section also contains the justification of using income as the indicator of welfare. By understanding that description (section 4.4), it can be concluded that the problems of income representing welfare will be raised if we deal with the issue of welfare distribution in a particular society. In other words, the view that income represents welfare is acceptable if we only deal with the growth of welfare under the assumption that there is an over-supply of labour in the labour market, and that people will always try to increase their income by reducing their leisure (Basu, 1994).

According to Lecaillon *et al.* (1984) the various factors accounting for inequality of incomes among various communities can be classified as economic, political or social. Highest ranked of the economic causes in income differences is the difference in productivity between agricultural and non-agricultural sectors. Lecaillon *et al.* (1984) further stated that such wide differences in productivity are due to the backwardness of production techniques in the traditional agricultural sector and differences in such factors as the quantity of capital per worker, the level of education and skill, the development of the economic infrastructure and of public services, the proximity to sources of supply and to markets which are the pull exercised on entrepreneurs, capital and labour and opportunities to expand economic activities. Lastly, inequalities between urban and rural areas can result in deterioration in the terms of trade for the agricultural sector. When the quantity of agricultural produce required for the acquisition of a particular quantity of non-agricultural product increases over the years, the purchasing power of farmers diminishes relative to that of town dwellers.

Although the revenue of the farmers of West Timor that can be predicted from the trend of the price of the agricultural products increased during the period 1980-1997, the increase in the price of non-agricultural commodities was higher. In the period 1980-1997 the average growth in the price (real price) of rice was about 7.7 per cent per year, maize about 12.3 per cent per year, coconut about 6.7 per cent per year and coffee about 8.1 per cent per year. In this period, the average growth in the price of soap was about 11.6 per cent per year and kerosene was about 11.5 per cent per year. At the same time, the average growth in the price of textiles was about 14.6 per cent per year and cement was about 14.2 per cent per year. However, according to Bautista (1999), maintaining the relative price of agricultural products is not likely to be the best policy choice if the promotion of comparative advantage and efficiency of domestic resource use is an important policy objective. It may serve other objectives such as promoting self-sufficiency and income protection for producers, etc., but the cost of such a policy with regards to income and welfare can be high.

If level of education is a proxy for the welfare of people, the level of West Timor farmers' welfare in this regard is also lower than non-farmers'. Data published by the Central Bureau of Statistic in 1998, show that 20 per cent of people in rural areas in NTT (including West Timor) were illiterate. At the same time, only 8.7 per cent of people in urban area were illiterate. If the welfare condition is determined by the size of the dependency ratio, the same source also indicates that the average dependency ratio in rural areas was about 70.3 (each 100 productive labour covers 70 non-productive labour) compared to 54.5 in urban areas.

As the data on income distribution are not available at the regional level, the distribution of income between urban and rural areas might be understood from the labour productivity in agricultural and non-agricultural sectors. Research into man-power planning in NTT (University of Widya Mandira, 2002) found that the labour productivity in the agricultural sector in 2002 was about Rp. 0.8 million, while the average labour productivity in non-agricultural sectors (mining, quarrying, industries, manufacturing, etc.) was about Rp. 6.8 million.

The average growth of food crops production was about 7.8 per cent per year in the period 1980-1998. Because of the growth in production of the agricultural commodities in this period (1980 – 1998), the average growth of the agricultural sector output was about 16 per cent per year and the average growth of farmers' per capita income (real income) was about 11.3 per cent per year. At the same time, the average growth of tree crops production was about 5.9 per cent per year, while livestock production was about 8.8 per cent per year. In the period 1980-1998, the average growth of the non-agricultural sector output of West Timor was about 22 per cent per year and the average growth of non-farmer's per capita income (real income) was approximately 20.4 per cent per year (see Figures 1.1 and 1.2). Although this figure is not too bad, if the average growth of farmers' per capita income (real income) is still below 20.4 per cent per year in the same period, cumulatively, it will accelerate unequal income distribution between farmers and non-farmers.

According to Lecaillon *et al.* (1984), in developing countries, the difference in average income between industries or services are generally less marked than the disparity between agriculture and non-agriculture activities, which is the principal factor in urban-rural inequality. In the early stages of development, that distinction largely tallies with the distinction between the traditional sector and the modern sector. It reflects structural dualism of the economy, which is held to be one of the fundamental causes of the general inequality of incomes.

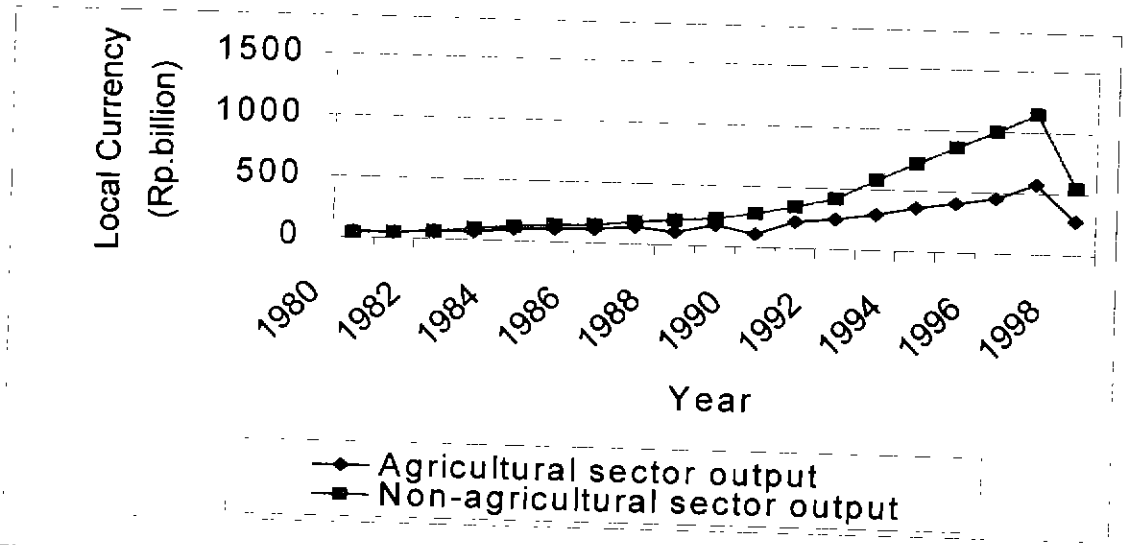

Figure 1.1. Trend of the Output of Agricultural and Non-Agricultural Sectors
Source: Statistical Office of Nusa Tenggara Timur Province of Indonesia, 1975-1998

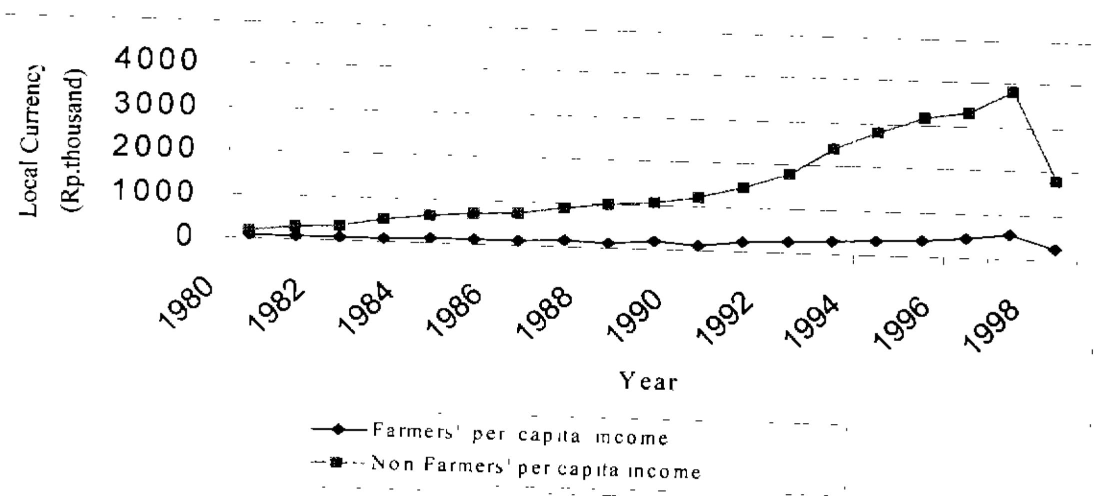

Figure 1.2. Trend of the Per Capita Income of Farmers and Non-Farmers
Source: Statistical Office of Nusa Tenggara Timur Province of Indonesia, 1975-1998

According to Kravis (1960) in Lecaillon *et al.* (1984) the differences in degree of inequality may be attributed to differences in people's characteristics affecting their performance in the economic field; to legislative or customary obstacles to social mobility; to structural factors accounting for highly differentiated and unequally remunerated types of work; and to socio-political organisation. In his classic 1955 paper, Kuznets advanced the theoretical conjecture that a nation's income distribution became less, rather than more, egalitarian as its level of development increases. According to Kuznets, the growth will bring more equality after a nation has passed some threshold level. Further, he stated that the evolution of income distribution follows an inverted U-shaped curve meaning economic expansion results in relatively more inequitable distribution in the initial stages of a nation's development, and relatively more equality at advanced stages.

In recent years however, the classic Kuznets hypothesis has come under attack (Adelman and Robinson 1989, Anand and Kanbur 1993, and Vanhoudt 2000). Adelman and Robinson (1989) and Anand and Kanbur (1993) have documented evidence suggesting that there is little empirical support for Kuznets' claim. Furthermore Vanhoudt (2000) found that the unsatisfactory empirical result for a typical Kuznets' regression is possibly due to the fact that the level of per capita GDP may not be a sufficient measure for the level of development. According to him, per capita income is endogenously determined by economic fundamentals.

Based on the descriptions above, it seems that the problem in agricultural development in West Timor is that the agricultural production has increased significantly, however, the welfare of farmers has not increased as fast as that of non-farmers. Although there is a shift in the economic structure of West Timor (from a high contribution of the agricultural sector to a high contribution of the non-agricultural sector), it does not mean that an unequal distribution of income between farmers and non-farmers is acceptable.

The growth of farmers' income (an indicator of their welfare) has to be accelerated as fast as the growth of non-farmers' income to eliminate the gap in income distribution. This target might be achieved if there is a proper policy in agricultural development that could be run consistently by the local government. For this reason, the evaluation of the structure of agricultural production, as well as the welfare of the farmers of West Timor, becomes an important issue that has to be addressed. A problem in respect to that issue is finding out what are the factors that have affected the structure of agricultural production, as well as the welfare of the farmers in West Timor. To answer this question, it is important to address the technical, economic, social, and policy factors that have simultaneously influenced the structure of the agricultural production as well as the welfare of farmers of West Timor.

1.2. Objectives

The objectives of the research are:

1. To describe the structure of agricultural production and farmers' welfare in West Timor.
2. To determine the technical, economic, social and policy factors that have influenced the structure of agricultural production as well as the welfare of the farmers of West Timor.
3. To examine the effect of possible policy scenarios of either the central government or the local government in agricultural production as well as the welfare of the farmers in West Timor.

Because there are various factors that have determined the structure simultaneously, econometrics will be considered as an integral technique for providing a numerical value for the parameters of the relationship and for verifying economic theories. Some variables that might have a relationship with the variable of agricultural production, as well as farmers' income (used as the indicator of farmers' welfare), will be derived from the review of theories as well as *a priori* knowledge to construct the specific model.

Accordingly, the formulation of the assumptions that will be tested in the analysis are (i) the production of agriculture in West Timor is determined by the prices of commodities, amount of credit, the price of production input, population, rainfall, cost of production, the size of irrigated area, harvested area, productivity, number of cooperatives, interest rate, per capita income, total output per sector, and total consumption, (ii) the per capita income of farmers in West Timor is determined by the level of inflation, total production per commodity, the prices of commodities, sex ratio, number of family planning clinics, total output per sector and population. All of the endogenous variables as well as the predetermined variables in the assumptions have been selected from the review of theory as well as *a priori* knowledge. The detailed review of these variables can be followed in section 4.2, section 4.3 and section 4.4 respectively.

1.3. Significance of the Study

This research determined the technical, social, economic, policy and marketing aspects that have influenced the agricultural production as well as the welfare of farmers of West Timor. This research also examined some policies that could be conducted by the local government to increase agricultural production, and the welfare of the farmers of West Timor. This study provides information to policy makers (especially the local government of East Nusa Tenggara) about the technical, economic, social and policy factors (in particular, the agricultural development and farmers' welfare program) that have influenced the structure of agricultural production as well as the welfare of farmers of West Timor. This research also provides information to scientists who are interested in agricultural development and farmers' welfare issues, particularly in Indonesia.

1.4. Concluding Remarks

The role of agriculture in Indonesia, especially in West Timor, is presented at the beginning of this thesis. There are two main phenomena; on one hand the production of agriculture has increased significantly in the last 25 years as the main contributor of the economy of West Timor, on the other hand farmers' welfare has not increased as fast as the increase in the welfare of non-farmers. Using income as an indicator of welfare, the growth of farmers' income has to be accelerated to eliminate the gap in income distribution. This target might be achieved if there is an appropriate and targeted agricultural development policy that could be run by the local government. For this reason, the evaluation of the structure of agricultural production, as well as the welfare of the farmers of West Timor, becomes an important issue that has to be addressed. The important question that will therefore be addressed in this research is what are the factors (technical, economic, social, and policy) that have influenced the structure of the agricultural production as well as the welfare of farmers of West Timor. The study was conducted to describe the structure of agricultural production and farmers' welfare and to examine the effect of policy alternatives on the agricultural development of West Timor.

Accordingly, a review of the theoretical background of agricultural and economic development is presented in Chapter 2. Chapter 2 contains information about some of the factors that determine the change in agriculture and per capita income. It also describes growth as a function of capital, labour input, the productivity of capital as well as labour, political and economic institutions, and government policies.

A description of agricultural development in Indonesia, particularly in West Timor is presented in Chapter 3. Chapter 3 contains information about some policies in Indonesia, especially in East Nusa Tenggara province, a short description of West Timor history, the general economic structure of West Timor, the contribution of the agricultural sector to the economic growth of West Timor, the demographic conditions and the economic crisis Indonesia. This chapter also contains information about agricultural production and marketing systems, as well as some major constraints to development in West Timor.

A review of research methods is presented in Chapter 4. This chapter contains the review of literature about approaches to modelling agricultural systems, the econometric method, the partial equilibrium model, the agricultural production function and the agricultural demand function.

The discussion about the choice of research methodology is presented in Chapter 5. This chapter includes assumption statements, a presentation of the structural equation, the analytical procedure, the process of data collection and the validation of the model.

Chapter 6 presents the result of the model estimation, the interpretation of the structural analysis and the interpretation of the elasticity coefficients. Chapter 7 presents the result of the validation and simulation of the model and the discussion of the simulations results.

The summary of the research is presented in Chapter 8. Conclusions of the research and some policy implications are also given in Chapter 8, along with identification of areas for future research.

CHAPTER 2

REVIEW OF ECONOMIC AND AGRICULTURAL DEVELOPMENT

2.1. Introduction

This chapter contains a review of economic development, especially in relation to the agricultural sector. Factors considered important in the analysis of agricultural economic development are presented. These factors can act either as an accelerator or as a decelerator of economic growth.

Section 2.2 presents a review of the meaning of development in general. It contains information about the theories of economic development. Section 2.3 presents the three main determinant factors that have to be considered in the economic development process. Section 2.4 presents a review of the role of agricultural development as a stepping-stone to success in economic development, and Section 2.5 presents some aspects that should be considered in agricultural development. Section 2.6 presents the concept of welfare and the concept of per capita income as an indicator of welfare. Section 2.7 contains a conclusion of this review of economic and agricultural development.

2.2. The Meaning of Development

In early attempts at constructing development theories the concepts of development and economic growth were considered to be synonymous (Blomstrom and Hettne 1984). This is why many economists played a major role in constructing development theories. Blomstrom and Hettne (1984) stated that the earliest modern theory of development was purely economic and based upon a simple model of growth, in which capital formation was the key factor.

In the history of economic thought there have been three distinct phases that have influenced the theory of development. First, the classical theory which was dominated by Adam Smith, David Ricardo, Thomas Malthus and Karl Marx. Adam Smith provided a thorough discussion about the causes of increasing productivity, which he related to the division of labour and the size of the market. Malthus is best known for his treatment of the problem of population growth, while Ricardo provided an analysis of the distribution of production among the various classes in society, and of how this distribution in turn affects economic development. Karl Marx, the last of the classical figures, qualifies as a classical economist despite his dissident views about the social desirability and future of capitalism (Combs 2001). Marx espoused a theory of value based on the cost of production. He contributed to the notion of stages of development – feudalism, capitalism, socialism and communism. In Marx's theory, the relationship between production and consumption is the most basic statement of the fundamental *law of social reproduction* (Kay 1975). Marx was not optimistic about capitalism or the importance of technological change in development. He argued that workers wage would be driven down to subsistence level by labour-displacing machinery and that only the capitalists would reap the surplus from production. These pioneers of the classical economic theory laid the foundation of the development of economic theory. The popularity of the classical, or labour-surplus, school of development economics arose out of a belief by a large number of economists that wholesale application of neoclassical economic theory to developing countries would lead to a misunderstanding of these countries and to inappropriate policy recommendations (Zarembka 1972).

The neoclassical economic theory was developed to replace the classical theory, because the last one failed to explain the phenomena of development with a long-term perspective. The neoclassical theory is focused on static, microeconomic relations and the main issue was how the market mechanism could optimally distribute the resources in society. However, according to Myint (1987), the consensus in the 1950s was that the problem of economic development was essentially "dynamic" and could not be satisfactorily considered in terms of the "static" neoclassical theory of resource allocation. It was also believed that economic development would not take place simply by relying on market forces, but needed development planning to push through massive investment programs.

This theory, however, has also come under attack by the Keynesian theory. According to Brohman (1996), there are three principal areas of criticism of neoclassical economics. First, the neoclassical theory is static and is focused on allocation of given resources, while development problems are dynamic and should concentrate on increasing resources through stimulating savings and investment. Whereas a 'big push' is needed to initiate the development process, neoclassical theory offers only marginal adjustment and piecemeal improvements to market forces. The second criticism is that the neoclassical models neglect structural rigidities common to developing countries that prevent markets from responding to price changes in the 'normal' theorised manner. Such rigidities might range from the sociological (e.g., 'irrational' peasant responses toward economic incentives) to the more technical (e.g., limits to labour or capital-intensiveness under differing historical conditions). Third, the neoclassical emphasis on development based on comparative advantage and free trade is inappropriate to the late industrialisation of the south. Direct static losses from state intervention to support industrialisation may be more than offset by dynamic gains (e.g., external economies associated with technological change and improved skills, linkages with other economic sectors, long-term benefits from promising 'infant' industries). Unlike the nineteenth century, export-led growth is no longer a viable option. Countries must turn to an alternative 'engine' of growth such as import-substitution, industrialisation or balanced internally-oriented development between agriculture and manufacturing.

The Keynesian theory focuses on macroeconomic problems. John Maynard Keynes contributed this theory after the classical and the neoclassical theory failed to explain the problem of depression and high unemployment in the industrialised countries (Brohman 1996). Keynes argued that aggregate demand and its various components (consumption and investment) were of strategic importance. An increase in expenditure which, in turn, will increase aggregate demand would eventually lead to increase in the level of economic activities and a decrease in unemployment. According to Brohman (1996), growth theorists turned steadily toward Keynesianism, doubting the ability of the neoclassical approach to translate its microeconomic theory based on individualised, short-run decision making, into a dynamic, macroeconomic theory for the long-term development.

These three theories of development, however, did not explain the strong relationship between an economy's rate of growth and its level of saving and investment. Consequently, the 'rate of growth' model of Harrold and Domar became the basis for modern growth theory, in which saving and investment are considered to be the central force behind economic growth.

Until the Harrold and Domar model influenced the development theories in the 1950s, economists saw no difference between 'under-developed' and 'developed' countries. The problem of underdevelopment was therefore characterised as being one of shortage of knowledge that has to be explained in the theory of development.

In the late 1950s, Walt Rostow released his doctrine of the stage of development to explain the difference between 'developed' and 'under-developed' countries. Rostow argued that basic sequences or stages of growth could be detected in the historical record (Gatrell 1988) According to Rostow, as cited by Blomstrom and Hattne (1984), there were five stages through which all societies had to pass in order to reach a self-sustaining economic growth. They are (1) the traditional society; (2) the pre take-off stage; (3) take-off stage; (4) the road to maturity; and (5) the society of mass consumption. Streeten (1979) called Rostow's doctrine of development as "a linear path" along which all countries travel. According to Rostow, a less-developed country (LDC) was simply a latecomer, whose current level of development was analogous to a stage of development that had already been experienced in Western Europe, especially England.

According to Gatrell (1988), there are other development theories that were also raised independently of Rostow. Most notably, Kuznets and Chenery wrestled with the issue of extrapolating from the experience of industrial countries, especially England, to the prospect for change in LDCs during the 1960s. Chenery's cross-section regression analysis of a large sample of national economies in the 1950s and 1960s led him to identify correlations between income per head and a range of development variables. Thus, given levels of income were associated with specific shares of primary and secondary sectors in total output, and with the composition of industrial output (Chenery 1960). To Chenery's further comment that such cross-section associations could also provide an indication of historical patterns of development, Kuznets responded with profound scepticism, noting the implicit assumption that the economic structure of presently developed countries was in their pre-development past like that of the less developed countries today (Kuznets 1966).

Kuznets acknowledged the possibility that 'modern economic growth' in LDCs could exhibit structural similarities to economic growth in developed countries. However, he argued that there were major dissimilarities between contemporary LDCs and developed countries on the eve of their modern economic growth. Chief among these were the probability that per capita product in LDCs was at lower level than in developed countries in their pre-industrialisation phase; the probability that agricultural productivity in LDCs was lower than it had been in what were now developed countries; and the differences in culture and social organisation. For these reasons, the LDCs cannot be expected to follow the pattern of presently developed areas, which had entirely different conditions at the beginning of the development process.

Lewis (1955) claimed that an under-developed country's economy was dual, i.e., that it consisted of two sectors – one industrial and the other agricultural. In Lewis's development model, the agricultural sector serves as a labour reserve for the industrial sector. The latter is thus capable of expanding, due to this 'hidden capital-reserve', until the labour surplus in the agricultural sector is used up.

According to Blonstrom and Hattne (1984), the subsequent theoretical development may be seen as an attempt to fill the gap between fact and theory. The problems of population growth were noticed first; the concept of capital was expanded to include health care and education; attitudes and institutions were brought into the theoretical discussion; the political factors were eventually given the important position they deserved. Furthermore, Blomstrom and Hattne (1984) stated that the entire process of theoretical development implied a dramatic end to the narrow, economic, model-oriented view that had influenced the earlier discussions of development theory. An increasing number of disciplines were included, and development theory has gradually grown to a more independent and interdisciplinary field of research.

Nowadays, development is seen in evolutionary perspective, and the state of development defined in terms of observable differences between rich and poor countries. Development implied the bridging of these gaps by means of an imitative process, in which the less developed countries gradually assumed the qualities of the industrialised nation. The task of analysing the qualities to be imitated was shared between economists, sociologists and political scientists, so that some specialised in economic structures, others in human attitudes, social institutions and political development.

Some economists now concentrate on the strategy of development to accelerate the growth and industrialisation especially in third world countries. According to Brohman (1996) throughout the post-war era, nearly all mainstream development strategies have called on the majority of third world countries to exploit their 'comparative advantage' in cheap land and labour by expanding exports of agricultural goods and other primary commodities. The 'agro-export' production did expand rapidly during the early post-war period in the third world, becoming a 'motor' for outward-oriented development. But many analysts now contend that a number of inherent contradictions have gradually played themselves out during recent years to render the 'agro-export' model, at least in its classical form, dysfunctional to future third world development (Brohman 1996). At the same time, however, many third world countries have few realistic alternatives to 'agro-export' production in the short to medium term, especially to earn foreign exchange necessary for economic stability. On the contrary, some industrial countries such as the USA and Australia, have dominated 'agro-export' production in the world to earn foreign exchange for their macroeconomic stability. Thus, a debate is now being waged over whether to retain 'agro-export' production as a major axis of development and, if so, what form would be suitable for third world countries to accelerate their development.

In the 1970s, economic development came to be redefined in terms of the reduction or elimination of poverty and unemployment within the context of a growing economy. In the new economic view, development must be conceived of as a multidimensional process involving major changes in social structures, popular attitudes, and national institution, as well as the acceleration of economic growth, the reduction of inequality, and the eradication of absolute poverty (Todaro 1990). The comparative advantages in terms of resources, especially in third world countries have to be exploited in a manner of increasing economic growth as well as reducing inequality and poverty.

Recently, economists have raised the issue of natural resources degradation as a key factor that has to be considered in the process of development (Vosti 1992). According to these economists, 'sustainable development is a process of development that has to give a chance for the next generation to have the benefit of the natural resources'. Thus, degradation of natural resources is a cost that has to be calculated in the process of development. The World Commission on Environment and Development (WCED), as cited by Turner *et al* (1994), defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Trainer (2000) introduced the concept of 'sufficient development' as an alternative development model to overcome the problem of absolute poverty in third world countries. In his concept, Trainer argues that it is totally impossible for third world people to rise to the living standards typical of rich countries. According to him, if all people in the world today were to rise to the per capita levels of production and consumption typical of the rich countries, world resource consumption would be about five times as great as it currently is. If the nine billion people expected on earth soon after 2060 were each to have the living standards of rich countries and if the average economic growth is three per cent per annum, world economic output would then have to be a hundred times what it is now. By citing Wachernager and Rees (1995), Trainer (2000) emphasised that if all people today were to have present rich world per capita food, settlement area, water and energy consumption, the area of productive land needed would be three to four times the total productive land area of the planet. For the expected nine billion people, the multiple would be five to six. Furthermore, Trainer (2000) stated that when the capacity to provide good water and housing has been developed especially in rich countries, then further development of these things (good water and housing) is unnecessary. Therefore, it can be said that the development in rich country is enough ('developed enough'), because there are many other people, especially in the third world, who still need the conventional development process by using the same quantity of resources on the earth to provide good water and housing.

The problem with this concept of development is that conventional development economists cannot make any sense of the term 'developed enough' and cannot comprehend that any region could ever be 'over-developed'. According to Trainer (2000), to the conventional development economists even Los Angeles and New York are not close to having had enough development. Indeed, the only thing the conventional economists recommended for solving the enormous problem of these cities is more development. Only if there is an increase in investment, production and consumption, tax revenue, etc., can the conventional economists see any way of accumulating the 'wealth' necessary to devote to the problem (Rostow 1950, Lewis 1955, Chenery 1960, Kuznets 1966, etc.).

Based on the perspective of development described above, it can be seen that there are many definitions as well as approaches to the theory of development which are characterised by different backgrounds and point of views. There are some other economists who basically support the conventional theory of development especially economic development. Seers (1972) stated that development means creating the conditions for the realisation of human personality, reducing unemployment and reducing inequality. While Pomfret (2000), argued that one component in modern economic growth is accelerated growth in per capita income, there is also structural transformation, such as the changes in the scale of the technology of production and shift of production from agriculture to other activities. However, according to Chenery and Syrquin (1986) the transformation is by no means uniform across countries. It is affected by resource endowments and the initial structure of the economy as well as by the choice of development policies.

Income distribution and structure are both part of the common understanding of economic development. For Pomfret (2000) there is a practical difficulty as soon as more than a single criterion for judging economic development exists. However, Lewis (1995) provided the most cogent defence of the use of per capita gross national product. He recognised the limitation of any single policy objective, but the case for putting increased output as the prime goal is that it gives humankind greater control over the environment, thereby increasing freedom.

The most important recent contributions on this debate are associated with Sen, as cited by Pomfret (2000), who emphasises the role of capabilities and entitlements. In his emphasis on capabilities, Sen includes education and health. These two indicators should be viewed as ends in themselves, because they directly increase people's capability to control their own lives. They should not just be seen as inputs to achieve higher living standards. Moreover, aggregating education and health spending with other goods and services to measure GNP is misleading. Furthermore, Pomfret (2000, p.3) stated that:

> *'Increased capabilities may be better captured by indicators such as literacy rates or life expectancy (as a reflector of communal care and public provision of health services) than by higher per capita incomes. Capabilities and access to material goods are determined by entitlements. Income plays a big part in determining entitlements, but it is not everything'.*

Another major issue in the theory of development, especially in economic development, is the importance of government intervention. Followers of the new Keynesian and the new classical hypothesis have long debated whether the government should or should not intervene in economic development. With regard to specific government functions and activities in the market economy, Adam Smith, as cited by Liou (1998), emphasised three duties of government: (i) protecting the society from violence and invasion by other societies; (ii) establishing an exact administration of justice; and (iii) erecting and maintaining certain public works and institutions. From the public finance perspective, Musgrave and Musgrave (1980) mentioned three functions of government: (i) the allocation of social and other goods that the market will not provide; (ii) the equitable distribution of income and wealth; and (iii) the stabilisation of unemployment and control of inflation. According to Ball and Mankiw

(1999), in the new classical hypothesis, government intervention should not exist once it is believed that: (a) inflation is more costly than unemployment; (b) the short-run Phillips curve is quite steep; (c) the economy's self-correcting mechanism works smoothly and quickly. This theory is based on the assumption that the economy has a basic rationale that maximisation for firms, individuals and markets is always clear. In the new Keynesian hypothesis, government intervention is important because it is believed that: (a) unemployment is more costly than inflation; (b) the short-run Phillips curve is rather flat; and (c) the economy's self-correcting mechanism is slow and unreliable (Ball and Mankiw 1999).

Ball and Mankiw (1999) in their comment about 'the new Keynesian theory and the output-inflation trade-off' concluded that strong evidence exists for the new Keynesian model and by implication, against the new classical model. However, Katsimbris and Miller (1996) conclude that: (i) evidence recently emerged to support the new Keynesian hypothesis with the pooled data; and (ii) when examining the issues on a country by country basis, there is a weak support at best for both the new Keynesian and the new classical models. Further, Asai (1996) found no evidence to support the new classical hypothesis, but found evidence for the new Keynesian model.

Generally there are two models that are usually practiced by policy makers in approaching development. The first is the conservative approach, which tends to emphasise taxing and spending that is helpful to investment and business. Conservatives advocate increasing investment through lowering taxes on the upper income brackets and lowering capital gains tax (Nagel 1998). Conservatives also advocate spending for highways, airports, railroads and other expenditures that will facilitate business profits. The second approach is the liberal approach which tends to emphasise taxing and spending that is helpful to consumption and workers. Liberals advocate increasing consumption through lowering taxes on the lower income brackets and raising exemptions for dependents and the standard deduction. Increased consumption is expected to stimulate economic growth. The liberal approach also advocates government spending for food stamps, housing vouchers, welfare, teacher salaries, health care and other government expenditure that result in high consumption

(Nagel 1998). The conservative approach of decreasing the money supply and increasing interest rates may decrease inflation but increases unemployment. Raising interest rates to decrease inflation may have the effect of decreasing prices by reducing spending from borrowed money. Those benefits may be more than offset but the undesirable effects include reducing the ability of business to borrow for expansion, inventory and other purposes. The reduction in spending may also have an adverse effect on employment. Raising taxes and decreasing spending to fight inflation may not be politically feasible. It would also reduce the ability of the government to give tax breaks and well-placed subsidies to increase productivity.

The liberal approach of increasing the money supply and decreasing interest rates may stimulate employment, but increase inflation. Lowering interest rates to decrease unemployment may have little impact because businesses are reluctant to borrow when they are reducing their operations and sales are down. Likewise, consumers are reluctant to borrow when they are already heavily in debt and fearful of a reduction in employment. This approach may not be politically feasible when the national debt and deficit are already too high.

A win-win approach might be taken to reduce inflation as well as unemployment by increasing the adoption of new technologies and raising the skill of workers. The approach may be used to help reduce inflation by (i) increasing the productivity of labour to offset increased wages, (ii) increasing the quality of goods to offset increased prices; and (iii) increasing the GNP and domestic income. A win-win approach might also be taken to help reduce unemployment by (i) making the workers more employable; (ii) increasing the GNP and domestic spending to stimulate the creation of more jobs; and (iii) increasing the productivity and wage rates thereby offsetting a possible reduction in hours.

It can be concluded that a moderate perspective of development that could be followed by policy makers to fulfil the goals of increasing growth, reducing poverty, improving equality, and rescuing resources are:

(i) Development, progress and improving welfare are essential in increasing the amount of goods and services available to people. Therefore development entails increasing the volume of production for sale by increasing investment in production, plant and infrastructure.

(2) Capital is a prerequisite for investing so that it is necessary to borrow, seek aid, save from earnings, and welcome foreign investment. Probably the best way to accumulate capital for some countries is by facilitating growth of export capacity.

(3) The more production increases, the more tax income the government will be able to spend on education, welfare, public facilities and the environment. However, exploitation of resources to increase production should be done in a suitable manner to take account of future generations.

(4) The effect of 'trickle down' of wealth to enrich all people is not a guarantee for improving equality. Therefore, development has to deal with the problem of how to share the resource capacity of the earth to increase living standards and improve equality either among people in a country or among countries in the world.

2.3. Determinants of Economic Development

The major factors in, or components of, economic growth in any society are: (i) capital accumulation, including all new investment in land, physical equipment, and human resources; (ii) growth in population and thus, although delayed, growth in the labour force; and (iii) technological progress (Todaro 1990). Devinney and Kirchner (1997) in their article "Perspectives on Growth: Implications for Asia, Australia, and New Zealand" note that, according to the additional approach, growth is a function of four factors: the level of capital stock, the level of labour input, the productivity of capital and the productivity of labour. However, Chenery *et al.* (1986) stated that the growth of capital, labour and productivity are of comparable importance for a sample of a study as a whole but vary significantly with the structure of an economy and the effectiveness of its policies.

2.3.1. Capital

Capital is the first determinant factor that could act as an accelerator in the process of economic development. Seers (1979) stated that there is a simple belief central to the whole tradition that increases its logical attraction, namely that capital investment ("accumulation" in Marxist jargon) is overwhelmingly the most important determinant of economic growth. Consequently, the generation and allocation of savings are seen as the mainsprings of development. According to Pomfret (2000), the emphasis on capital formation as the key to economic growth means that, at the start, governments would be involved in mobilising savings. If increased savings are not a sufficient condition for economic growth, investment is still helpful and probably a necessary condition for economic development. Pomfret (2000) further states that increased emphasis on the profitability of capital, as opposed to its amount, and on investment in human capital (via education and vocational training) as well as physical capital (buildings, machinery, and equipment) does not overturn the conclusion that increased investment will raise per capita output. According to Bernstein (1973), there is a whole catalogue of means applied in various proportions in different countries, which provide the resources necessary for substantial productive investment. A substantial productive investment, according to Bernstein, is an investment, which is large enough to achieve the "take-off" from stagnation to intensive development.

2.3.2. Population growth

Population is also a major determinant of economic development. Population (human capital) is important in economic development, but it might also create obstacles to economic development. In human resources development theory, a growing population with lack of skills is a burden on economic growth and may be an obstacle to technological change. During the 1950s, when development economists emphasized physical capital formation and saw surplus labour in agriculture, increased population was viewed as a threat to economic growth (Pomfret 2000). That is why McNamara (1973), the former World Bank President, as cited by Pomfret (2000) stated that "the threat of unmanageable population pressure is much like the threat of nuclear war."

Cuthbertson and Cole (1995) said that until 1987, assessments of the evidence available on the link between population growth and economic development determined that there was no basis for suggesting that a rapid rate of population growth retarded economic growth. A more recent assessment has concluded that the balance of emerging evidence indicates that there may be a negative relationship between population growth and economic performance (Kelley 1988). Furthermore Kelley (1988), as cited by Robinson and Srinivasan (1999), suggests that the opposing view has three essential aspects. First, population growth may have positive as well as negative aspects. Second, both direct and indirect linkages are important in connecting population and economic growth. Third, several problems typically attributed to population are due largely to other causes such as health and education, and lack of infrastructure. A recent study by Kelley and Schmidt (1988), cited by Robinson and Srinivasan (1999), also found evidence of a negative relationship between the rate of population growth and per capita income growth. These authors found that this effect is much more pronounced for developing countries and is, in fact, even sometimes positive for developed countries.

Economic growth, however, is not only influenced by the growth of population, but also by other important components in population growth such as fertility, mortality and migration. These different components of population growth, as well as absolute size of the population, might be recognised since they may have an effect on economic growth (Barlow 1998). For instance, despite rising incomes, rapidly expanding population in many developing nations, mean that income had to be divided among many more people (Anonymous 1997). Thus, despite a higher economic growth rate in many poorer countries, the actual gap in per capita income between rich and poor countries has widened in the last decade. Fields (1989) and Tanzi (1998), as cited by Schwatz and Ter-Minasian (2000), suggested that economic growth is necessary for reduction of absolute poverty. However, it may not be sufficient to improve the distribution of income.

Todaro (1990) stated that if development entails the improvement in people's level of living (income, health, education, and general well-being) and if it also encompasses their self-esteem, respect, dignity, and freedom to choose, then the really important question about growth is (Todaro 1990, p. 87):

> *'How does the contemporary population situation in third world countries contribute to or detract from their chances of realizing the goals of development, not only for the current generation but also for future generation? Conversely, how does development affect population growth?'*

2.3.3. Technological progress

The third determinant of economic development is technological progress. In its simplest form, technological progress results from new and improved ways of accomplishing traditional tasks. Todaro (1990) identified three basic classification of technological progress. First, "neutral" which occurs when higher output levels are achieved with the same quantity and combination of factor inputs Simple innovations like those that arise from the division of labour can result in higher total output levels and greater consumption for all individuals. Second, 'labour-saving' which covers the skill of labour to operate modern machinery and equipment. Third, "capital-saving technological progess". This is a much rarer phenomenon because all of the world's technological research conducted in developed countries tends to save labour, rather than capital. In the third world, however, capital-saving technological progress is what is most needed.

2.3.4. Other factors

Besides these three determinant factors, there are many other factors that also influence economic development. Some development economists put the level of consumption and inflation as other important factors in economic growth function. The level of consumption can be viewed as the 'engine' of growth, and inflation should be considered as the 'engine oil' of growth. Both of these factors can take the role of accelerator as well as decelerators of economic growth (Gillis *et al.* 1992).

Many studies have found that the level of inflation will affect the rate of economic growth in a particular region (Bryan and Cecchetti 1999, Ball and Mankiw

1999, Davis and Kanago 2000). The level of inflation will depend on the economic condition of a particular region. In the decade 1950 – 1960, economists suggested a moderate level of inflation of between 8 per cent and 12 per cent for developing countries (Gillis *et al.* 1992). Davis and Kanago (2000) in their study of the level and uncertainty of inflation, say that time-series studies that derive inflation uncertainty from a survey of forecasters conclude that higher inflation causes greater uncertainty. However, Davis and Kanago (2000) did not mention the other effects of uncertainty to economic growth in their study.

Bryan and Cecchetti (1999), in their article "Inflation and the Distribution of Price Change" found that when inflation is high, the distribution of relative price changes is typically skewed to the right and when inflation is low, it is skewed to the left. Their model, however, does not capture the reality of how price indices are constructed. Indeed, the observed correlation of the mean and skewness is based on the full population of sectors. Their model is not a good example, because usually there are a large number of sectors, and the government computes the level of inflation by sampling a small number of those sectors. Their model does not consider the problem of " small-sample bias", so, one should be cautious in making conclusions about the correlation of the mean and skewness (Ball and Mankiw 1999). Another exogenous variable in the economic growth function (economic development) is the level of education either formal or non-formal. Education can be used as an indicator of the skill of human resources used in economic development. According to Ahluwalia (1974), education, of the right type, increases the quality of the labour input leading to higher labour productivity, which is then reflected in higher wage earnings. Underlying this optimism about the role of education are assumptions about technology and the operation of sector markets. The technological assumption is that the marginal product of skilled labour is higher and will remain relatively high even though the supply of skilled labour increases. The factor market assumption is that wages paid reflect the marginal product of labour. Three other important factors in economic development are public budgeting, public infrastructure, and research and development. The use of public budgeting for purposes of promoting economic growth, employment and income distribution has so far been considered as part of development economics in general, and, more especially, as a part of economic planning. Some countries, particularly those in Eastern Europe which are in the process of moving from planning to market orientation have adopted market-friendly policies. These countries have put priority on public budgeting and public infrastructure as the main instruments in their economic development. According to Premchand (1998), in these countries in Eastern Europe, governments are increasingly funding the provision of goods and services to the community while the actual service delivery is undertaken by the government sector. Furthermore, Premchand (1998) stated that for analytical purposes, three broad sectors are recognised: public, corporate and the third sector (individuals, voluntary associations, cooperative institutions, and non-government organisations that are mostly on a non-profit basis).

Public infrastructure is another important factor in economic development. At the most basic level, public structure such as roads and sewers make direct contributions to commerce and health. An efficient road and highway system helps to move people and their product in a timely and low-cost manner. Modern water and sewerage systems have improved health in the industrialised world and are making a similar contribution in many of today's emerging economies. Asshauer (1984) and Munnell (1990) found that the decline in U.S. productivity growth and poor economic performance in the 1970s were caused by slower growth in public investment.

Research and Development (R&D) is quite often related to the development of technology. In the win-win approach of development, technological improvement is one of the alternative solutions to overcome the problem of trade-off between unemployment and the level of inflation.

With the requisite scientific and technical effort, nations will find it easier to adopt the technology that they encounter in international trade or through foreign direct investment. As an example, research and development activity might enable domestic firms to realise the spillovers resulting from the transfer of technology by multinational corporations. In addition, a country's R&D activity will enhance its ability to make product and process innovations of its own. According to Gettleman (1998) although R&D activity is not the only prerequisite for a country to develop its technological capabilities, clearly investment in R&D and the presence of manpower with sufficient training to engage in R&D are important components of this task. Gittelman and Wolff (1995), as cited by Gettleman (1998), in their study about 'why should the impact of R&D vary by level of per capita income' found that those countries in the early stages of industrialisation are likely to spend less on R&D than those with a well-developed manufacturing sector.

Finally, political stability is another prerequisite to ensure the continuity of the development process. Morawetz (1977) stated that political stability, of whatever ilk, and stability of the economic "rules of the game" may be an important and underrated determinant of economic growth. According to Morawetz (1977) most of the countries that grew faster during the period of development process had such stability, while many of the slowest growers conspicuously did not.

Based on the description above, some important factors that have to be considered in the study of development can be identified. These are capital, population, level of consumption, level of inflation, health and education, public budgeting, public infrastructure, and research and development. There are many other factors that actually have a significant role in the development process such as leadership, cultural background, motivation, ambition, and political stability (Benu, *et al.* 1994) but the influences of these factors are difficult to measure.

The theory of development is concerned with the existing value and condition of those societies that we seek to understand (Dos Santos 1973). In many countries, agriculture plays a major role at the beginning of the development process. Agriculture usually serves as a stepping-stone in the process of development for improving welfare and improving living standards of a society.

In the next section, we will take a closer look on the role of agriculture in economic development.

2.4. Role of Agriculture in Economic Development

Johnston and Mellor (1967) identified five contribution of agriculture to economic development. First, agriculture provides food and raw material inputs for other sectors. Second, agriculture contributes to a country's foreign exchange earnings (if the country has a competitive advantage in producing some agricultural products). Third, because of its size, the agricultural sector is an important potential source of demand for other sectors' output. Fourth, it is a source of labour for the industrial sector. Finally, the agricultural sector usually produces a surplus which can be transferred to other sectors with lower incremental capital/output ratios.

Increasing agricultural productivity or agricultural output may not be a necessary condition for economic development. Theoretically, an open economy can always produce either goods for export and import its food. Nevertheless, for larger countries there is a strong connection between increasing agricultural output and increasing GNP (Pomfret 2000). According to Pomfret (2000) to some extent, the positive correlation between increasing agricultural output and increasing GNP is because agriculture has a large weight in pre-industrial countries' GNP, but the relation goes beyond simple arithmetic as agriculture can make many contributions to economic development. For most LDCs, agriculture is a major sector and contributor to income and employment. Hence, neglecting agriculture in the development strategy may have a negative effect on the development process or at least will lead to a slower growth of the country's economy.

According to Pomfret (2000) the potential contributions of agriculture to economic development are impressive. The catch is that they are predicated on increasing agricultural productivity. Ideally, agricultural productivity should increase at least as quickly as the demand for agricultural goods, so that the relative price of these goods can decline and create an incentive for the expansion of non-agricultural sectors.

Todaro (1990) mentioned that traditionally the role of agriculture in economic development has been viewed as largely passive and supportive. Based on the historical experience of western countries, economic development was seen as requiring a rapid structural transformation of the economy from one predominantly focused on agricultural activities to more complex modern industrial and service society. Furthermore, Todaro (1990) identified three broad stages in the evaluation of agricultural production. The first and most primitive is the pure, low-productivity, mostly subsistence, peasant farm. The second stage is what he called "diversified" or "mixed" family agriculture, where part of the produce is grown for self-consumption and part for sale to the commercial sector. Finally, the third stage represents the "modern" farm, exclusively engaged in high-productivity, "specialised" agriculture geared to the commercial market.

There are a number of contributions that the agricultural sector must make throughout the process of transformation, and there are many interactions and interdependencies between agriculture and industry. According to Dorner (1972), agriculture must provide the food surplus for a growing population and for the increased demand resulting from the higher per capita incomes. Agriculture must also produce a surplus for export to finance the capital equipment and other imports needed for development. Another contribution of agriculture is it contributes both capital and labour to the non-agricultural sector in the process of development. Agriculture can also create capital transfers in economic development. Several mechanisms that can create capital transfers are taxation, direct quota deliveries of farm products to the state, rental payment to landlords, former savings channelled into industrial investment, migrations, and terms of trade that are unfavourable to farm products *vis-à-vis* manufactured goods. Young people in rural areas can be viewed as an important resource of capital transfers. According to Dorner (1972), the quantity and quality of capital represented by such migrants from agriculture to non-agriculture depends upon the investments made on their behalf before they leave agriculture. The transfer of manpower from agricultural to non-agricultural occupations is inherent in the overall transformation processes of development. Finally, agricultural development can provide the increased rural incomes needed to enlarge the demand for industrial products.

According to van Kuelen *et al.* (1998), the poor harvests in Asia in the 1960s and in Africa in the 1970s marked a turning point in the view taken of agriculture. The viewpoint of agriculture as a labour reserve and a source of domestic savings and foreign exchange is now increasingly recognized along with its importance in improving food supplies and enlarging the market for industrial goods. In the 1970s, the emphasis on employment and rural development led to the inclusion of agriculture in economic thinking when the redistribution of growth and basic needs strategies were formulated. In the 1980s, considerable emphasis was placed on the role of macro-economic policy as a requirement for agricultural development. In this period, it also became clear that inadequate incentives for agricultural production were occasioning serious damage to the environment, such as soil and water pollution in high-income countries and deforestation and soil degradation in developing countries.

Discerning the links between agriculture, environment and poverty is crucial for sustainable growth. In the long term, if the natural resources base is degraded and conservation investments are not made, increased poverty is unavoidable. Maintaining agriculture's productive capacity for future generations thus becomes a matter of priority. With a growing number of people living in rural areas with modest agricultural potential, increasing attention is being asked for policy incentives that enhance farm-level adoption of sustainable, yield-enhancing technologies in those areas as well.

According to Vosti and Reardon (1997), policymakers in developing countries are faced with the need to pursue three challenges simultaneously. Agricultural production must grow to keep up with a rapidly increasing population, increased crop production will have to come from higher yields, and technological improvement, not more land under the plough. The reduction in the number of people who live in poverty is important, for poverty ruins lives and undermines development, the environment and political stability. At the same time, the issue of natural resources sustainability has to be addressed. However, according to Fan *et al.* (1999), targeting government expenditures simply to reduce poverty in rural areas is not enough. To provide a permanent solution to the poverty problem and to increase the overall welfare of all rural people, government spending must stimulate economic growth and improve environmental capacity as well.

According to Mellor (1995), "agriculture is important because it employs so much of the labour force in the early stage of development". It has the capacity to exploit productivity; increasing technological innovations that make large net additions to national income and hence to purchasing power. Todaro (1990) mentioned that the basic reason for the concentration of people in agriculture is the simple fact that at the early stage of development, the first priorities of any person are for food, clothing, and shelter. Agricultural productivity in the early stage of development is low not only because of the large number of people in relation to available land but also because it is often characterised by primitive technologies, poor organisation, and limited physical and human capital input. However, Pinstrup-Andersen (1994) noted that investment in agricultural research has decreased since the 1980s, particularly in areas that are critical to increasing yield levels. According to this author, failure to invest in agricultural research today will show up in production shortfalls 10 – 20 years from now. The International Food Policy Research Institute (IFPRI 1995) and Rola-Rubzen and Hardaker (1999) also support this view saying that without greater investment in agricultural research and development, poor countries that now suffer widespread malnutrition and a general lack of food security are likely to see little improvement.

According to IFPRI (1994), investment in agricultural research to develop and improve technologies is essential for agricultural growth. The acceleration of agricultural growth due to investments in agricultural research and development is strongly aligned with growth in other sectors of the economy. In the past 20 years, the countries that achieved the most rapid agricultural growth due to investment in agricultural research and development also had the most rapid economic growth, while countries that experienced real declines in agriculture also experienced negative economic growth rates. IFPRI reports that a one-dollar increase in income within agriculture, mostly because of the investment in agricultural research and development, creates incomes of more than a dollar in the rest of the economy. While Degaldo *et al.* (1998) in their research in sub-Saharan Africa found that adding \$1.00 of new farm income is likely to increase total household income by \$1.96 to \$2.88.

Since the twentieth century, improvements in agricultural productivity have been closely linked to investment in agricultural research and development (Alston, *et al.* 1999). However, despite continuing food crises in the developing countries, agricultural development assistance from major governments and international institutions has declined since the early 1980s (von Braun *et al.* 1993). There are several reasons why many governments and international institutions reduced their assistance for agricultural development. These are: (i) agricultural projects were generally sound but would perform better under better macroeconomic conditions. This spurred the desire to promote policy and government reforms; (ii) the rise in third world debt in the 1980s contributed to the shift to structural adjustment and policy-based lending, and reduced the power of agricultural ministries in low-income countries. Lending institutions believed that macroeconomic adjustment, such as elimination of overvalued exchange rates, would have a greater positive effect on agriculture than provision of the same funds for the agricultural sector in the absence of reform; (iii) the revenues that governments could derive from agriculture were negatively affected by declining international commodity prices. Pressure to liberalise trade rules, eliminate overvalued exchange rates, and reduce subsidies led to smaller government gains from agriculture; and (iv) reduction in the number of agricultural specialists in donor agencies presented a major barrier to the design and implementation of successful agricultural projects (von Braun *et al.* 1993).

According to von Braun *et al.* (1993), the decline in external assistance to agriculture in developing countries could be justified only if their food situation was improving, if their rural poverty was diminishing, and they were becoming more capable of meeting their needs for the public goods that are essential for agricultural growth. The report by Pinstrup-Andersen, Lindberg, and Garret (1994) cited by IFPRI (1995), showed that foreign aid to agricultural research not only generates broad economic growth in recipient countries, but also creates developed-country employment by expanding developing-country imports. According to these authors, aid directed to agricultural research produces a positive chain reaction that benefits both recipient and donor.

After discussing the role of agriculture in economic development and the current trend of the world's agriculture, it is important to review in more detail agricultural development as a theoretical basis for a study. Therefore some important aspects in agriculture that have to be considered in agricultural development are reviewed in the next section.

2.5. Some Important Aspects in Agricultural Development

Amang (1987) stated that demand in the agricultural sector is a function of population, relative food price and income. Bautista (1998) contended that, analytically, the relative price of any tradable good in a given period is the outcome of several influences, including both policy and non-policy factors. However, Boserup (1970) said that the growth of population is a major determinant of technological change in agriculture. Under the pressure of increasing population, there has been a shift in recent decades from more extensive to more intensive systems of land use in virtually every part of under-developed regions. In Boserup's view, population is highlighted as the major determinant of technological change in agriculture (Boserup 1970). What was not emphasised enough was that technological change in agriculture could also determine population growth. In fact, the relationship between these two variables might be a vice-versa relationship. That is, the determinant factor and the effect factor can be reversed.

In respect to agricultural development, government policies of many developing countries are constructed under the premise that by increasing the flow of agricultural credit, the acceleration of rural development is possible (IFPRI 1994). However, according to Karmakar (1999), credit cannot be created merely by increasing money supply, nor can capital be used for developmental purposes if farmers divert savings for consumption purposes. He goes on to say that combining additional labour with more capital can enhance both production and productivity. Furthermore, Karmakar (1999) stated that credit plays a crucial role in the modernisation of agriculture, but its role in the fight against rural poverty has seldom been recognised.

He further stated that financial institutions in developing countries, whether public or private, have shunned rural areas for various reasons, such as opportunity cost and low financial credibility. According to Zeller and Sharma (1998), in many developing countries, poor rural households face severe constraints when they seek credit from formal lending institutions. Formal financial services such as those offered by banks are often not available to those below the poverty line because of restrictions requiring that loans be backed by collateral. As a result, the poor usually turn first to informal sources such as friends, relatives, or money lenders, who loan small amounts for short periods, or to informal indigenous institutions such as savings clubs, and lending networks to borrow enough money to purchase their needs. Nerlove *et al.* (1996) found in their analysis that credit constraint is a primary determinant of technology adoption.

Walinsky (1986), cited by Karmakar (1999), mentioned that farmers in developing countries are generally hampered by the high interest costs of short-term crop loans, usually from small-scale, private money-lenders and by the almost complete lack of sources from which they can borrow the longer term loans they need to purchase animals and equipment, upgrade their stock, reclaim acreage, implement soil conservation measures and finance other capital needs. High cost loans from moneylenders constitute a major charge against their current income and depress their living standards. The unavailability of long-term credit prevents them from improving and expanding their output. A well-designed agricultural credit programme based on an agricultural bank can overcome both limitations. Many studies have also shown that well-designed financial institutions (credit and saving institutions) can overcome the problem of the high interest cost of short-term crop loans and the unavailability of long-term credit schemes (Zeller and Sharma 1998; Rola-Rubzen and Hardaker 1999; Rola-Rubzen, Hardaker, and Dillon 2001).

According to Karmakar (1999), however, Walinsky (1986), did not emphasise enough the role of technological progress in the development process According to Karmakar, capital can also be used to improve the existing technology for growth acceleration.

Nerlove *et al.* (1996), found in their research that the result of applying green revolution technologies to marginal land has often been disappointing. Not only have yield increases been lower and less uniform than on high-potential lands, but the environmental costs of soil degradation and loss of forest cover, in particular, have been high. According to these authors, changes in policy and technologies are necessary for use of modern technology to increase the productivity of these marginal lands effectively and sustainably.

With regard to environmental degradation, Vosti (1992) points to population pressure as one of the important issues that has to be addressed in respect to the problem of sustainability. He goes on to say that population pressure is a major source of stress on natural resources, particularly in parts of Africa and Asia where the carrying capacity of the land may have already been exceeded. That is why Pinstrup-Andersen *et al.* (1997) suggested that agricultural research and policy should focus on improving agricultural productivity of small-scale farmers in low-income countries to reduce poverty, food insecurity and environmental degradation. At the same time, more emphasis must be placed on research and policy that will help farmers, communities and governments better cope with expected increases in risk. Besides the above factors of capital, labour, land and technology, the availability of good infrastructure in the agricultural sector is another prerequisite to ensure success in agricultural development.

Hazell (1998) stated "agricultural development strategies have traditionally emphasized irrigated agriculture and high-potential rainfed lands in an attempt to increase food production and stimulate economic growth". These strategies have been spectacularly successful in many countries and were responsible for the Green Revolution. At the same time, however, large areas of less-favoured lands have been neglected. Agricultural potential is generally low in these lands, often because of poor soils and low and uncertain rainfall, but also because neglect has left them with little infrastructure and poor access to markets. To overcome these problems IFPRI (1998) recommended some specific policies for struggling lands to better link them with markets and to enhance their capacity to compete. These policies include (i) improving roads and transport systems; (ii) establishing appropriate legal and regulatory frameworks to strengthen input and output markets; (iii) establishing policy and legal structures for security of land tenure, leading to better management of natural resources; (iv) strengthening the capacity of environment institutions to reclaim degraded lands, develop land-use plans and implement community-based conservation measures; (v) assessing the problems of existing technological packages and their application by farmers, strengthening national agricultural research systems and ensuring that research and extension are demand-driven; (vi) reforming rural financial markets in fragile areas to encourage savings and the use of non-traditional forms of collateral; and (vii) developing infrastructure that promotes off-farm employment and better access to health, nutrition and education facilities in fragile lands.

In relation to the development of off-farm employment, IFPRI (1997) found that in most developing countries the rural labour force is quickly outgrowing the opportunities for employment in agriculture. As new land for expansion of agricultural production dwindles, workers must find employment in the rural non-farm sector (small-scale manufacturing, trade, construction, transportation or services) or migrate to cities or abroad in search of jobs.

One important aim in economic development is to increase the welfare of economic actors. In the agricultural sector this aim should be addressed to the farmers, as they are the main economic actors in agricultural development. The next section presents a detailed description of the welfare concept and indicators of welfare that might be used in the evaluation of welfare.

2.6. Welfare and Per Capita Income

The concept of welfare contains many aspects. Usually a single attribute is not enough to describe or evaluate the welfare of an individual or a society. This has been stressed by several authors, including Sen (1973, 1985), Kolm (1977), Atkinson and Bourguignon (1982, 1989) and Maasoumi (1986)

According to Moster (1994) several attributes arise, for example in the investigation of economic inequality: households vary in income and wealth, individuals differ in earnings and education, countries in per capita income and mineral resources, etc. Further Moster (1994) stated that if we think of economic aspects in a narrow sense only, and money as a universal numeric measure (everything which can be desired can be bought by money), differences in needs might be relevant. There is a differentiation in the needs of a household dependent on the size of the family (Atkinson and Bourguignon 1989) while the differentiation in the needs of individuals will be dependent on sex, age, health, and the ability to consume (Sen 1973, 1985). According to Mosler (1994) countries also have different needs (e.g. for fuel due to their geographic latitudes).

There are several criteria that may be considered when evaluating the social welfare of a society (Mosler 1994). First, they arise if simultaneous use is made of different indices of inequality. Second, in a more technical sense, several criteria arise if a society welfare function (SWF) is employed, since an SWF is usually determined only up to certain transformations. Third, and most important, the evaluation may be based on an SWF which is determined by qualitative properties only. In this case a given social state of a society is regarded as better than another if it is better with respect to all criteria considered simultaneously.

IFPRI (2000) stated that when we look at a family's welfare, we are not just looking at how much daily food they have to eat, but we are looking at whether they have secure livelihoods, whether their crop yields can sustain them even through a bad monsoon, and if they have the assets they need to produce for tomorrow or get through a tough period.

The Indonesian government has defined a poverty line as a general indicator of the living standard of the society. People who live (income or expenditure) under this poverty line are categorised as poor people, while those who live above this line are categorised as pre-welfare, welfare I, welfare II, and welfare III. The essential non-food commodities are decided based on the consumption pattern of each region including some aspects of clothing, housing, education, health, and transportation. The poverty line that has been decided by the Indonesian government consists of two components as the indicators of living standard. These are the food sufficiency limit component and non-food sufficiency limit component. The food sufficiency limit has to indicate the minimum food needs (2100 calories per day per capita), while non-food sufficiency limit has to indicate the minimum non-food needs. The poverty line that has been decided is the nominal value of the Rupiah equivalent to 2100 calories per capita per day plus the nominal value of the Rupiah equivalent to the minimum consumption of the essential non-food commodities.

According to Garner and de Vos (1994), poverty can be defined generally in a variety of ways: absolutely, relatively, and subjectively. An absolute definition reflects a standard below which basic needs cannot be met. Relative definitions consider one's relative position in a distribution (e.g., with respect to income or expenditures) as crucial. Subjective definitions are based upon the opinions of people about their own situation (e.g., about the income level minimally necessary to make ends meet). So far, the Indonesian government has released four poverty lines, which are different from region to region (dependent on the consumption pattern of each region) in 1990, 1993, 1996 and 1999.

Generally, the indicator of the living standard of a society in Indonesia is the nominal value of the Rupiah that is purchased or earned. Although recent research on living standard has raised questions about the relevance of cash income for the measurement of economic welfare by developing broader indicators of well-being (Travers and Richardson 1993; Raskall and Urquhart 1994; Johnson, Manning and Helwig 1995), the poverty literature has continued to debate where the (cash income) poverty line should be set and how it should be adjusted over time (Gruen 1995, Saunders 1995). According to Amiel and Cowell (1994) inequality changes and income growth are two of the most important issues which concern economic policy makers. Evaluation of these two economic phenomena is accordingly a central problem in the field of applied welfare economics. Further, they state that the derived social welfare function would imply a particular inequality measure. Typically the axioms involved for this purpose include the behaviour of the function under changes in level of total income, in income distribution and in the size of the population.

According to Basu (1994) the preoccupation with income distribution may be justified if one assumes that income represents welfare (IRW) and equal income between individuals means equal welfare. Logically, the problem of representing welfare as income will be raised if we deal with the issue of welfare distribution in a particular society. In other words, the view that income represents welfare is acceptable if we only deal with the growth of welfare in a particular society. Several economists have attacked this assumption. Some economists have argued that equality of income does not imply equality of welfare. The first reason for economists to refute the assumption of IRW is if two individuals face the same feasibility set in the income-leisure space, then there seems very little reason for saying that the person with the lower income is worse-off. Let two individuals face the same budget constraint, AB, as shown in Figure 2.1. Individual 1 chooses point "a" and individual 2 chooses "b". According to the IRW view, individual 1 is better off than individual 2 since 1 earns y_1 and 2 earns y_2. The opponent of IRW is justified in pointing out that this is unreasonable since individual 1 may be earning more but he also gets less leisure (Basu 1994).

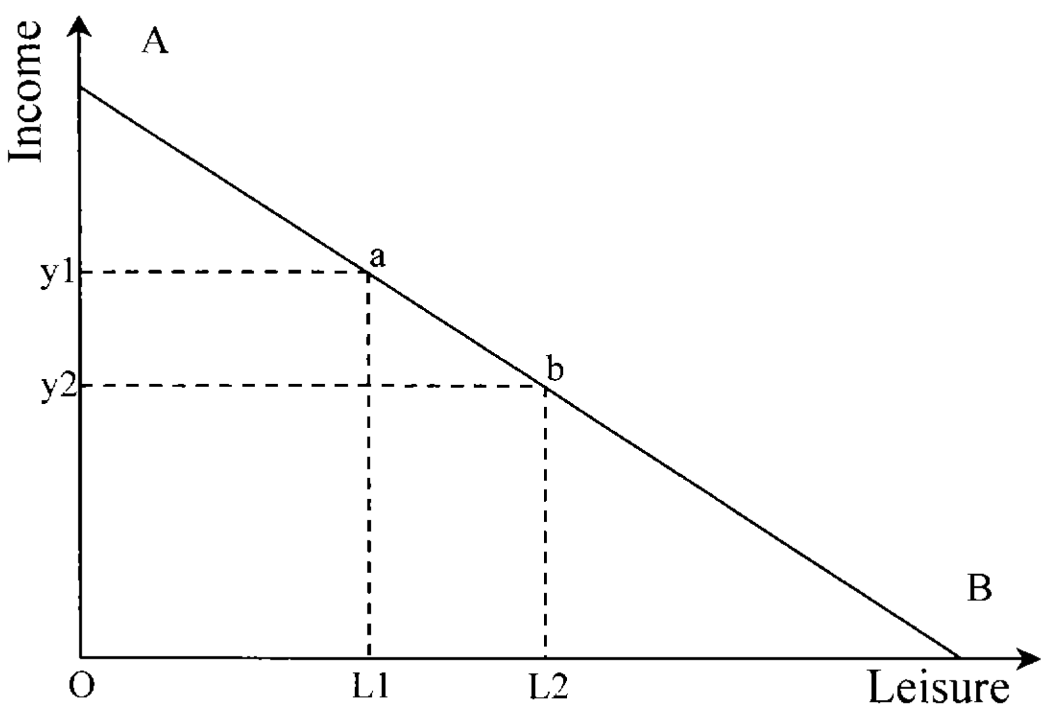

Figure 2.1. Two Individuals with the Same Budget Constraint

Source: Basu (1994)

However, this argument has also been attacked by Basu (1994) as illustrated in Figure 2.2. Basu (1994) assumes that utility is a function of two variables, X and Y, which are represented on the two axes. X and Y could be two goods, or leisure and income He assumes individual utilities are ordinal and indifference curves are the usual contours. Basu (1994) demonstrates that the opponent of IRW implies a type of comparison which is internally inconsistent. Let U (a,I) be the utility of individual 1 at point "a". I_1 and I'_1 are individual 1's indifference curves and I_2 is individual 2's indifference curve. Let both individuals face the same budget set, AOB. Then 1 and 2 will choose a and b, respectively. The utility of 1 is equal to the utility of 2 {$U(a,I_1) = U(b,I_2)$}. Now let prices change and both individuals face the budget set COD (CD is tangential to I_2). But $U(b,I_2) = U(z,I_2)$, since b and z are both on I_2. For individual 1 to maintain his/her utility, $U(a,I_1) = U(w, I'_1)$. This is not the case as I_1 is a higher indifference curve than I'_1. Hence the reasoning of the IRW opponent is also unacceptable.

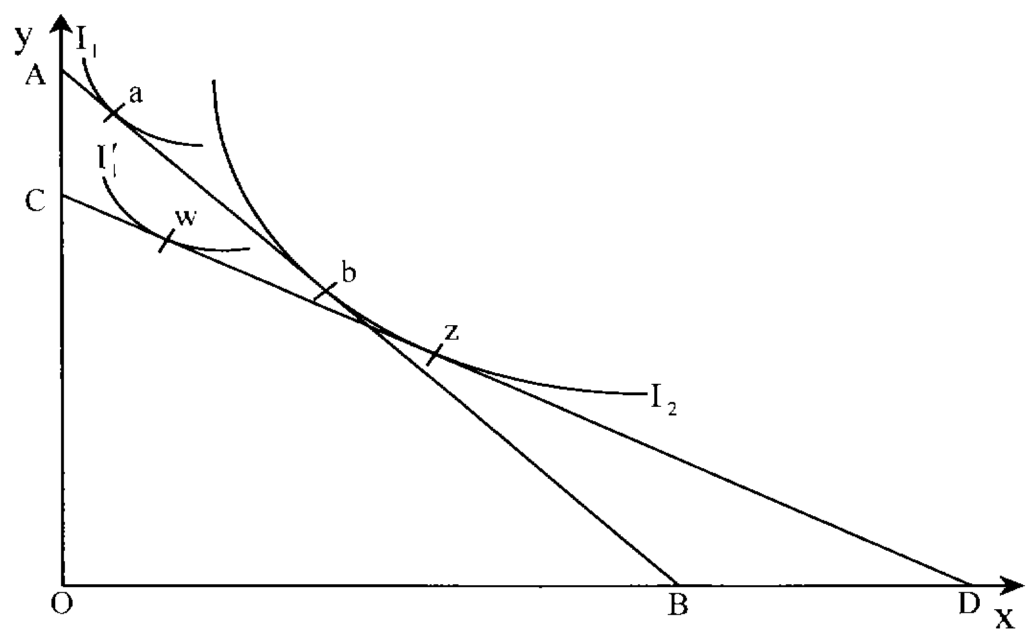

Figure 2.2. Two Individuals with Different Budget Constraints

Source: Basu (1994)

Logically, the view that income represents welfare is acceptable if we only deal with the growth of welfare in a particular society, regardless of the distribution of welfare. In other words, the problem of representing welfare as income will be raised if we deal with the issue of welfare distribution in a particular society.

Income (per capita) is one of the exogenous variables in the econometric analysis. Per capita income is derived from regional income divided by population. This means that regional income and population have to be decided first, before narrowing down to per capita income. The basic component of regional income is gross domestic regional product, which is derived from the sum of gross value added of all industrial origins including the repayment service of production factors (wages, income, industrial surplus), and the reduction of gross indirect tax. This means that the output of each sector should be included in the regional income function. Per capita income can be used as a measure of the wealth of an area's population, as well as an indicator of the economic wealth of that region (Anonymous 1999). However, it should be noted that wealth is not the same as per capita income. Wealth is the value of a person's assets including income, and it can be accumulated if income is greater than expenditure. The fundamental difference is that wealth is a stock whereas income is a flow.

2.7. Concluding Remarks

Development, progress and improving welfare are essential to increasing the amount of goods and services available to people. The more that can be produced, the more wealth and benefit there is. Therefore development is basically about increasing the volume of production for domestic consumption and trading by increasing investment in production, plant and infrastructures. In the development process, capital is a prerequisite for investing so that it is necessary to borrow, seek aid, save from earnings, welcome foreign investment and promote export. The more production increases, the more tax income the government will have to spend on education, welfare, public facilities and the environment to accelerate growth of development and improve equality either to all people or to the next generation.

Some determinant factors in economic development are capital accumulation; population growth including fertility, mortality and migration; technological progress; consumption; inflation; health and education; public budgeting; public infrastructure; and research and development. The first three factors (capital, population and technological progress) must be considered in the evaluation of economic development. A substantial productive capital investment is an investment which is large enough to achieve the 'take-off' or passage from stagnation to intensive development. In relation to public growth, the positive and negative aspects are important in connecting population and economic growth either directly or indirectly.

There are many other factors that have significant roles in the process of economic development such as leadership, socio-cultural background, motivation and ambition, and political stability, but as mentioned in Section 2.3.4, the influence of these factors are difficult to measure.

Several main contributions of agriculture to economic development are providing food and raw material inputs for other sectors, producing some agricultural products, creating potential source of demand for other sectors' output, producing a surplus that can be transferred to other sectors with lower incremental capital/output ratios, creating income and employment, providing capital to finance important equipment and other imports needed for development, and supplying labour to the non-agricultural sectors in the process of development.

Some important aspects that have to be evaluated in the study of agricultural development are capital formation, land tenure, population growth, agricultural productivity, relative food prices, income per capita, agricultural credit, interest rate, financial institutions, technological progress, environmental degradation, agricultural infrastructure, public transportation and government policy.

In the condition where other indicators of welfare are not available, the concept of representing welfare with income is acceptable if we only deal with the growth of welfare (not the distribution of welfare) in a particular society under the assumption that there is an over-supply of labour in the labour market and people will always try to increase their income by reducing their leisure.

After summarising the overall review of economic and agricultural development in general, it is important to take a closer look on the agricultural development in Indonesia especially in West Timor as well as related policies. This will be the subject of the next chapter.

CHAPTER 3

AGRICULTURAL DEVELOPMENT IN WEST TIMOR AND INDONESIA

3.1. Introduction

This chapter reviews agricultural development in West Timor and Indonesia. Section 3.2 presents some policies in the agricultural sector in Indonesia, especially in East Nusa Tenggara province. The influence of the Indonesian government on agricultural development since the beginning of the 1970s is presented in this section. This section also presents price policies and agricultural inputs policies. At the regional level, five special programs that have been run by the regional government since 1969 and an evaluation of those programs are presented at the end of this section.

A short description of the history of West Timor is presented in Section 3.3. Section 3.3 contains some information of the influence of colonialism on the economic condition of West Timor since the 17th century. Some information on cultivation techniques are presented in the middle of this section. while at the end of this section the modern cultivation techniques introduced by the Indonesian government since 1960 are presented.

Section 3.4 presents the general economic structure of West Timor. The composition of the sub-sectors is presented at the beginning of this section. At the end of this section, the growth of each sub-sector, together with some comments are presented. The contribution of the agricultural sector to the overall economic growth of West Timor is presented in Section 3.5. Descriptions of each district in West Timor are also presented in this section to illustrate the dependency of each district on agriculture.

There are four districts belonging to West Timor island i.e., Kupang district, Timor Tengah Selatan (TTS) district, Timor Tengah Utara (TTU) district, and Belu district. Kupang city, which belongs to the Kupang district, is the biggest city in Timor island and is the capital city of East Nusa Tenggara province.

Sections 3.6 and 3.7 present the demographic conditions of West Timor and the economic crisis of Indonesia respectively. The section on demographic conditions contains a description of the structure of demographics in West Timor. The section on the Indonesian economic crisis contains information on the economic condition of Indonesia at the beginning of the crisis as well as the end of the crisis at the regional level.

Information about the agricultural production system in West Timor is presented in section 3.8. The agricultural production system is divided into food crops, tree crops and livestock. However, it should be noted that it is difficult to make a strict differentiation of the production system for food crops, tree crops and livestock because most farmers run a mixed farming system. To get a broad understanding of agriculture in West Timor, the description of the land tenure is presented in Section 3.9. This section contains information of four land tenure patterns in West Timor that have been carried out by the people of Timor Island for the last 600 to 700 years. The agricultural marketing system in West Timor is presented in Section 3.10. This section contains information about crop and livestock commodity marketing.

Finally, major constraints to development are presented in section 3.11. This section contains some constraints that need to be considered and addressed to accelerate the economic growth in West Timor. Section 3.12 presents a conclusion of the whole review and discussion of agricultural development in West Timor and Indonesia.

3.2. Agriculture Policies

3.2.1. Agriculture policies in Indonesia

The Indonesian government has introduced many agricultural development programs since the beginning of the 1970s. Very few programs on agriculture were run by the government before that time because of political instability.

In 1969, the Indonesian government introduced a special program in agricultural development known as *Bimbingan Masal* (BIMAS) to accelerate agricultural production, especially of food crops BIMAS was an intensification program which promoted the use of a technology package (fertiliser, pesticide, modern varieties, etc.), provided credit and fertiliser subsidies, an intensive extension program at the village level, and investment in irrigation development. Later, the BIMAS program was modified for further intensification program packages known as *Intensifikasi Masal* (INMAS) and *Intensifikasi Khusus* (INSUS), which emphasised mutual cooperation among members within farmer groups and the mutual cooperation among groups at the village level. The type of intensification program in a particular region depended on the result of the evaluation of the existing program package. Usually the initial type of intensification program, in a particular region is INMAS. If the result of the evaluation of the program shows a successful result, it is then extended to INSUS. In fact, in many cases, the evaluation processes are usually not valid. Many of INSUS programs have been established merely to fulfil the target of a project, not the target of the program. That is why the management of the program could not totally fulfil the main goal of increasing the agricultural production as well as farmers' welfare. Indeed, there are some obstacles in the implementation of the program regarding the socio-cultural heritages of the local people. These obstacles have to be managed properly in the spirit of development before moving to the higher level of the program.

Agricultural production in Indonesia is also influenced by government price policies on inputs and outputs. Maintaining stable and favourable commodity prices together with highly subsidised fertiliser prices has encouraged agricultural production, especially of food crops. The main instruments of rice price policy include the use of a farm-level floor price, a ceiling price for consumers, and control of international trade in rice. The main goal of the floor price set by the government every year is to protect farmers from a price drop below the rational level. Such price drops can occur because of imperfect competition in the market. The rational level of price is a minimum level of price that can determine profit for farmers. The floor price of rice at the farm level is set annually, taking into account a number of factors, including the cost of rice production, farm income, potential inflammatory effects, and the cost to the government of supporting the floor price (Gonzales *et al.* 1993). The floor price is implemented by the grain stabilisation agency, Badan Urusan Logistik (BULOG), which procures rice in major rice producing regions. However, the policy of controlling the floor price is only implemented for the main foods stuff, especially rice. The central government has increased the floor price of rice at least 50 per cent in the last 10 years. Until 2003, there are at least four commodities that have been involved in INSUS program, i.e. rice, corn, soybean, and garlic.

BULOG has maintained the ceiling price by holding substantial rice stocks as well as releasing rice on the urban market from stocks, domestic procurement and imports. The ceiling price is set to protect consumers from a high level of price which is unreasonable because of an imperfect competition in the market. If the price in the market is too high (depending on the current moderate level), BULOG will release its stocks into the market to reduce the price level. Usually, BULOG continues this procedure for a certain period until the price falls back to a moderate level. The Indonesian government has also tried to keep the domestic rice price in line with world prices. The only large departure from the price in the world market occurred when the government protected consumers from an extraordinarily high world price in 1974. The ceiling price and the actual wholesale price of rice has been much less variable than world market prices, indicating that BULOG has generally been successful in insulating domestic prices from short-term fluctuation in world prices. By maintaining a stable domestic level of price, farmers are able to predict the profitability of their business and decrease uncertainty. This is important in motivating farmers to increase their agricultural production. At the same time, consumers do not need to worry about an unpredictable price that may cause them to speculate when buying the product. The speculation of buying is a bias in the supply and demand process of an agricultural product. However, the policy of maintaining a stable price can create inefficiency in the market, because the government has to spend the budget on maintaining prices. At the same time, inefficiency in the market can produce another inefficiency in the process of production. Price subsidies can send wrong price signals which in turn may not motivate producers to rationalise their process of production. This is one of the main problems faced by farmers in Indonesia in recent years.

The price of fertiliser has also been regulated by a high subsidy as an incentive to increase production. The paddy-fertiliser price ratio increased sharply from the early 1970s to the early 1980s reaching a peak of 1.92 in 1983 (Gonzales *et al.* 1993). In the early 1970s, the paddy-fertiliser price ratio in Indonesia was about double that of the Philippines and Thailand, and triple in the early 1980s According to Gonzales *et al.* (1993) the now favourable paddy-fertiliser price ratio has provided a strong incentive for fertiliser use in Indonesia. However, the price policies for paddy and fertiliser have not played a major role in the growth of other crops in Indonesia. The government policy has generally resulted in a slightly negative price protection for other crops at the wholesale level (Sudaryanto *et al.* 1992). The government floor price for corn, instituted in 1978, has not affected production incentives for corn, because the market price of corn has been consistently above the floor price and government purchases of corn have generally amounted to less than one per cent of corn production (Sudaryanto *et al.* 1992). Compared to cassava, more favourable government interventions in rice and corn have resulted more rapid technological change, as well as increased the profitability of these crops. Therefore, there is a great deal more investment in cultivating rice and corn than in cassava. This condition has resulted in land being diverted from cassava to other crops, especially rice and corn.

According to Rosegrant *et al.* (1987), investment in irrigation has been the other major contributor to growth in rice production. In addition to investment in new irrigation, the government has made substantial investment in the rehabilitation of existing systems and in development of tertiary distribution systems within existing systems.

The irrigation development program grew relatively rapidly through the early 1980s, but the completion of new service areas slowed significantly thereafter. This slowdown was the result of budgetary cutbacks due to declining government revenues, declining world rice prices and the increasing cost of investment in new irrigation (Rosegrant and Pasandaran 1992).

Indonesian government policy initiatives for non-rice crops increased in the 1980s. Parallel with world economic trends in agricultural development, Indonesian government policies now give greater incentives and comparative advantage across a range of crops. According to Gonzales *et al.* (1993), four key developments led to a broadening of the government agricultural policy. Firstly, the success of the rice production program eliminated imports of rice for a number of years. Secondly, it was perceived that it would be difficult to maintain the growth of rice production in the future because high level of use of modern varieties, fertiliser and irrigation had already been achieved. The costs associated with replicating these achievements in more marginal areas would be high. Thirdly, resources available for agriculture had tightened due to declining oil prices prior to 1990 and declining government revenues and budgetary expenditures. Declining world commodity prices put an additional squeeze on the agricultural sector by reducing the economic profitability of investments in agriculture. Fourthly, competition for land had increased among agricultural commodities. As a result, the agricultural and non-agricultural sectors have become more integrated through investment in marketing and in rural infrastructure such as roads and communication.

3.2.2. Agriculture policies in East Nusa Tenggara province of Indonesia

Since the early 1970s, the government of East Nusa Tenggara province has had five special programs to accelerate economic development at the regional level, especially in the agricultural sector (Government of East Nusa Tenggara province of Indonesia 1999). Between 1969-1978, the regional government conducted the program of *Tanam Sekali Lagi Tanam* to overcome the problem of poverty, backwardness and underdevelopment. Generally, this program emphasised an extensification program in the agricultural sector by planting many varieties of crops and expanding the area of cultivation of food crops.

In the livestock sector, the export of livestock especially cattle, is the major contributor to the export earnings of West Timor. However, this attractive business has undermined the livestock sector of West Timor because many good breeding cattle were shipped out to fulfil the demand of the international market. In 1977, the Indonesian government adopted the policy of banning the export of livestock to Singapore, Hong Kong and other countries to fulfil the livestock demand in the domestic market.

In the 1978-88 period, the programs of *Operasi Nusa Makmur* (ONM) and *Operasi Nusa Hijau* (ONH) were introduced to consolidate the program of food-sufficiency for local people. Some intensification packages for food crop cultivation were integrated in these programs to increase food crop production. In 1988, under the new regional government, the program *Gerakan Meningkatkan Pendapatan Asli Rakyat* (GEMPAR) was introduced to increase the per capita income of local people. More intensification packages were integrated into this program until 1993.

These three programs were considered successful in the 1980s, making East Nusa Tenggara province self sufficient especially for maize (Adam 2000). However, the programs of ONM and ONH had not fulfilled the target of self-sufficiency for other food commodities such as rice, soybean, peanut, etc., due to some obstacles in the physical conditions (agro-climatic and edaphic factors), human resources and the consistency of the programs. There has been a tendency for each new regional government to introduce its own new development program that is different from before. In many cases the goal as well as the target of the program are different. Because of lack of planning, the GEMPAR program did not have significant indicators that could be used to evaluate whether or not the program had accelerated the per capita income of local people (Government of East Nusa Tenggara province of Indonesia 1983). In normal situations, economic growth is expected to have a multiplier effect on per capita income even without acceleration from any program packages

In relation to the improvement of other aspects of development in East Nusa Tenggara province, in the period 1993-98, the new government introduced another program known as *Tujuh Program Strategis*. This program emphasised seven strategy programs; (1) a program on improving the quality of human resources, (2) a poverty alleviation program, (3) an economic development program, (4) a lay out program of land and space, (5) a strengthening and application program of science and technology, (6) a program of improving and broadening communication, and (7) a tourism program. The agricultural sector was regarded as only one of the strategic aspects in the economic development program to be improved and there was a balance in emphasis on the implementation of each aspect of development. So far, no empirical study has been conducted to evaluate the program.

A new program to accelerate regional development was introduced in 1998, under the new regional government of East Nusa Tenggara province. This new program known as the *Tiga Batu Tungku program* emphasised three main aspects i.e., the economy, education and health. The agricultural sector was placed as one of the sub-sectors under the economic sector. Some operational activities to improve agricultural production included a) efforts to increase food crop production, b) efforts to increase tree crop production, c) efforts to increase livestock production, and d) efforts to improve fishery production (Government of East Nusa Tenggara province 1999).

Production of crops will be improved through increased extension activities, land use optimisation, intensification and diversification of farming systems, developing some production centres based on commodity mapping, expanding some pilot projects, improving dry-land agriculture practices, improving post-harvest activities, and improving market information systems. On the other hand, the production of livestock will be increased through increasing the number of livestock (large, small, and poultry) per family, improving integrated farming systems (between livestock and crops), improving quality of forage through extensification, intensification and diversification, and improving the program of insemination.

The *Tiga Batu Tungku* program is the latest regional development program that has been run by the government of East Nusa Tenggara province since 1998. Another new proposal has been issued to Jakarta for consideration as a special development program for West Timor in response to some socio-economic and political problems that have emerged after the East Timor crisis.

Another aspect that has to be added to the description of socio-economic performance of West Timor is the economic crisis that has battered Indonesia since early 1997. In the next section, the impact of the crisis on the Indonesian economy as well as the West Timorese economy will be examined.

3.3. The Economic Crisis of Indonesia

According to IFPRI (1998), Indonesia is one of the Asian countries that has had a miraculous economic growth during the last 25 years. Hong Kong, Taiwan, Singapore and Japan are the main Asian countries that played the role of "locomotive" of growth in this region. Taken as a group, the Asian economies, especially East and South East Asia, grew at over 7 per cent per annum in per capita terms over the decade from 1985 to 1995, a much faster growth rate than any other major region in the world (World Bank 1997). In this period, the Indonesian economic growth rate averaged 7.5 per cent per annum with the level of inflation remaining less than 10 per cent.

Starting in Thailand in 1996, some warning signals emerged with respect to low rate of economic growth, but it was thought that this was just a slowdown phase in economic development. Virtually no one predicted that a slowdown in Thailand would have a serious impact on overall economic growth in the Asian region. The slowdown then spread over the region and is now known as the "Asian economic crisis" with a significant decline in the GDP growth sharply declining exports, depletion in foreign exchange services, lowering of foreign direct investment, increasing external debt burden and bankruptcies of several banks and companies. Capital flow and currency performance got worse, with 80 per cent decline in the Indonesian Rupiah, 50 per cent in the Thai Baht, and 54 per cent in the Korean Won (Jha 2000).

In July 1997, the monetary authorities of Thailand were put under pressure to allow the Baht to float against the dollar and other currencies. A year after the devaluation of the Baht (in mid-1998), Indonesia suffered an economic crisis. The Indonesian currency (Rupiah) that was trading at around Rp 2,500 to the US Dollar in June 1997, fell to around Rp. 14 850 to the US Dollar by June 1998 (Far Eastern Economic Review, 26 June 1997, p.74; 9 July 1998, p.82).

According to Booth (1999), the June 1998 rate in fact reflected a recovery from the low point reached in late January 1998 of Rp 17,000 to the US dollar. However, the Indonesian economy is still in the process of recovery, because it was more severely battered than any other country in the Asian region. The poor economic condition of Indonesia can also be attributed to the poor economic policies of the Indonesian government and external factors including IMF policies.

The decline in real GDP in Indonesia between 1997 and 1999 was around 14 per cent which was slightly less severe than in the worst affected South American economies in the early 1980s (Booth 2000). Further Booth (2000, p.12) stated that:

> *'The impact of the devaluation was most serious for those firms producing non-trade goods which had contracted large foreign debts in the later part of the 1980s and early 1990s. By mid-1998, it was clear that the private sector foreign debt was much larger than most observers (and indeed the government) had realised, and that many heavily indebted companies were simply unable to generate sufficient Rupiah incomes to meet their debt service obligation'.*

They were, in effect, bankrupt. Indeed, they had contributed to their own bankruptcy by rushing to buy Rupiah in the latter part of 1997. When the Central Bank refused to defend the Rupiah by selling foreign exchange reserves, the steep slide in the value of the Rupiah was a foregone conclusion. To overcome the problem of decreasing purchasing power of the people, especially those in lower and middle income classes, the Indonesian government released a subsidy scheme in 1998 known as *Jaring Pengaman Sosial* (JPS), a social safety net. This program is one of the program packages in the letter of intent between the Indonesian government and the International Monetary Fund (IMF) for economic recovery. However, this program faced corruption problems, collusion and nepotism in the government.

At the regional level, the real GDP growth of West Timor declined from 18.8 per cent in 1997 to –52.2 per cent in 1998, while the level of inflation increased from 7.7 per cent in 1997 to 62.6 per cent in 1998. Like the financial crisis at the national level, West Timor also suffered bankruptcies of some big commercial banks as well as companies, because almost all big commercial banks and companies in West Timor are branches of national institutions. However, some small-scale businesses as well as small financial institutions (either formal or informal) survived because they were not really directly influenced by international market mechanisms. The small-scale business and financial institutions had a big role in supporting economic processes at the regional level during the crisis.

The economic crisis had more of an impact on the industrial and service sectors than on the agricultural sector. The real agricultural sector output decreased by approximately 51 per cent in 1998, while the fall in the industrial and service sector output was about 53.3 per cent in the same year. According to Booth (2000), many millions of smallholder producers of agricultural products initially enjoyed a substantial increase in their Rupiah incomes, even allowing for the impact of the severe drought on production. But the non-tradable goods sectors, such as construction and trade, were severely affected. In the city, consumers' confidence collapsed as more and more companies faced insolvency. Wholesale and retail trade suffered as a result.

Although there was a substantial increase in farmer's Rupiah incomes, it did not really improve their welfare since prices of non-agricultural commodities also increased significantly. The average food crops price increased by 58 per cent in 1998 compared to 1997, while tree crops price increased 48.6 per cent and livestock product 15.4 per cent. On the other hand the average price of clothes increased by 82.8 per cent, soap by 78.1 per cent, kerosene by 60.2 per cent and sugar by 63.8 per cent (Statistical Office of Nusa Tenggara Timur Province of Indonesia 1998).

Many of the labour force in the secondary sector moved back to the primary sector and/or informal tertiary sector because of collapses in the secondary sector. Although these people have a background in agriculture and this movement pattern was just a temporary phenomenon, it created a poor structure of the West Timor economy. It will take a long time to correct the problem of over allocation of labour force to the agricultural sector and to create a better economic structure. An appropriate policy is needed to put the moving pattern of labour force allocation back on the right track (see description of the economic structure of West Timor, Section 3.4).

The next section gives a brief description of the history of West Timor as a background before narrowing down to other issues.

3. 4. A Brief History of West Timor

Timor came under the influence of Portugal in May 1642. In the early 19th century, the Dutch influenced the political situation in West Timor. Although the role of Portugal declined, it still played an important role in East Timor until the early 1970s (Ataupah 1995).

According to CIDA (1980), the largest ethnic group in West Timor is the *Dawanese* or *Atoni* whose language is *Atoni*. They live in the uplands or mountains and are probably the most conservative people in the area. Another large group in West Timor is the *Belunese* who live in the eastern part of West Timor and speak *Tetun*. There has been some inter-ethnic mixture primarily due to the more outward-looking and mobile character of the Belunese. The third group of West Timorese is the *Marae* who differ distinctly in language and culture from the adjoining Belunese (Omerling 1955). This group lives in the far northeast corner of the area. A few *kemak* ethnic groups are also found in this area. Other ethnics groups that are also found in West Timor are the Rotinese, Savunese, Alornese, Florinese, Sumbanese, Sulawesians, Javanese, Balinese and Chinese. These ethnic groups are small and mainly transmigrants from other islands. According to Ataupah (1995) the ancestral leaders of the Timorese were generally royal descendants of the *Wewiku-Wehale* empires which actually controlled the *Benain* river (the longest river in Timor Island).

The island of Timor has been known to the outside world for some five centuries due to the trade in sandalwood. The quality of sandalwood from Timor Island is generally regarded as one of the best in the world (Barlow *et al.* 1990). Because of its profitability, many nations vied to dominate the trade in sandalwood. According to Barlow *et al.* (1990), the sandalwood trade involved the Chinese as well as the Portuguese and Dutch. Later the East India Company or VOC dominated the trade.

Since West Timor became a part of the East Nusa Tenggara province of Indonesia in 1945, the Indonesian government has regulated the trade in sandalwood. It was decided that sandalwood would be one of the commodities authorised by the local government. Even though there are a lot of sandalwood trees growing on farmers' lands, local farmers only get a small return from the sandalwood trade.

The Dutch colonial government dominated the trade of sandalwood in West Timor for more than 300 years. This control was broken by the Japanese invasion of 1942. The Japanese government was not an important influence in the trade of sandalwood because of the short duration of their rule in this region. The trade in sandalwood did not grow well in the period 1942-45 because of World War II and the war of independence.

Sandalwood was historically one of the important commodities that made a great contribution in the economic development of West Timor. However, this economic resource has been degraded because of over exploitation in the last 50 years resulting in its reduced contribution to the economic development of West Timor. Over the last 25 years, the role of sandalwood has been overtaken by other agricultural commodities.

Many studies that have reviewed the current economic situation in West Timor showed that some agricultural commodities have made a significant contribution to economic development of this region (Ataupah 1991, Barlow *et al.* 1990, Barlow *et al.* 1991, Bamualim and Saramony 1995). Maize, wet and dry paddy and cassava are planted for subsistence, whereas coconut is planted for both subsistence and cash, while coffee is produced for cash only.

Amongst livestock, live cattle are a major cash export, whilst buffalo and horses are primarily kept for working purposes. Pigs, goats and poultry are reared for both subsistence and cash. Barlow *et al.* (1990) mentioned that all agricultural products of the East Nusa Tenggara province have low yields, and that livestock is characterised by disease and high mortality. This comment can perhaps be generalised to West Timor. Farming households in West Timor commonly follow a mix of activities since this practice reduces the risk arising from large annual yield fluctuations which characterises agriculture in general.

Since the beginning of the 19th century, the agricultural activities in this region have been characterised by swidden slash-and-burn cultivation. Some farmers are still carrying out this practice. Farmers in this region clear forest (bush) areas by cutting down trees for their new farming land. The new open area is cultivated for 3 to 4 years, using manual digging sticks. Wooden perimeter fences are then constructed to keep out pigs and other animals. When the nutrients are depleted, farmers shift to open another forest area. According to Momuat, Subandi and Momuat (1995), the most critical factors determining farming practices in the region are water availability, soil conditions, population pressure and access to markets.

Since the population density in this region increased, there has been a reduced area for planting as well as a reduced length of cultivation cycles. To solve this problem, some new crops have been introduced to replace traditional crops, such as roots, tubers and fruits. Rice was introduced during the first millennium and is largely grown dry. In the 17th century, maize was brought from the Americas, and was readily adopted by local people throughout West Timor. Indeed, according to Ataupah (pers. comm. 1999), maize was introduced in West Timor by Captain William Dampier in 1699. Maize is one of the important commodities planted by farmers to reduce the risk of famine, and it has become the primary food commodity for West Timor. Another important food crop commodity is cassava, again from the Americas, which also started to be cultivated some time after maize and gave another major boost to food production as well as being an important fallback in times of scarcity. According to Barlow *et al.* (1990), coconuts, bananas. areca nuts (palms) and citrus were introduced during the early western incursions, while coffee was first grown in the late 19th century.

Some livestock, such as pigs, goats and buffalo came from elsewhere in Indonesia as well as China and India. These livestock are used as a source of meat and for ceremonial purposes as well as for animal labour. According to Barlow *et al.* (1990), horses were brought in around the 16th century, and have become an important means of transportation. The Dutch took Bali cattle to Timor in 1912 (Ataupah 1995).

Since the beginning of the1960s, the Indonesian government has augmented the program of agricultural development, especially its agricultural production program to overcome food scarcity This policy has influenced agricultural production in West Timor since the beginning of the 1970s through the intensification program packet. The agricultural production program has had a substantial impact on farmers' welfare by providing advantages such as irrigation channels, agricultural extension packets and credit packets.

Since the late 1960s the government has also had a policy of increasing cattle productivity and control disease through research and extension services. The most significant program for increasing livestock production is the introduction of giant *lamtoro*, a variety of *leuceana* producing much forage, which has spread rapidly throughout the region since the 1970s (Bamualim and Saramony 1995).

After gaining a historical perspective of West Timor, the next section presents a description of the economic structure of West Timor.

3.5. The Economic Structure of West Timor

In 1997, the average contribution of the agricultural sector to the total GDRP of West Timor was 41.8 per cent. The economic structure of West Timor tends to fluctuate especially in times of economic crisis, as at present. According to Hayami and Ruttan (1971), there has been a sharp transition in economic doctrine with respect to the relative contribution of agricultural and industrial development to national economic growth in the 1960s. There has been a shift away from an earlier "industrial fundamentalism" to an emphasis on the significance of growth in agricultural production and productivity for the total development process. The average contribution of the primary sector (agriculture) to the total GDRP of West Timor (based on 1993 constant price) was 52.5 per cent in 1989, decreasing to 42.2 per cent in 1995 and 41.8 per cent in 1996. The average contribution of the secondary sector (mining, quarrying, manufacturing, construction) has increased from 6.2 per cent in 1989 to 11.6 per cent in 1995 but has remained constant in 1996 (about 12 per cent), whereas the contribution of the tertiary sector (service sector) increased from 25.1 per cent in 1989 to 40.2 per cent in 1995 and 46.3 per cent in 1996.

Generally, the changing pattern of West Timor's economy was encouraging, but it was challenged by the economic crisis in 1997. The economic growth of West Timor is hampered by: (1) the slow growth of the primary sector; (2) the slow growth of the secondary sector; and (3) the too rapid growth of the tertiary sector (Statistical Office of Nusa Tenggara Timur Province of Indonesia 1998). Changes in the structure of the labour force are illustrated by: (1) the average proportion of people who work in the primary sector has only decreased from 80 per cent in 1994 to 79 per cent in 1997, (2) the average proportion of people who work in the secondary sector has increased from 7.9 per cent in 1994 to 8.1 per cent in 1997, and (3) the average proportion of people who work in the tertiary sector has increased from 11 per cent in 1994 to 13.1 per cent in 1997. The trend of structural changes in labour allocation is not very good because the growth of people who work in the tertiary sector is too fast compared to the growth in the secondary sector. At the same time, the decrease in the proportion of people who work in the primary sector is too slow. The number of people who are entering the labour market can be seen from the labour force participation level[1)]. The labour force participation level was about 66.2 per cent in 1997, which means that the number of population ten years old and over that have entered the labour force is about 0.68 million people. The number of unemployed is derived from the number of "open

[1)] The labour force participation level is derived from the number of labour force divided by the number of people ten years old and over (Statistical Office of Nusa Tenggara Timur Province of Indonesia 1998) unemployment" (number of people that are looking for a job) divided by the number of labour force (Statistical Office of Nusa Tenggara Timur Province of Indonesia 1998). The level of unemployment in West Timor was about 1.6 per cent in 1997.

3.6. The Contribution of the Agricultural Sector to the Economic Growth of West Timor

Agriculture is the sector which covers most of the labour force in West Timor with about 80.8 per cent employed by the sector in 198 decreasing to 77.9 per cent in 1996. This means that the proportion of people working in the agricultural sector has decreased by approximately 0.2 per cent per year. But this proportion increased again in 1997 (79.0 per cent) because of the economic crisis. Although the proportion of people working in the agricultural sector decreased over the decade, this sector still covers a major proportion of the labour force because the rate of decrease (proportion of labour force) is very slow. On the other hand the average growth of the agricultural sector output of West Timor (based on 1996 constant prices) increased from Rp. 96.7 billion in 1985 to Rp.380.9 billion in 1996.

The average contribution of the agricultural sector to the average GDRP of West Timor was about 41.8 per cent in 1996. Almost all regencies (except Kupang) still make a significant agricultural contribution to the total GDRP. The contribution of the agricultural sector to the total GDRP of Kupang was about 18 per cent in 1996. The regencies that had the highest contribution of the agricultural sector to the total GDRP in 1996 were TTS (54.8 per cent) and TTU (51.3 per cent). This description shows that the economic growth of almost all regencies in West Timor is dependent on the primary sector (agriculture). Martin and Warr (1990) said that as economic development proceeds, agriculture declines as a proportion of GDP.

Generally, the total production of crops in West Timor increased by approximately 16.4 per cent in 10 years (1989-97). At the same time the average farmer's per capita production of crops increased approximately 21 per cent (see Table 3.1).

In the period 1989-97, the average farmer's per capita production of crops in the Kupang regency increased by about 24.5 per cent. In the same period the TTS, TTU and Belu regencies increased their per capita production by 22.4 per cent, 25.7 per cent and 12.2 per cent, respectively.

Although the average farmers' per capita population of large livestock in West Timor had not increased in the period 1989-97, per capita population of small livestock increased by about 125.6 per cent. In the same period poultry increased about 63 per cent (Tables 3.2, 3.3 and 3.4).

Table 3.1. Total production of crops and farmer per capita production

Regency	1989			1997			Growth of per capita product. (%)
	Production (metric tonne)	Population (number of people)	Per capita Production (kg/capita)	Production (metric tonne)	Population (number of people)	Per capita production (kg/capita)	
Kupang	203 564	414 812	490.74	282 728	462 616	611.15	24.5
TTS	245 640	278 107	883.26	320 137	296 139	1081.04	22.4
TTU	98 332	130 172	755.40	131 843	138 835	949.64	25.7
Belu	125 024	172 827	723.41	154 677	190 425	812.28	12.3
West Timor	672 462	995 918	675.32	889 387	1 088 015	1817.44	21.0

Source: Derived from East Nusa Tenggara Province in Figure, 1989 and 1997

Table 3.2. Average farmer per capita population of large livestock, 1989 and 1997

Regency	**1989**		**1997**		**Growth of per capita population (%)**
	Population (head)	**Population/capita (head/capita)**	**Population (head)**	**Population/capita (head/capita)**	
Kupang	221 357	0.53	272 830	0.59	11.3
TTS	225 975	0.81	257 977	0.87	7.4
TTU	114 013	0.88	94 159	0.68	-22.7
Belu	132 275	0.76	135 704	0.71	-6.6
West Timor	693 620	0.70	760 670	0.70	0.0

Source: Derived from East Nusa Tenggara Province in Figure, 1989 and 1997.

Table 3.3. Average farmer per capita population of small livestock, 1989 and 1997

Regency	**1989**		**1997**		**Growth of per capita population (%)**
	Population (head)	**Population/capita (head/capita)**	**Population (head)**	**Population/capita (head/capita)**	
Kupang	643 146	1.12	1 022 717	2.21	97.3
TTS	213 370	0.77	321 650	1.09	41.6
TTU	76 245	0.59	649 306	4.68	693.2
Belu	139 589	0.81	220 316	1.16	43.2
West Timor	892 350	0.90	2 213 989	2.03	125.6

Source: Derived from East Nusa Tenggara Province in Figure, 1989 and 1997.

Table 3.4. Average farmer per capita population of poultry livestock, 1989 and 1997

Regency	1989		1997		Growth of per capita population (%)
	Population (head)	Population capita (head capita)	Population (head)	Population/capita (head/capita)	
Kupang	1 391 950	3.36	2 552 254	5.52	69.3
TTS	360 653	1.30	635 287	2.15	65.4
TTU	100 153	0.77	141 616	1.02	0.34
Belu	373523	2.16	644 407	3.38	56.5
West Timor	2 226 279	2.24	3 973 564	3.65	63.0

Source: Derived from East Nusa Tenggara Province in Figure, 1989 and 1997.

In the period 1989-97, average farmer's per capita population of large livestock in the Kupang regency had increased by about 11.3 per cent, whereas that of small livestock increased by 97.3 per cent. Poultry increased by 69.3 per cent. The TTS regency followed a similar trend with a small increase in large livestock (7.4 per cent) and greater increases in small livestock (41.6 per cent) and poultry (65.4 per cent). In the TTU regency the population per capita of large livestock actually decreased by 22.7 per cent, while at the same time small livestock experienced a large increase of 693.2 per cent. However, poultry only received a marginal increase of 0.3 per cent. The Belu regency had a decrease of 6.6 per cent in the population per capita of large livestock. But the population per capita of small livestock increased by 43.2 per cent and poultry by 63 per cent in the period 1989-97.

Based on these statistics, it can be concluded that the total production of crops as well as the population of livestock of West Timor increased significantly in the period 1989-97. The growth rate of crop production and livestock population in West Timor are faster than the total population growth rate in West Timor, as well as the increase in farmer population in West Timor. Thus, it can be seen that there was increased growth of per capita production (population) in the period 1989-97. The average growth of food crops production was about 7.8 per cent per year in the period 1980-98. Because of the growth in the production of agricultural commodities in this period (1980-98), the average growth of the agricultural sector output was about 16 per cent per year and the average growth of farmers' per capita income was about 11.4 per cent per year. At the same time, the average growth of tree crop production was about 6 per cent per year, while livestock production was about 8.8 per cent per year. In the period 1980-98, the average growth of the non-agricultural sector output of West Timor was about 22 per cent per year and the average growth of non-farmer's per capita income (real income) was approximately 20.4 per cent per year. Although this figure is not too bad, if the average growth of farmers' per capita income is still below 20.4 per cent per year in the same period, cumulatively, it will accelerate unequal income distribution between farmers and non-farmers. El-Said *et al.* (1996) in their simulation analysis of alternative development paths for Indonesia found that households that rely more heavily on agricultural income have lower income growth rates than those who receive the bulk of their income from other sources. Based on the descriptions above, it seems that agricultural production has increased significantly, however, the welfare of farmers has not increased as fast as that of non-farmers. Although there is a positive change in the economic structure of West Timor (from a high contribution of the agricultural sector to an increasing contribution from the non-agricultural sector), it does not mean that an unequal distribution of income between farmers and non-farmers is desirable.

As social factors have a big role in determining economic performance, it is important to discuss the demographic structure of West Timor. The next section provides this discussion.

3.7. Demographic Condition in West Timor

One of the main problems of West Timor is the high population density which is exacerbated by the high rate of population growth. As mentioned in section 3.4), on the one hand, a high population density can be viewed as human capital that can be harnessed for economic development, but on the other hand, it can be viewed as a constraint to economic development, particularly if the quality of human resources is low (Boserup 1970).

The population in West Timor increased from 0.9 million in 1975 to 1.3 million in 1996. Over the same period, the number of farmers increased from 0.7 million to 1 million.

The rate of population growth of West Timor in the period 1988-98 was slower than the period 1977-87 because the birth rate was decreasing faster than the mortality rate and there was a high level of out-migration. The rate of population growth in West Timor in the period 1988-98 was dominated by the high rate of population growth in the TTS, Belu and Kupang districts. High birth rate was a determinant of the rate of population growth in the TTS and Belu districts, whereas the level of in-migration affected the rate of population growth in the Kupang district (Statistic Office of East Nusa Tenggara province of Indonesia 1996). Job seeking and studying are the main motives for in-migration for people from outside Kupang district. Population growth in the TTU district is low because of out-migration, especially for either job seekers in Kupang and East Timor or for students in Kupang.

Two factors indicating the rate of mortality are the rate of infant mortality (IMR) and the life expectancy at birth. The rate of infant mortality has decreased in the period 1977-92. In 1977, the average rate of infant mortality in each district in West Timor was about 11.1 per 1000-live births. This decreased to 6.8 per 1000-live births in 1987 and 5.1 per 1000-live births in 1992.

The rate of infant mortality is affected by the level of knowledge and understanding of child health as well as the capability of the mother to manage the health environment of the baby. Furthermore, sanitation can be viewed as a determinant of infant mortality. A survey of household health conditions (IKRT 1980) showed that there are five main causal factors of infant mortality rate (IMR) in East Nusa Tenggara province. These are diarrhoea (23 per cent), respiratory tract infection (22.6 per cent), tetanus (19.9 per cent), prenatal hindrance (8.9 per cent), and nervous system diseases (7.4 per cent). These five factors accounted for approximately 81.8 per cent of IMR in that period.

Life expectancy in West Timor increased in the period 1977-92. In 1977, the average life expectancy in West Timor was about 51.8 years. This has increased to 59.3 years in 1987 and 62.6 years in 1992 (Statistics Office of East Nusa Tenggara province of Indonesia 1996). The highest rate of life expectancy is in the TTU district, and the lowest rate of life expectancy is in the Kupang district.

3.8. The Agricultural Production System in West Timor

The agricultural sector in West Timor can be divided into the food crops sector, the tree crops sector and the livestock sector. Each will be discussed below.

3.8.1. Food crops

According to CIDA (1980), agriculture is the mainstay in West Timor. Many social, economic and religious activities revolve around this sector, and usually the whole family is engaged in some part of it. Farmers in West Timor have carried out a traditional agricultural production system for generations. This system is mostly at the subsistence level where the main orientation is to provide food for the family.

The production system in this region is influenced by the climate, which is characterised by limited annual rainfall. The main climatic influences in West Timor are the *monsoon* winds. When the sun is over the Northern Hemisphere, Timor Island is influenced by the dry monsoon wind, which blows from Southeast Australia to the northwest. Conversely, when the sun is over the Southern Hemisphere, Timor Island is influenced by the west monsoon, which blows from Northwest Asia to the southeast dropping much water on the western parts of Indonesia.

Because of the influence of the monsoons, rainfall in West Timor is limited to 3 or 4 months of the year. Precipitation in West Timor, as the dominant element of climate, fluctuates in location and time. Momuat *et al.* (1995) mentioned that the climatic condition in the agricultural sector of East Nusa Tenggara Province of Indonesia (which includes West Timor) could be divided into (1) rainfall variability, (2) long dry season and short wet season, and (3) rain storm.

The dominant long dry season (8 or 9 months of the year) has influenced farmers to retain their traditional agricultural production system, even though the productivity is low. Their most important goal is how to fulfil basic food needs during the year. According to von Braun *et al.* (1994), the rapidly rising person-land ratio is expected to further increase intensification of food crop production with higher labour inputs per unit of land. However, von Braun *et al.* (1994) did not describe the socio-cultural constraints that have reduced the pace of change from extensive to intensive farming.

Most West Timor farmers view shifting cultivation as advantageous, because they do not need to spend much time or money on this farming system. The two main activities in a shifting cultivation system are bush clearing and burning. This technique enables farmers to overcome the problem of weeds and fertility depletion and also provides some fertiliser in the form of sawdust and ash for their crops. According to Hartanto (pers. comm. 1999), farmers in West Timor do not believe there is another technique that is better than shifting cultivation. Ahmed and Sanders (1998, p.5), in their article "Shifting from extensive to intensive agricultural system: a case study in the Sudan", stated that:

> *'If area expansion is becoming more difficult with falling yields and increasing transportation cost, the need to shift from extensive to intensive system is recognised by both policy makers and researchers'.*

However, they found that on depleted soils, with or without the subsidies, it is unprofitable to carry on cultivation and farmers just move on to new areas. Although the cost of area expansion is more than double in their model by removing the subsidies, extensive production is still profitable on virgin soil without shifting to more intensive fertiliser technologies. This is because the cost of bringing additional units of land under extensive production using available farm resources is still low, the additional cost of fertiliser are high and the marginal yield increase from fertiliser application on virgin land is relatively small.

A mixed cropping system is typical of shifting cultivation and has been adopted to minimise the risk of crop failure. Crops are planted in the first week of the rainy season with no fertiliser application. Weeding activities are then conducted manually two or three times during the growing period. In this system, two or more seeds (eg. maize and legume) are commonly put together in one hole. Another dominant crop in the same cultivated area is cassava.

The productivity of a shifting cultivation system is generally very low and fluctuates from year to year depending on the precipitation and the level of fertility of the cultivated area. Furthermore, the chief concern of farmers in this system is with subsistence rather than the level of productivity.

After the Indonesian government introduced a program of intensification, many farmers throughout West Timor adopted semi-modern techniques in their cultivation. Understandably, the rate of adoption is greater with farmers living in semi-urban areas with more developed infrastructures than with farmers living in rural areas (Purawoha 1995). Some modern cultivation techniques that have been adopted by farmers are fertiliser application, irrigation, weeding, land preparation and pest control.

The intensification program has increased the productivity as well as the total production of crops since the 1980s. According to Gonzales *et al.* (1999), the production of primary food in Indonesia, increased rapidly at 5 per cent a year during the period 1970-88. In addition to sharp increases in rice yields, growth in corn has also been impressive, averaging 4.8 per cent a year, largely due to the introduction of improved varieties and increased use of fertiliser on corn. But the intensification program has not had a dramatic effect on cassava yields. Growth in cassava production was weak - only 1.7 per cent a year- as a result of a steady loss in cassava area due to government interventions favouring rice. Over the years, Indonesia has subsidised the major agricultural inputs, particularly irrigation, fertiliser and pesticides, and supported and stabilised the domestic price of food crops. The average implicit subsidy on the domestic price of fertiliser reached a peak of 55 per cent in 1980-82, but declined steadily after the mid 1980s to about 35 per cent. The cost of irrigation was also subsidised by more than 75 per cent. Before the government decided to encourage integrated pest management, pesticides were subsidised by more than 60 per cent. Pesticide subsidies have now been eliminated.

3.8.2. Tree crops

Tree crops are more dominant in Flores Island - another part of East Nusa Tenggara Province - than in West Timor. This is because the climate, topography and fertility levels of Flores Island are more conducive to tree crops cultivation. According to NTADP (1992) food crops are produced mainly for subsistence consumption and tree crops are for cash earning, while livestock are also one of the major sources of income.

Of the tree crops, coconuts occupy the largest area (38 per cent of the total area of 111 161 hectares in 1998), but coffee is considered more important because of its profitability. Coconuts are one of the traditional tree crops that have been cultivated by farmers since the early western incursion, whilst coffee was first grown in the late 19^{th} century. Coffee is mainly grown for cash whereas coconuts are grown for both subsistence and cash. Another cash crop grown only in the TTS district is citrus. This crop was introduced after coconut and coffee were introduced.

Other traditional tree crops are *lontar* (*Borasus flabelifer*) and *areca nut* (*Areca lutescens.*). According to Barlow (1990), *lontar*, the traditional tree crop of Rotenese and Savunese, is grown extensively and various fruit trees are also quite significant; however, data are not available. *Areca nut* trees only occupied 2.5 per cent of the total area of 111 161 hectares of tree crops in 1998.

Farmers in West Timor, generally practice a traditional agro-forestry system known as mamar. Coconuts, areca nut, coffee and some fruit crops, such as bananas and jackfruit, are planted irregularly (mixed) on the same land (*mamar*), so that they can create a comfortable microclimate condition for crops. The productivity of crops under the *mamar* system is low. However, the main objective of the *mamar* system is to reduce the risk of crop failure.

3.8.3. Livestock

West Timor was known as a region of cattle production until the beginning of the 1990s. There were a lot of cattle shipped to abattoirs in Java, Singapore, Hong Kong and elsewhere. In the period 1980-90, the number of cattle shipped out of West Timor was about 50 000 head per year. However, cattle in West Timor have degraded in quality in the last few decades because of over-exploitation. This is indicated from the number of cattle that has been shipped out of Timor Island in the period 1991-98. In this period, the number of cattle exported out of West Timor decreased by 6000 head per year compared to the period 1980-1990 (Statistical Office of Nusa Tenggara Timur Province of Indonesia 1980-1990). Statistically, the decreasing number of cattle exported out side of West Timor is not too significant. However, as Barlow *et al.* (1990) mentioned, although total cattle numbers have continued to increase, the total weight of finished animals has dropped. This cannot be properly checked, since no comprehensive data are available. Other large livestock dominant in West Timor are horses and buffalo. Buffaloes are used for animal labour in cultivation, whereas horses are used for transportation.

The livestock production systems in West Timor use few modern inputs and fully reflect the difficulties of the environment. Livestock roam freely without any intensive control by the farmer and with no supplements given by farmers. Livestock (cattle) mostly depend on pasture capacity but over grazing has degraded pasture by at least 50 per cent in 25 years (Ataupah 1991). In addition, pasture degradation is exacerbated by a calving rate of 50 - 70 per cent per year (Barlow *et al.* 1990. Under the conditions of pasture degradation, water scarcity and no supplementary forage, the growth rate of livestock (cattle) is low and averages some 70 kg annually. General constraints to livestock production development are scarcity of forage at the end of the dry season, Newcastle disease and high mortality of weaner bulls, chickens and goats.

Some farmers in some wet regions adopt a traditional semi-intensive livestock production system. Farmers in the Amarasi sub-district of Kupang district run a semi-intensive production system known as *paron*. Under this production system, cattle do not roam freely and are kept in a pen. Weaner bulls are frequently taken from the grazing herds at the ages of 1.0 to 1.5 years with weights of approximately 100 kg. They are then fattened on a labour-intensive cut-and-carry (*paron*) system, which mostly uses the *lamtoro* (*Leuceana leucepala*). According to Bamualin and Saramony (1995), the "Amarasi" system is a classic example of how some dryland farmers were able to keep four to five fattening cattle per family at any one time, when "*lamtoro*" was in full production. The system was originally developed to reduce degradation in Amarasi in the 1930s. Under this system, farmers had to intercrop "lamtoro" with the maize crop on their land. By the 1970s, most of the district was covered by "*lamtoro*" which was an ideal source of fodder for cattle.

The growth rate of cattle under this system is faster than in a traditional system and averages some 100 kg of growth annually (Barlow *et al.* 1990). Under this system, the farmer has to spend three or four hours per day collecting forage. However, the *paron* system cannot be adopted by farmers in all regions, due to the unavailability of *lamtoro* as a source of forage.

Amongst small livestock, pigs and goats are dominant in West Timor. These small livestock are used for subsistence as well as cash. Like the cattle production system, goats roam freely for grazing. However, some farmers, especially those who live in town and semi-urban areas, keep their goats in cages and give them forage such as legumes and grass.

The pig production system is characterised by a semi-intensive system. Pigs are kept in cages with four pigs on average owned by each family. Generally, pig raising is carried out by farmers and can also be conducted by other people (Statistics Office of East Nusa Tenggara province of Indonesia 1990-1998). Pig production has increased by more than 100 per cent in one decade. Pigs are one of the most popular livestock, because there are many sources of forage that can be found to support pig fattening. Some sources of forage that are used during the fattening process are maize, banana stems, vegetable leaves, leftovers from meals and by-product of milling. The growth rate of pigs is low with an average of 40 to 50 kg being reached in 2 years or more.

Chickens, which have dominated the poultry production system, live mainly from scavenging, although they may sometimes be given crushed corn. The traditional chicken production system suffers from high mortality, owing not only to disease but also to predators and climatic and nutritional stresses. However, since the beginning of the 1980s there has been some intensive chicken production in urban areas (Ataupah, pers. comm. 1999). Rural people find it hard to rear chicken intensively due to the difficulty of obtaining capital. It seems to be difficult for farmers in rural area to get access to credit from some finance institutions. Under the intensive chicken production system, the number of poultry in West Timor has increased by 8.5 per cent per year in the period 1990-1998.

3.9. Land Tenure

According to Ataupah (1995), cultivation activities, especially of food crops, have been carried out by the people of Timor Island for the last 600 to 700 years. Ataupah conducted research into the land tenure pattern on Timor Island. In his report, Ataupah said that the land tenure patterns on Timor Island are determined by the land use systems carried out by the local people. The local people conducted their cultivation activities (shifting cultivation, extensive livestock, hunting, etc.) under the control of local social customs, which differ from region to region. There are several principles in relation to the land tenure pattern on Timor Island (Ataupah 1995).

1. Each local community in a region has a specific land-right pattern for people in that region. This community consists of the offspring of the landlord and others who have been accepted in that community.

2. Each local community has freedom to conduct their agricultural activities (shifting cultivation, extensive livestock, hunting etc.) in their region. This freedom is only limited by their internal rule.

3. The borders of the local community region sometimes overlap with the border of the administrative region of the formal government.

4. There is no formation of a new local community region anymore. The application of formal rule by the local government is not relevant in relation to the border of the local community region, because it is controlled by the rule of local custom.

There are four categories of land holdings found on Timor Island (CIDA, 1980). First, *tanah suku,* which means land belonging to the clan. The landlord is in charge of the allocation of such land. Second, *tanah adat* is traditional land. This land is owned by people who have been able to prove or convince others that their forefathers used the land. As such, they have inherited the piece and have sole title to it. In practice, this land is indistinguishable from *tanah suku.* Third, *tanah negara* is state land owned by the government. This land can be used with the approval of the local government. Fourth, *tanah pribadi* is privately owned land. With the process of modernisation, more land has been added to this category. In most villages the plots on which the houses stand are privately owned.

It is hard for the landlord or the government to sell the first three categories because of complicated formal and informal regulations. Some problems usually arise when *tanah adat* has not been used for a couple of years and is occupied by another party. Before the other party occupies the land, they have first to enquire whether or not some one else has a claim on it. Another problem arises since too much *tanah suku* or *tanah adat* is transferred to private ownership. A problem arises when purchase and registration of such land is not recognised by the clans that previously held it. They must then attempt to get compensation from the owner.

According to CIDA (1980), under the land reform law (*Undang-Undang No. 56/1960, Tentang Penetapan Luas Tanah Pertanian*) users of land can obtain title to own the land. Most of such land was previously *tanah suku* or *tanah adat.* However, the 1960 land reform law has not been widely adopted especially by the rural people. This is because rural people are likely to adhere to the traditional system under which the clan holds land.

Because the borders of traditional land property sometimes overlap with the borders of the administration region of formal government, the utilisation of cultivation land is as follows:

The local people who have property of a particular land according to the internal traditional rules will occupy that property without any consideration about the formal borders of the land. They also will occupy their traditional property without any confirmation with the local formal leader as a legal formal administration process.

Generally, the traditional communities give property rights back to the person to reoccupy the land that has been left a couple of years for reforestation. When the population increases and land rotation cycle in the shifting cultivation activities become shorter than before, many people claim the land as their private property. This land might be granted by this people based on the local traditional rules.

3.10. Agricultural Marketing Systems in West Timor

As will be described in more detail in the section on major constraints to development, the Timorese had difficulties engaging in western type economic rationalisation. Because the main orientation of West Timor farmers' is to fulfil their basic needs every year, they focus only on "on-farm" activities with little value adding. There is limited market orientation of their agricultural production. Even though markets are found in almost every area, not every village has one. Daily markets are only found in the capital cities of the four districts (Kupang, So'E, Kefa and Atambua), whereas village markets operate only once a week (weekly market). Benu (1994) stated that local markets, especially weekly markets, serve as an economic institution at the village level. However, these markets serve more as place for social activities rather than as economic centre. According to CIDA (1980. p.54),

> *'In western countries there is usually a decline in the price as soon as supply increases. In Timor, however, the law of supply does not always operate. The vendor shows a reluctance to drop the price of*

their produce when the quality deteriorates or the supplies increase'.

Lack of market information is one of the main problems for farmers competing in the market. Monopolistic, oligopolistic and monopsonistic conditions created by middlemen and profit seekers aggravate this weakness. In such situations small farmers and producers often become the victims of institutions with greater economic power. Klau (1994) in his study on market information for legume growers in the Kupang district found that 71.4 per cent of farmers receive the information on the price of their product at the point of sale. On the other hand the middlemen always got their information beforehand and on a broader scale than farmers. Middlemen have always decided the prices of commodities, while farmers are only in the position of "price taker" in the bargaining mechanism. As the middlemen have a monopoly, the farmer is forced to sell to the middlemen at a price over which he has little control. According to CIDA (1980), the majority of middlemen are Chinese traders. Others are Buginese from Sulawesi, Rotinese, and Savunese. It is interesting to note that the Timorese have not yet moved into this position. The socio-cultural obligation to share with clan members makes it difficult for them to create business.

Another problem area, alluded to by Barlow *et al.* (1990), is that the market for purchased inputs needed in both production and consumption is hampered by high transport charges as well as by the various "transit fees" and taxes imposed by the government. Further, the number of traders permitted to supply inputs is often deliberately limited, which directly reduces competition and raises charges. One institution at village level that has been given legal status and is concerned both with supplying certain material inputs and handling the sale of commodities is the cooperative *koperasi unit desa* (KUD). Unfortunately, the role of KUD is limited due to low quality human resources, lack of good management and lack of supporting finance. KUD's role is that of the middle-institution in marketing agricultural commodities and it imposes taxes on some commodities, notably on cattle. Although KUD is concerned with supplying certain inputs such as fertiliser and pesticide, farmers are allowed to buy their inputs directly from the market negotiating the price as well as the quality of input. However, farmers are only included in the credit scheme if they become members of KUD which charges an annual fee for membership.

Marketing channels for agricultural crop commodities in West Timor take several forms (Bano and Seran 1999; Seran 1994). First, farmers can sell their products to the collectors at village level and the collectors will sell them to the wholesaler at sub-district level. The wholesaler will then sell the product to another wholesaler at district level. This wholesaler will then distribute it to the retailers who will sell the product to the consumers. Second, farmers can sell their products to KUD and KUD will sell it to wholesalers from the district level who have permission to operate at village level. The wholesaler will then sell it to the retailer who will sell it to consumers at the district as well as sub-district market. Third, farmers can sell their products to the retailer who will sell it to consumers at the district as well as sub-district market. Lastly, farmers can sell their products directly to consumers at the village market, sub-district market and district market. However, it should be noted that only a few farmers sell their food products, especially maize and rice, to middlemen or even the market. Many of them (83.6 %) retain their produce for their family consumption during the year (Widiyatmika 1995) while cash is obtained from livestock selling.

Cattle are the foremost external market product. Cattle marketing entails collectors who organise the purchase of livestock from local centres or even farms, buying by live weight that is often estimated without the use of scales. Sometimes the collectors buy live cattle in livestock markets such as *Camplong* market and *Takari* market. Farmers usually bring their cattle to these weekly markets to get a good price, but are not reimbursed for transportation cost from the farm gate. In some cases, farmers have to walk 50 km to bring their cattle to the market. Moreover, they have to pay tax (Rp. 5000 per head) from their selling price, while collectors have to pay another tax for a legal document issued by KUD. The minimum weight of cattle that can be sold by a farmer is 200 kg of live weight (ACIL 1983 cited by Barlow *et al.* 1990). These collectors pay in cash for their purchases and consign the animals in trucks to the port at Kupang (Tenau), Atambua (Atapupu) and Kefa (Wini) where they are first placed in quarantine. These exporters arrange the shipment of cattle to Surabaya and elsewhere, together with their subsequent trucking to Jakarta and other abattoirs where they are slaughtered prior to retail sale. The cost of this marketing operation was estimated in the early 1980s as approximately 28 per cent (including 5

% taxes) of the Jakarta price for a 300 kg beast prior to slaughter (ACIL 1983 cited by Barlow *et al.* 1990). According to this source, a farmer producing a fat beast in West Timor accordingly receives some 72 per cent of the Jakarta return.

This quoted cattle margin may nonetheless be judged reasonable in light of the operations performed, and the current degree of competition between separate collectors and exporters is thought sufficient to maintain this situation. However, the margins received by the retailers are not as large as with other commodities. Many collectors and several exporters have retired from the cattle trade, having been unable to earn enough profits in such a competitive business (Barlow and Gondowarsito 1991).

3.11. Major Constraints to Development

As a part of eastern Indonesia, West Timor is known as one of the under-developed regions. The underdevelopment of West Timor is not only due to unfavourable agro-climatic and edaphic conditions, but also the socio-economic and cultural background, which in some cases are counter-productive.

The agricultural sector of West Timor cannot be developed as productively as other regions because of its dry climate and long dry season as well as its limited irrigation infrastructure. The method of shifting land cultivation that ruins the ecology is still carried out in places. At the same time, land use potential that does exist, such as in the uplands, is not utilised to an optimal level, while in other places the land is over-exploited because of high population density. The physical and climatic conditions, as well as the kind of technology used in land preparation, which is not appropriate to the environmental conditions, can significantly influence the outcome of efforts to raise living standards (Manuwoto 1991).

Unpredictable weather conditions such as rainfall timing, thunderstorms and winds aggravate the unfavourable agro-climatic and edaphic conditions in West Timor

(Ataupah 1991 Boeky 1991). This condition is the main cause of instability of agricultural production and thus the main constraint in the agricultural development of West Timor. Because of the low productivity of agriculture, output in this sector is less than consumption. Annually large amounts of food have to be imported, and as a result, the savings are zero and development suffers.

A further constraint faced by the region of West Timor is structural poverty, which means that people are unable to fulfil their basic needs in terms of productivity, consumptive power and the availability of basic commodities. Structural poverty is caused by such factors as limited natural resources, geographical isolation, the lack of a basis for industrial development and a low level of absorption of labour in the non-agricultural sector, as well as socio-cultural constraints.

As a result of poverty, there are inadequate levels of education, skill and health, so that the quality of human resources limits further economic development, especially a change in the economic base, i.e., from agriculture to industry (Benu, *et al.* 1992). The general level of health is far from ideal. Many suffer from a variety of diseases. During the dry season when more labour should be available for outside projects, less work can be accomplished. Workers are not very energetic when poorly fed and their motivation is very low. Unhygienic conditions contribute much to poor health. These conditions tend to become worse when people are concentrated on a project without proper facilities. Poor hygienic conditions are possibly the greatest threat to effective manpower planning. Outbreaks of contagious diseases have in the past paralysed the entire labour force on a project. Malaria can also paralyse the labour force, and little is done to control malaria (CIDA 1980).

As will be mentioned in greater detail in Section 4.2, West Timor is a small open economic region. There is limited market orientation in farmers' activities and there are some difficulties involved in efficiency and the resources augmenting aspects of external trade activities. According to CIDA (1980), the Timorese have difficulties engaging in western-type economic rationalisation. Traditional forces and lack of training are the major contributing factors. This constraint creates limited utilisation of economic potential.

As in many part of Indonesia, lack of market information is one of the main problems for farmers in West Timor competing in the regional market. This weakness is aggravated by the monopolistic, monopsonistic and oligopolistic conditions of the market created by middlemen and profit seekers. In such situations small farmers and producers often become the victims of institutions with greater economic power. If this condition persists, small, powerless farmers will not gain from any development program, and could become more impoverished.

The imbalance of economic growth among regions, especially between the growth centre regions and hinterland, means that the growth centre regions absorb the interregional advantages. This condition is caused by the fact that the strategy of development does not consider enough the flow of demand and supply spatially. Therefore areas like the hinterland do not have enough access to the advantages of economic growth. Further, the relationship between the hinterland production centres and the market is weak resulting in subsistence type agriculture.

The physical, socio-cultural and socio-psychological isolation of the hinterland is caused by the lack of quality infrastructure and transportation. The effect of this condition is the lack of development of the hinterland, which is only based on "on-farm" agriculture with low value adding. Efforts to accelerate the economic growth of the hinterland through "off-farm" agricultural development face problems in relation to the lack of quality infrastructure and transportation.

Lack of appreciation of various cultural aspects such as religion, social and economic factors are often constraints to development. As these aspects are strongly interwoven, it cannot be assumed that economic inputs will produce only economic outputs. A wide range of considerations will affect development schemes.

According to CIDA (1980), Timorese society can be categorised as heterogeneous. There are various ethnic divisions and a lack of inter-ethnic mixing. Over the centuries isolated communities have developed which do not blend easily together. The heterogeneity of these societies suggests the necessity for a tailor-made development approach to ensure good interpersonal relationship and successful implementation.

The weaknesses of government institutions are another problem that have to be overcome to accelerate development in West Timor. As in many parts of East Nusa Tenggara province, West Timor faces the problem of rigidity in government bureaucratic systems and a lack of interdepartmental coordination. According to Kameo (1995) the coordinative function of the regional development-planning agency (BAPPEDA) is far from ideal, both because of the departmental bureaucratic system as well as internal weaknesses inherent in BAPPEDA. Furthermore, he said that this condition is often reflected in the absence of good regional development planning. Development programs are often merely viewed as simple projects needing to be completed within a given budget year.

Lack of effective leadership is paramount in most communities. This deficiency has contributed to the loss and waste of human and physical resources. Manpower is often hired in large numbers, while with good leadership a job could be done with fewer people. Some traditional leaders still maintain a strong position at the village level, even in the formal government management. Most of them are conservative and contra-modernisation, because they perceive that accommodating modernisation will erode their position. These people have little understanding of, nor appreciation of. the process of modernisation. Indeed, they are reluctant to change their lifestyles in any way. Several attempts in the past to bring about change through development projects have failed. According to Barlow and Gondowarsito (1991), local leaders and their followers are actually crucial elements in development, for which their support is essential. Hence the well-established church groups at the village level in Timor have demonstrated their ability to mobilise people in economic enterprises. Further they stated that consultation and cooperation between traditional groups and non-government organisations have been vital to the viability and sustainability of small community improvement projects in West Timor.

Lack of motivation and ambition are two other factors that will determine the immobility of any development program unless the local people can be involved.

According to CIDA (1980), people can be put on a project, but they do not stay long. Coercion is sometimes applied to keep them working. The government can do this up to a point, and people will sometimes accept it. However, private enterprise does not have such coercive ability. If workers leave, private enterprises have to use other means that are limited and not very effective. Usually they have to keep hiring new people. Farmers are not anxious to work on projects outside of agriculture. Participation rates for outside projects are very low and the total labour force is relatively small.

Kameo (1995) mentions that the absence of well functioning output and input markets, as well as a lack of service oriented financial institutions as a source of affordable funds, and other service institutions can be a disincentive and even an obstacle to various development efforts.

3.12. Concluding Remarks

Agricultural development in Indonesia has been influenced by government policies introducing intensification program packages. These programs have been introduced to promote the use of a technology package (fertiliser, pesticide, modern varieties, etc.), provide credit and fertiliser subsidies, an intensive extension program at the village level and investment in irrigation development. The Indonesian government supported the program of food crops production, especially rice, by maintaining stable and favourable commodity prices together with highly subsidised fertiliser prices. At the same time, less support has been given to other food crops, such as corn and cassava.

At the regional level, so far, the government of East Nusa Tenggara province has had five special programs to accelerate economic development including the agricultural sector. In the 1980s, East Nusa Tenggara province reached food sufficiency status especially for maize. However, this region still faced problems of low quality of human resources, unfavourable agro-climatic and edaphic conditions, non-conducive conditions of the socio-cultural background and government budget constraints.

All the government programs have been introduced to increase agricultural production as well as to promote the welfare of the people in this region who are hampered by the unfavourable agro-climatic and edaphic conditions as well as inefficient agricultural practices. Since the beginning of the 19^{th} century, the agricultural activities in this region have been characterised by swidden slash and burn cultivation. As the population density increased, there has been reduced area for planting, as well as reduced length of cultivation cycles. Some new crops such as rice, bananas, and peanuts have been introduced to replace traditional crops such as roots, tubers and fruits.

Shifting cultivation is viewed as advantageous by most West Timor farmers because they do not need to spend much time or money on this farming system. A main characteristic of shifting cultivation is mixed cropping system which has been adopted to minimise the risk of crop failure. The productivity of a shifting cultivation system is generally very low and fluctuates from year to year depending on the precipitation and the level of fertility of the cultivated area. Furthermore, the chief concern of farmers in this system is with subsistence rather than the level of productivity.

Livestock production systems in West Timor are low in modern inputs and fully reflect the difficulties of the environment. Livestock roam freely without any intensive control by the farmer and are given no supplements. Because the main orientation of West Timor farmers is to fulfil their basic needs every year, they focus only on "on-farm" activities with low value adding and there is limited market orientation of their agricultural production.

Unpredictable weather conditions such as rainfall timing, thunderstorms, and winds aggravate the unfavourable agro-climatic and edaphic conditions in West Timor. This condition is the main reason for instability in agricultural production and thus the main constraint in agricultural development. However, the agricultural sector of West

Timor is still biggest contributor to the total gross domestic regional product of West Timor. The changing pattern of West Timor's economy has shown a good trend, but was recently challenged by the economic crisis.

In the middle of 1998, Indonesia entered the economic crisis era. The real GDP of Indonesia declined around 14 per cent between 1997-1998. At the regional level, the real GDP growth of West Timor declined from 18.8 per cent in 1997 to – 52.2 per cent in 1998. Like the financial crisis at the national level, West Timor also suffered bankruptcies of some big commercial banks as well as companies. The economic crisis has aggravated the poor economic condition of Indonesia especially West Timor. So far, the Indonesian government has introduced a social safety net program to stimulate economic development by improving purchasing power of the people. This program is one of the program packages in the letter of intent between the Indonesian government and the International Monetary Fund (IMF) for economic recovery. However, this program faced corruption problems, collusion and nepotism in the government. These three problems are the main constraints faced by the government that need to be eliminated in order to ensure the success of the economic development program.

Some other major constraints in the economic development of West Timor are the physical. socio-cultural and socio-psychological isolation conditions of the hinterland (which is caused by the lack of infrastructure and transportation), lack of motivation and ambition, imbalance of economic growth among regions, poor heath conditions of people, lack of market information, and the weaknesses of government institutions.

CHAPTER 4

REVIEW OF APPROACHES TO MODELLING AGRICULTURAL SYSTEMS

4.1. Introduction

This chapter is devoted to a review of literature on modelling and related methodologies for analysing agricultural production and farmers' welfare.

A review of the approaches to modelling agricultural systems is presented in Section 4.2. This section focuses on a review of the econometric method and the partial equilibrium model. Section 4.2.1 contains a review of the estimation of the parameters and the derivation of the parameters for the elasticity coefficients. Section 4.2.2 contains a discussion of the advantages and disadvantages of the partial equilibrium model compared to the general equilibrium model.

Section 4.3 presents the derivation of the agricultural production function. This section contains also a review of physical, social, economic and policy factors involved in a production function. A review of the agricultural demand function is presented in Section 4.4 along with the socio-economic factors to be covered in a demand function.

Section 4.5 presents a discussion of the whole review of literature in relation to the econometric method and the partial equilibrium model, along with implications for the research. Section 4.6 presents a conclusion of the whole review on methodologies of the research using econometric method and partial equilibrium models.

4.2 Approaches to Modelling Agricultural Systems

There are two principal approaches that are generally used in modelling agricultural systems, i.e. mathematical programming modelling and econometric modelling. Mathematical programming involves finding an optimal solution for a specific objective subject to some constraints. An optimal solution refers to a solution that satisfies both the conditions of the problem and the given objective (Gass 1964, Dent and Woodford 1986, Mitchell 1993, Pannell 1997). The econometric approach on the other hand is concerned with the empirical estimation of economic relationships among variables.

Mathematical programming models can be classified into two general types: linear programming models and non-linear programming models. Linear programming is the most widely used of the various mathematical programming techniques (Driebeek 1969, Mitchell 1993, Pannell 1997). It deals only with those problems for which all the relationships between the variables are linear. Linear programming allows us an opportunity to combine the constraining limitations of the decision environment with the interaction of the unknown values we are seeking to optimise (Schniederjans 1984). In mathematical programming models, the logical approach to problem solving is more important than the mechanical manipulation of any model. According to Hughes and Grawiog (1973, p. 4), a mathematical programming model:

> *'...provides an efficient mathematical method of determining an optimal strategy when there are numerous alternative strategies which might be followed in seeking a certain objective and the picture is clouded by the fact that the various courses of action are interrelated by numerous restrictions and constraints.'*

In order for a mathematical programming model to be used effectively, there are several basic requirements that must be satisfied by the problem and the problem environment. First, there must be alternative courses of action; second, the alternative course of action must be interrelated through some types of restriction; third, there must be an objective involved and this objective must be explicitly stated before the model can be built; and lastly the variables in the problem must be stated either linearly related or non-linearly related, both in terms of resource usage and objective contribution (Hughes and Grawiog 1973).

A mathematical programming approach could be an effective way of policy analysis of an existing problem in agriculture regarding some constraints such as the availability of input (capital, land, water, labour), externality and infrastructure. However, the solution that the user might get is simply based on the technical coefficients given. The user might only use the technical coefficients without a justification of whether the coefficients are from a significant relationship among variables. The econometric approach on the other hand empirically estimates relationships among variables, but the user will not know the optimal solution for the problem regarding the constraints of the variables. However, both of these approaches can be used together in modelling a particular agricultural system. The econometric approach might be used to get some empirical coefficients of relationships among variables, and further these coefficients might be used as the technical coefficients in the mathematical programming model.

Nevertheless, since the goal of this research is to describe the empirical relationship among social, economic, technical and policy factors with respect to agricultural production and farmers' welfare in west Timor, the econometric technique is the preferred approach for this particular study. As a branch of economics, econometrics is concerned with the empirical estimation of economic relationships (Intrilligator 1978).

Generally, there are three main uses of econometric analysis, i.e., structural analysis, forecasting and policy analysis (Intrilligator 1978, Koutsoyiannis 1978, Kmenta 1980). Structural analysis refers to the use of an estimated econometric model for the quantitative measurement of economic relationships. Forecasting is the use of an estimated econometric model to predict the value of certain variables outside the sample of data actually observed, and policy evaluation is the use of an estimated econometric model to choose between alternative policies. The econometric approach is not confined exclusively to economic phenomena; it can also be applied to other phenomena such as population growth.

4.2.1. The econometric method

There are four stages involved when using the econometric approach; that is, model specification, estimation of the model, evaluation of the parameter estimation and evaluation of the forecasting power of the model. A model, by definition, is any representation of an actual phenomenon such as an actual system or process (Intrilligator 1978). Furthermore, Intrilligator (1978) mentioned that the actual phenomenon is represented by the model in order to explain it, to predict it and to control it. Labis (1979) stated that a model is a formal representation which reflect the underlying economic, political and social institution.

According to Koutsoyiannis (1978) specification of the model and estimation of the model are the most important aspects of any econometric research. These aspects require the skill of an economist with experience in the functioning of the economic system. Evaluation of the parameter estimation and evaluation of the forecasting power of the model on the other hand are technical aspects which require knowledge of theoretical econometrics. The "goodness" of an econometric model is judged customarily according to five desirable properties. These are theoretical plausibility, explanatory ability, accuracy of the estimates of the parameters, forecasting ability and simplicity (Koutsoyiannis 1978).

According to Intrilligator (1978), typically, an econometric model is a special type of algebraic model, namely a stochastic one that includes one or more random variables. It represents a system by a set of stochastic relations among the variables of the system. The algebraic model for the purpose of econometrics is the most important type of model; it represents the real-world system by a system of equations.

Koutsoyiannis (1978, p. 331) stated that:

> *'If we have two-way causation in a function this implies that the function can not be treated in isolation as a single equation model, but belongs to a wider system of equations which describe the relationship among all the relevant variables'.*

If $Y = f(X)$, but also $X = f(Y)$ it is not appropriate to use a single-equation model for the description of the relationship between Y and X. We must use a multi-equation model, which would include separate equations in which Y and X would appear as endogenous variables, although they might appear as explanatory in other equations of the model. This requires simultaneous equations modelling.

In simultaneous equations modelling, the application of the ordinary least squares will be biased and inconsistent and the statistical test will be invalid (Dougherty 1992, Pindyck 1998). Several methods that can be used to estimate the parameters of the model are: the reduced form method or indirect least squares (ILS) method, the method of instrumental variables (IV), two stage least squares (2SLS), limited information likelihood (LIML), full information maximum likelihood (FIML), three stage least squares (3SLS), and the mixed estimation method (Koutsoyiannis 1978, Gujarati 1995).

The first five methods are called single-equation methods, because they are applied to one equation of the system at a time. The Three Stage Least Squares and Full Information Maximum Likelihood are systems methods, because they are applied to all the equations of the system simultaneously.

The regression coefficient that is derived from any econometric method can be viewed as an elasticity coefficient or a component of the elasticity. If the model is a linear function, the regression coefficients that are derived from the function cannot be treated as an elasticity coefficient. It is just a component of the elasticity coefficient. But, if the model is a Cobb-Douglass function, the regression coefficient can be treated as an elasticity coefficient. From the estimation of linear function:

$$Y = b_0 + b_1 X_i \qquad (4.1)$$

where:

Y = dependent variable
X_i = independent variable
b_0 = constant
b_1 =parameter regression

The coefficient b_1 is the derivative of Y with respect to X, i.e., $b_1 = dY/dX$ which shows the rate of change in Y as X changes by a very small amount. According to Koutsoyiannis (1978), it should be clear that if the estimated function is a linear function, the coefficient b_1 is not the elasticity, but a component of the elasticity, which is defined by the formula:

$$\eta = (dY/Y)/(dX/X) = (dY/dX)\,(X/Y) \tag{4.2}$$

It is clear that b_1 is a component dY/dX. An average elasticity can be derived from the formula:

$$\eta = b_1(\bar{x}/\bar{y}) \tag{4.3}$$

Where:

η	= elasticity coefficient
$\bar{x}$	= mean of x
$\bar{y}$	= mean of y

Equation (4.3) describes the elasticity coefficient of a linear function in the short-term. A long-term elasticity coefficient of a linear function can be calculated by weighting a short-term elasticity with the regression coefficient of a lagged endogenous variable (Sinaga 1989).

$$\eta_L = \eta_s/(1-\beta_{lag}) \tag{4.4}$$

Where:

η_L	= a long-term elasticity coefficient
η_s	= a short-term elasticity coefficient
β_{lag}	= regression coefficient of the lagged endogenous variable

The regression parameter can be viewed as the elasticity coefficient when it is derived from the Cobb-Douglas production function. According to Thomas (1985), Douglas when working in the late 1920s, observed that the share of total US national output going to labour remained approximately constant over time, i.e.,

$$Q = AK^{\alpha}L^{\beta} \quad (4.5)$$

where:

Q	= quantity of production
K	= capital
L	= labour
α and β	= parameters

The parameters α and β of the Cobb-Douglas production function (4.5) measure the elasticity (assumed constant and between zero and unity) of output with respect to capital and labour, respectively.

Kuyvenhoven *et al.* (1998), stated that the elasticity analysis in the agricultural development policy measures particularly impact of relative prices for agricultural inputs and outputs, trade and exchange rates policy, availability of public goods and services, on the agricultural sector output (largely based on Nerlove's supply response analysis in 1958) Supply response can take the form of area expansion, technological resource allocation and the environment. Responses will vary among different types of rural households and can be lagged as a result of differences in expectations and adjustment costs. The development of a new analytical method is required for an adequate understanding of the determinants of agricultural supply, the differences between short and long-run responses and the effectiveness of different policy instruments for the adjustment of resources used within prevailing farming systems.

Koutsoyiannis (1978, p.296) gave his view of the lagged endogenous variable as:

> *'In view of the nature of economic behaviour, any realistic formulation of economic models should involve lagged variables among the set of explanatory variables. Lagged variables are one way for taking into account the lengths of time the adjustment of processes of economic behaviour and perhaps the most efficient way for rendering them dynamic'.*

Lagged models have made possible the handling of expectation about futures events, if only in a rigid and not very satisfactory way. In short, a lagged model offers much flexibility to the formulation of models of economic behaviour.

There are several kinds of distributed-lag models, such as the Almon Scheme of Polynomial lag, Koyck's Geometric Lag Scheme, Nerlove's Partial Adjustment Model and Cagan's Adaptive Expectation Model (Koutsoyiannis 1978). The Almon Scheme of Polynomial lag is the method for estimating the parameters of the lagged exogenous variables, while the other three methods are the methods for estimating the parameters of variables in the models with lagged values of endogenous variables among the set of regressors (Koutsoyiannis 1978).

The Cagan's Adaptive Expectation Model is based on the behaviour hypothesis that the value of Y in any one period t depends not on the actual value of X_t but on the 'expected' or 'permanent' level of X at time t, say X_t^*. This method has become popular because it can deal somehow with 'expectation' (about future factors) whose importance in economic behaviour is being increasingly recognised.

Koyck's distribution lag model assumes that the weights (lag coefficients) are declining continuously following the pattern of a geometric progression. The original model includes only exogenous lagged variables (Koutsoyiannis 1978, p.304)

$$Y_t = a_0 + b_0 X_t + b_1 X_{t-1} + b_2 X_{t-2} + \ldots + \mu t \quad (4.6)$$

where:

Y_t	= endogenous variable
X_t	= exogenous variable
X_{t-1} X_{t-2}	= lagged exogenous variable
a_0	= intercept
b_0, b_1, b_2	= parameters
μ_t	= random variable

This model is constructed under the assumption that

$u \sim N\left(0, \delta_u^2\right)$, i.e., μ is normally distributed around zero mean and constant variance δ^2_{μ}; and,

$E(u_i u_j) = 0 \qquad (i \neq j)$, i.e., the successive values of the random variable μ assumed in any one period is independent from the value which it assumed in any previous period.

$E(\mu_i X_j) = 0 \quad (j=1,2,\ldots,k)$, i.e., the value of the random variable X assumed in any one period is independent from the value of the random variable μ in any previous period.

Koyck's geometric lag-scheme implies that more recent values of X exert a greater influence on Y than remoter values of X. In particular the lag coefficients of this model decline in the form of a geometric progression.

$$b_1 = \lambda b_0$$
$$b_2 = \lambda^2 b_0; \text{ and}$$

In general

$$bi = \lambda^i b_0 \qquad 0 < \lambda < 1$$

where:

λ = constant

Substituting in the original model we obtain:

$$Y_t = a_0 + b_0 X_t + (\lambda b_0)X_{t-1} + (\lambda^2 b_0)X_{t-2} + \ldots + u_t \tag{4.7}$$

Lagging by one period:

$$Y_{t-1} = a_0 + b_0 X_{t-1} + (\lambda b_0)X_{t-1} + (\lambda^2 b_0)X_{t-3} + \ldots + u_{t-1} \tag{4.8}$$

Multiplying through by λ and subtracting from the first we obtain:

$$Y_t - \lambda Y_{t-1} = a_0(1-\lambda) + b_0 X_t + (u_t - \lambda u_{t-1})$$

or:

$$y_t = a_0(1-\lambda) + b_0 X_t - \lambda Y_{t-1} + v_t \tag{4.9}$$

where:

v_t = $u_t - \lambda u_{t-1}$

The Nerlove's Partial Adjustment model postulated a model based on a different behaviour hypothesis. There is a desired level of Y in period t, say Yt^*, which depends on the value of X in period t, X_t, that is $Y_t^* = b_0 + b_1 X_t + U_t$. For example, the formulation of the theory of investment in fixed capital is based on what is known as the "stock adjustment principle" which postulates the following behaviour of the firm.

It is assumed that there is a desired level of capital stock, Y_t*, which the entrepreneur thinks is right for a smooth production. The desired level of capital stock is determined by the level of output X_t. The model $Y_t^* = b_0 + b_1 X_t + U_t$, cannot be measured because the desired quantity Y_t* is not observable. To replace it, we must postulate some behavioural principle. The "stock adjustment principle" implies the following behaviour pattern. Because of the gestation period involved in all investment projects and the administrative and financial problems associated with investment, the actually realised change in the capital stock in any one period is only a fraction of the desired change. In other words the adjustment of capital to the desired level is only gradual due to technological, financial or administrative managerial constraints. This gradual adjustment process may be expressed in the so-called "adjustment equation" (Koutsoyiannis 1978, p. 310).

$$Y_t - Y_{t-1} = \delta\,(Y_t^* - Y_{t-1}) + u_t \qquad (4.10)$$

where:

$Y_t - Y_{t-1}$ = Actual change in capital stock

$Y_t^* - Y_{t-1}$ = Desired change in capital stock

Substituting $Y_t^* + b_1 X_t + u_t$ into the adjustment equation (4.10) we obtain:

$$Y_t - Y_{t-1} = \delta\{(b_0 + b_1 X_t + U_t)\} - Y_{t-1}\} + V_t$$

Rearranging, we find:

$$Y_t = (\delta b_0) + (\delta b_1)X_t + (1-\delta)Y_{t-1} + (V_t + \delta U_t \qquad (4.11)$$

According to Koutsoyiannis (1978) the stock adjustment principle has become the most popular hypothesis for the explanation of the behaviour of economic units.

One of the basic assumptions that has to be addressed in regards to the time series data is that of autocorrelation. By the assumption of the classical normal linear regression model we have Cov $(\varepsilon_i, \varepsilon_j) = E[\varepsilon_i - E(\varepsilon_i)][\varepsilon_j - E(\varepsilon_j)] = 0$; (for all $i \neq j$). Since the means of ε_i and of ε_j are assumed to be zero, this means that $E(\varepsilon_i\ \varepsilon_j) = 0$. (Koutsoyiannis 1978). Combined with the assumption of normality, the zero covariance of ε_i and ε_j also means that ε_i and ε_j are independent. This feature of the regression disturbances is known as non-autocorrelation. It implies that the disturbance occurring at one point of observation is not correlated with any other disturbance. This means that when observations are made over time, the effect of the disturbance occurring at one period does not carry over into the following period.

In the case of the order-autoregressive process, the autocorrelation function is geometrically declining when ρ (ρ is a parameter whose absolute value is less than one) is positive and is characterized by damped oscillations when ρ is negative. Processes such as this, for which neither the variance of ε_t nor ε_{t-s} depend on t, are called stationary. According to Kmenta (1986), a convenient way of taking the effect of the pre-sample disturbances into account is to specify the first sample disturbance as $\varepsilon_t = \mu_t / \sqrt{(1 - \rho^2})$, while leaving the remaining sample disturbances to be generated according to $\varepsilon_t = \rho\varepsilon_{t-1} + \mu_t$ (for all t).

4.2.2. Computable General and Partial Equilibrium modelling

There are two techniques that can be used to analyse agricultural production as well as farmers' welfare in West Timor. These are the Computable General Equilibrium (CGE) model and the Partial Equilibrium model.

The general equilibrium approach overcomes three limitations of multiple regression (Dixon *et al.* 2000) First, it allows us to work at a detailed industry level rather than dealing with average (economy-wide) variables. Second, we are able to work with primary variables rather than proxies. Third, the general equilibrium model is based on explicit microeconomic assumptions, such as constrained utility maximisation by consumers and profit maximisation by producers.

For example, Nielsen (1999) included 16 regions and 19 sector aggregations in his analysis of the common agricultural policy in the European Union. In his CGE model. there are 10 primary agricultural sectors (wheat, coarse grains, vegetables, fruit and nuts, oilseeds, sugar cane and beet, other crops, bovine livestock, non-bovine livestock, raw milk and wool) and five processed food sectors (bovine meat products, other meat products. dairy products, processed sugar and other processed food products).

As a tool of analysis, partial equilibrium analysis illustrates results for one market at a time. However, there often exist market interaction and thus market feedbacks. A more sophisticated tool of analysis that can be used to analyze this situation is Computable General Equilibrium (CGE) Model. Indeed, the form of economic model of welfare most commonly considered is one whose solution is reached through the equilibrium of a set of demand and supply condition. In equilibrium, the quantity exchanged on a market at every instant and the price of these exchanges are such that demand equals supply. To simplify, we consider some demand and supply functions that are linear in prices, i.e.

$$D_t = a_0P_t - X_tb_0 - \mu_t,\ a_0 < 0 \qquad (Demand)$$

and $$S_t = a_0P_t + Z_t\beta_0 + v_t,\ \alpha_0 > 0 \qquad (Supply)$$

It is assumed that the error terms μ_t and v_t are uncorrelated with means zero and variance covariance matrix. The equilibrium condition $D_t = S_t$, and the definition of the quantity exchanged $Q_t = D_t$ can be used to obtain the equilibrium quantity and price at time "t" as a solution to $Q^e_t = a_0P^e_t + X_tb_o - \mu_t$, and $Q^e_t = \alpha_0P^e_t + Z_t\beta_0 + v_t$.

CGE model offers some advantages and has been used broadly. Fisher and Depotakis (1989) employed a single-region CGE model to estimate the impacts of alternative energy taxes on the California economy. Robinson *et al.* (1993) estimated economic impacts in the Los Angeles basin from instituting marketable permits to reduce pollution. Kraybill *et al.* (1992) applied an interregional CGE model to estimate impacts of a national policy change on the Virginia economy. Koh (1991) completed simulation experiments to estimate distributional impacts in the Oklahoma economy from alternative economic development policies. Upadhyaya and Holland (1995) investigated the economic and fiscal impacts in the state of Washington from reduction in state business and occupation tax.

The CGE model has normative power for policy analysis in such issues as tax policy and foreign liberalization. But it has some disadvantages when applied in a small open economy region because usually tax policy applies only for few sectors and not all sectors are connected to the international market (Capros *et al.* 1990). Although the Partial Equilibrium model tends to mix up the efficiency and resource augmenting aspects of external trade activities, the effect of external price to the internal market price can be involved in the model.

According to Nielsen (1999), a partial equilibrium model focuses on a single sector or even a single commodity. By their very nature, such models allow for highly detailed and focused studies on the impact of policy changes on the agricultural sector. In contrast, general equilibrium models attempt to describe the whole economy and particularly the inter-sectoral linkages. Indeed, of particular importance, general equilibrium models capture the agricultural sector for resources such as labour and capital. In partial analysis, supply and demand responses in a certain market are implicitly conditional on other prices and/or quantities in the economy being fixed. Anderson and Hill (1983), cited by Furubotn, Anderson and Hill (1987), considered that the partial equilibrium approach has much to offer, when used to describe welfare changes.

According to Kost (1975), partial equilibrium analysis is a broad methodology covering a wide range of techniques: from a fixed production-fixed consumption model at one end of a continuum to supply-demand models at the other end. Browning (1987) used partial equilibrium model to determine the marginal welfare cost (MWC) of taxes on labour earnings. The results apparently imply that a more precise estimate of MWC may depend on narrowing the range of possible parameter values than on developing a more rigorous model.

Proponents of the partial equilibrium model argue that by opting for a simpler framework, more effort can be put into careful estimation of key behavioural relationship in the sector of interest. Furthermore, some argue that although input-output relationships among agricultural products and substitutability in production between inputs are important, the impact of agricultural policy changes will generally be limited to the agricultural sector (Nielsen 1999).

The CGE model also has a disadvantage in that it is unable to adequately reflect a dynamic effect. According to Rodrick (1997) the gains from trade liberalisation will be overestimated unless the model accounts for the forgone consumption necessary to build the capital stock. Baldwin (1999) also emphasises that, with its focus on income effect, the CGE model might substantially overestimate the actual welfare effect when consumers optimise over time.

The elasticities index in a partial equilibrium model can also be used to generate the general equilibrium elasticities. According to Hertel (1997), as cited by Staehr (1998), the elasticities of interest in general equilibrium models are the ones that measure the total equilibrium effect on a certain variable (e.g. a quantity), and a change in another variable (e.g. a price) after the change has worked its way through the whole system, that is, after all the markets have adjusted to the change and have reached a new equilibrium. Furthermore, Staehr (1998) claims that the usual economic definition of elasticities is that they are related to partial equilibrium considerations. They measure the isolated (or partial) effect on a certain variable of a change in another variable, when this change is allowed to potentially spread to other markets, but not to feed back into the analysed market through changes in other variables in the model. These types of elasticities will be referred to as partial equilibrium elasticities.

According to Staehr (1998) and Nielsen (1999) general equilibrium elasticities might be derived from partial equilibrium elasticities as illustrated below. Consider the following stylised general equilibrium model consisting of N markets, where each market is described by a set of three equations, that is, a supply equation, a demand equation and an equilibrium equation (Staehr 1998, p.2):

$$Qi^S = S_i\ (Pi, \ldots, P_N, Pf_1 \ldots, Pf_L),\ i = 1, \ldots, N \tag{4.12}$$

$$Q_i^D = Di\ (P_1, \ldots, P_N, Y_1, \ldots, Y_S);\ i = 1, \ldots, N \tag{4.13}$$

$$Q_i^S = Q_i^D = Q_i;\ \ i = 1, \ldots, N \tag{4.14}$$

where:

Pi	= Equilibrium price on commodity i, $i = 1, \ldots, N$
Pfi	= Equilibrium price on primary factor l, $l = 1, \ldots, L$
Y_r	= Total equilibrium income in region r, $r = 1, \ldots, S$
Q_i^D	= Aggregate quantity of commodity i demanded at the equilibrium commodity price and equilibrium incomes, $i = 1, \ldots, N$
Q_i^S	= Aggregate quantity of commodity i supplied at the equilibrium commodity and factor price, $i = 1, \ldots, N$
Qi	= Aggregate equilibrium quantity of commodity i at the equilibrium commodity and factor price and equilibrium commodity and factor prices and equilibrium incomes. $i = 1, \ldots, N$

Equation (4.12) describes the behaviour of the suppliers in market i. The total supply of product i is assumed to be determined by the product's own price, Pi, the prices of other products, some of which might be used as inputs in the production of commodity i, and by the prices of the various primary factor inputs used in the production process, Pf_l, l= 1,..., L.

Likewise, the total demand for product i is described by equation (4.13). It is seen that the demand depends on the price of the product, Pi, on the price of other products (they being substitutes or complements), on the income in the region where the product is produced and on the income in other regions included in the model, that is, Y_r, $r = 1,\ldots, S$.

Finally, equation (4.14) is the market clearing condition which says that the total supply of product i is equal to the total demand for product i. This equilibrium quantity will be denoted Qi in the sequel.

Reducing the equation system in (4.12) to one equation for each market leaves us with the following expression for the equilibrium quantity:

$$Qi = Qi\,(P_1,\ldots,P_N, Pf_1,\ldots, Pf_L, Y_1,\ldots,YS);\ \ i = 1,\ldots,N \qquad (4.15)$$

Saying that the market clearing quantity is determined by the prices of all the products and all the primary factors together with the incomes in all the regions in the model.

The elasticities that are easiest to calculate are the general equilibrium output elasticities defined by:

$$\varepsilon_{ij}GEM = \frac{dQ_i}{dP_j}\frac{P_j}{Q_i};\ i, j = 1,\ldots, N \qquad (4.16)$$

This is the equilibrium price elasticity of demand. The elasticities defined in (4.16) measures the percentage change in the equilibrium quantity of product i when the price of product j has changed by one per cent, that is, a rise in the price of product j might have a direct effect on the demand for product j partly because product i has become relatively cheaper, and partly because, after the price rise, consumers can buy less of product j, which makes them relatively poorer.

The other type of elasticities that economists are more familiar with, namely, the partial equilibrium elasticities, are defined by:

$$\epsilon_{ij}PEM = \frac{\partial Q_i}{\partial P_j}\frac{P_j}{Q_i};\ i, j = 1, \ldots, N \tag{4.17}$$

where:

$\epsilon_{ij}PEM$	= the partial equilibrium elasticity
Qi	= Equilibrium quantity of product i
Pj	= Price of commodity j

The partial equilibrium elasticity defined in (4.17) measures the percentage change in the equilibrium quantity of product i when the price of product j has changed by one per cent.

The general equilibrium elasticities can be calculated from the partial equilibrium elasticities through equation (4.15). According to Staehr (1998, p.5), the total derivative of equation (4.15) for fixed i, $i = 1 \ldots, N$ is as follows:

$$dQ_i = \sum_{j=1}^{N}\frac{\partial Q_i}{\partial P_j}dP_j + \sum_{l=1}^{L}\frac{\partial Q_i}{\partial Pf_l}dPf_l + \sum_{r=1}^{S}\frac{\partial Q_i}{\partial Y_r}dY_r \tag{4.18}$$

$$= \frac{\partial Q_i}{\partial P_k}dP_k + \sum_{\substack{j=1\\ j\neq k}}^{N}\frac{\partial Q_i}{\partial P_j}dP_j + \sum_{l=1}^{L}\frac{\partial Q_i}{\partial Pf_l}dPf_l + \sum_{r=1}^{S}\frac{\partial Q_i}{\partial Y_r}dY_r$$

Dividing by Q_i we get:

$$\frac{dQ_i}{Q_i} = \frac{\partial Q_i/Q_i}{\partial P_k}dP_k + \sum_{\substack{j=1\\ j\neq k}}^{N}\frac{\partial Q_i/Q_i}{\partial P_j}dP_j + \sum_{l=1}^{L}\frac{\partial Q_i/Q_i}{\partial Pf_l}dPf_l + \sum_{r=1}^{S}\frac{\partial Q_i/Q_i}{\partial Y_r}dY_r \tag{4.19}$$

Dividing by dP_k/P_k gives:

$$\frac{dQ_i/Q_i}{dP_k/P_k} = \frac{\partial Q_i/Q_i}{\partial P_k/P_k} + \sum_{\substack{j=1\\j\neq k}}^{N} \frac{\partial Q_i/Q_i}{\partial P_j/P_j}\frac{dP_j/P_j}{dP_k/P_k} + \sum_{l=1}^{L} \frac{\partial Q_i/Q_i}{\partial Pf_l/Pf_l}\frac{dPf_l/Pf_l}{dP_k/P_k} + \sum_{r=1}^{S} \frac{\partial Q_i/Q_i}{\partial Y_r/Y_r}\frac{dY_r/Y_r}{dP_k/P_k}$$

$$\in_{ij}GEM = \in_{ij}PEM + \sum_{\substack{j=1\\j\neq k}}^{N} \in_{ij}PEM + \sum_{l=1}^{L} \in_{iPfl}PEM\,\pi_{Pjk} + \sum_{r=1}^{S} \in_{iyr}PEM\,\psi_{yrk} \qquad (4.20)$$

where:

$$\pi_{Pjk} = \frac{dP_j/P_j}{dP_k/P_k},\ \pi_{Pjk} = \frac{dPf_l/Pf_l}{dP_k/P_k} \text{ and } \psi_{yrk} = \frac{dY_r/Y_r}{dP_k/P_k};\ \ k = 1,\ldots,N.$$

Equation (4.20) shows that the general equilibrium quantity elasticity, $\epsilon_{ij}GEM$, can be written as a weighted sum of some relevant partial equilibrium quantity elasticities, e.g. $\epsilon_{ij}PEM$, $\epsilon_{Pfl}PEM$ and $\epsilon_{iyr}PEM$, where the weights are the relevant general equilibrium price elasticities. A partial equilibrium model can also be modified for a general equilibrium model by adding some equilibrium conditions. Nielsen (1999) in his analysis found that by comparing partial and general equilibrium models, certain quantitative results might not reveal substantial differences between the alternative set-ups.

4.3. The Agricultural Production Function

As mentioned in Section 3.8, the program for increasing agricultural production in West Timor is hindered by an unfavourable climate. West Timor is part of East Nusa Tenggara province that has a semi-arid type of climate with only three or four wet months (Oldeman *et al.* 1980).Climatic conditions determine productivity and cultivated area. In West Timor, climatic conditions have played a significant role in the low agricultural production. Agricultural production is a deterministic function of productivity and harvested area. According to Austin *et al.* (1998), the farm comprises a family business in which lifestyle and personal considerations interact strongly with management decisions. Further, a farm business operates in an environment which, on account of unpredictable and uncomfortable factors such as water availability, contains a large and unavoidable degree of uncertainty. However, Austin *et al.* (1998) did not elaborate on these as the main determinant factors or supporting factors in farm business. Sison *et al.* (1978) stated that climatic conditions are the main independent variables both in the harvest area function and productivity function. Other independent variables are the price of commodities and the price of inputs.

According to Lains (1978), in a subsistence economy, physical factors such as weather and irrigation, are more important in determining productivity than economic factors. The last one is more important in modern farm business. In relation to the efficiency of water supply, Duncan (1998) in his article "An optimistic view of world food prospect" said that whilst increasing water supplies will be difficult and costly, much could be done to make the use of existing supplies more efficient. He further stated that water is too often unpriced to farmers. Raghuwanshi and Wallender (1998) in their article "Optimal furrow irrigation scheduling under heterogeneous conditions" found that increasing water demand by competing water users (non-agriculture), increases environmental awareness and cost efficiency of water use. However, an irrigation strategy that maximises crop yield may not necessarily result in a maximum return for water. This is because the marginal income from the last increment of attainable yield produced by full irrigation will generally not be as great as the last increment of production cost. Therefore, one of the simplest and economically viable solutions to overcome the problem is to change the irrigation strategy from full irrigation to optimal irrigation.

Benu (1996) in his simulation analysis of the structure of paddy production in East Nusa Tenggara province of Indonesia, found that increasing the irrigation area of paddy production will increase the harvested area, but with a decrease in productivity. Rather than increasing the amount of irrigation channel, he suggested using existing irrigation channels more efficiently to support the program of paddy production.

Some socio-economic factors, which determine agricultural production are labour, capital, level of education, price (inputs and outputs), interest rates and purchasing power of consumers. According to Wennergren *et al.* (1983) the endowment of human capability, the availability of new technological knowledge, the use of modern industrial inputs and the system of public and private institutions serving agriculture are also of considerable relevance to the production of agriculture. Per capita income as the indicator of purchasing power (for inputs in the production process) is one of the economic factors that can stimulate farmers to increase their production subject to the total area available (Wennergren *et al.* 1983). Benu (1996) found that per capita income has a significant influence on rice production in East Nusa Tenggara province of Indonesia. However, in his structural equation, Benu (1996) put per capita income as one of the exogenous variables only. It should be noted that in a simultaneous model, per capita income might not be placed as an exogenous variable only, but as an identity variable that is derived from total output and population (see definition and background of variables, section 6.2). Mathematically, this can be written as:

$$PI = TO/TP \quad (4.21)$$

where:

PI = Per capita income

TO = Total output

TP = Total population

However, both total output and population should be placed as endogenous variables that are functions of other technical and socio-economic factors. According to Schwartz and Ter-Minassian (2000), economic growth is the endogenous outcome of an economic system, not the result of exogenous factors.

According to Handerson and Quandt (1980, p.23), for a given level of technology, the agricultural production function can be defined as follows:

$$Q_B = q\,(L, F, I, O) \quad (4.22)$$

where:

Q_B = Production quantity (tonne/ha)
L = Labour input (man hours/ha)
F = Fertiliser input (kg/ha)
I = Pesticide input (l/ha)
O = Other production input (unit/ha)

As the given price for each production factor is:

P_B	= Price of product (Rp/kg)
P_L	= Wage of hired labour (Rp/day)
P_F	= Price of fertiliser (Rp/kg)
P_I	= Price of pesticide (Rp/l)
P_O	= Price of other production inputs (Rp/unit)

The profit function of an agricultural commodity can be derived as below:

$$\Pi = P_B \, x \, q\,(L_B, F_B, I_B, O_B) - (P_L x L + P_F x F + P_I x I + P_O x O) \quad (4.23)$$

If first and second order conditions are fulfilled, the profit function can be maximized as below:

$$P_B \, x \, L' - P_L = 0 \text{ or } P_L = P_B \, x \, L' \quad (4.24)$$

$$P_B \, x \, F' - P_F = 0 \text{ or } P_F = P_B \, x \, F' \quad (4.25)$$

$$P_B \, x \, I' - P_I = 0 \text{ or } P_I = P_B \, x \, I' \quad (4.26)$$

$$P_B \, x \, O' - P_O = 0 \text{ or } P_O = P_B \, x \, O' \quad (4.27)$$

where:

L', F', I', O' are marginal products of input L, F, I and O. These variables are endogenous variables, whereas P_B, P_F, P_L, P_I, and P_O are exogenous variables.

The function of input demand by producers can be derived as below:

$$L = f\,(P_L, P_B, P_F, P_I, P_O) \quad (4.28)$$

$$F = f\,(P_F, P_B, P_L, P_I, P_O) \quad (4.29)$$

$$I = f\,(P_I, P_B, P_F, P_L, P_O) \quad (4.30)$$

$$O = f\,(P_O, P_B, P_F, P_L, P_I) \quad (4.31)$$

The function of agricultural commodity supply can be derived through substitution of (4.28), (4.29), (4.30), and (4.31) into (4.22), and we get:

$$Q^S = f\,(P_B, P_L, P_F, P_I, P_O) \quad (4.32)$$

where:

Q^S = Supply quantity

Equation (4.32) explains that agricultural commodity supply is the function of the price of the commodity (P_B), and the price of production inputs (P_L, P_F, P_I, and P_O).

Labis (1975) mentioned that the commodity prices (own price, substitution price and competitive price) should be decided as explanatory variables in the production function. The price of a commodity can improve (or reduce) farmers' motivation in their cultivation of a particular commodity. This motivation can determine the level of productivity and quantity of production of a commodity. Other explanatory variables that should be covered in the production function are the price of production inputs such as fertiliser, seed and pesticides. The prices of production inputs are closely related to the level of farmers' capital. Under the assumption that farmers' capital is given, the prices of production inputs will determine how many inputs can be purchased for a production process.

Furthermore, the amount of credit released for farmers has a major role in the agricultural production process. This factor can also be considered as one of the explanatory variables in the production function. According to William C. Baum (World Bank 1979) cited by Bathrick (1981, p.12),

> '*...whether viewed in the context of prevailing food grain shortages, or of concern for the small farmer and the reduction of poverty among the rural poor, or of the new initiatives aimed at increasing the flow of investment for agricultural production in the developing countries – agricultural credit might be considered not just timely but an urgent concern*'.

Nevertheless, a credit package with a lack of supervision is counter-productive to agricultural production, because of possible misuse by farmers. In many developing countries, farmers use their production credit for non-productive activities and thereby suffer repayment problems. This is why Trautwein (2000) mentioned that the new view of credit is focused on bank lending (and other forms of external finance) with the presumption that the corresponding liabilities of the firm and the household play a role in the determination of real activity. Zeller *et al.* (1997) mentioned that people must be educated and healthy enough to use credit in productive activities. Efficient functioning markets are also critical for small-scale farmers and entrepreneurs to obtain the inputs and outputs they need to produce and get their products to the market. Investments in social safety nets, as well as in roads, electricity and communications are necessary to enhance the impact of credit in relieving poverty. In a quantitative analysis, the measurement of the ability of farmers to repay loans poses some difficulties in relation to the availability of data. However, McMillan and Woodruff (1999) were able to use duration of relationship between customers and creditors as an indicator of credit repayment ability. Another economic factor is interest rate, which can be used as an indicator of the opportunity of investment.

Physical factors that should be covered in the production function are rain fall, irrigation and technology. Rainfall and irrigation are used as indicators of water availability, whereas the trend in technology use is used as an indicator of innovation in cultivation. According to Chacko, Wacker and Asar (1997), innovations in technology and information systems together with changes in demography, global economies and even climate have had a significant impact on the product market.

Some policies, which have been introduced by the local government in relation to agricultural development, such as floor price, ceiling price, agricultural intensification programs and other social economic programs, should be covered in the production function as well. According to Kristensen and Jensen (1999), the extent to which farmers are able to adjust to such policy regulation is likely to vary considerably, according to farm size, soil quality or composition of production. They further say that farmer's adjustment possibilities reflect their abilities to reduce economic losses due to regulation.

Social factors such as population (including some important components in population growth such as birth rate, mortality and migration), the level of education and health condition should also be included in the production function, because they will determine the quality of agricultural production in a particular region (Boserup 1970).

Finally, the agricultural marketing system is another important aspect that should be covered in the production function. The marketing system can either be an accelerator or a decelerator of agricultural production. Kohls and Uhl (1990) defined food marketing as the performance of all business activities involved in the flow of food products and services from the point of initial agricultural production until they are in the hands of consumers. According to these authors, the three approaches that can be used to analyse food-marketing systems are the functional approach, the institutional approach and the behavioural systems approach. According to Rhodes (1993), agricultural marketing, as defined from a macro (social) perspective, is the performance of all business activities involved in the forward flow of food and fibre from farm producers to consumers. There is also an important micro (individual firm) perspective in which agricultural marketing is defined as the performance of business activities directing the forward flow of goods and services to customers and accomplishing the objectives of that particular firm (farmer or agribusiness). IFPRI (1994) stated that the combined effects of agricultural market reforms and technological progress in agriculture have increased output and competition in the food grain market and reduced in season and inter- year price fluctuations for food grains.

One macro aspect to emphasise is the institutions. An institution can be thought of as an organised system of behaviour, such as organised markets, corporations and marketing orders. Another macro approach is to emphasise the functions performed in marketing. According to Rhodes (1993) function can be categorised as: (i) exchange function which consists of buying (procurement) and selling (merchandising); (ii) physical function which consists of storage, transportation and processing; and (iii) facilitating function which consists of standardisation, financing, market intelligence gathering and risk bearing.

IFPRI (2001), found eight key themes for completing the agricultural marketing reform process. These are to (i) fully implement market liberalisation; (ii) find institutional solutions to provide input credit to farmers; (iii) develop a legislative infrastructure to facilitate market exchange; (iv) promote smallholder production of high-value crops; (v) invest in transportation, research, extension and communication infrastructure; (vi) promote effective governance and monitor market development; (vii) provide safety nets; and (viii) maintain credible and sustainable macroeconomic policies.

4.4. The Agricultural Demand Function

The standard theory of economics states that demand of a particular good is dependent on its price, level of income, the price of other goods (competitive goods and substitute goods) and the taste and preferences of consumers. For those with lower levels of income, the elasticity of demand of primary goods for income is higher than luxury goods. On the contrary, for those with higher levels of income, the elasticity demand of luxury goods is higher than for primary goods (Handersen and Quandt 1980, Koutsoyiannis 1982). Among all primary goods, food is the basic need for consumers. The quantity supplied of this primary good is determined by the price of inputs and wages of labour.

Generally, demand for agriculture products might be divided into demand for food consumption and non-food consumption. In Indonesia, the proportion of demand for food consumption is more than non-food consumption (Nainggolan and Suprapto 1987). Examples of demand for non-food consumption are the demand for agricultural products such as seeds, forage and industrial inputs. Mangahas (1972) stated that population is the main determinant of increase in agricultural product demand, and it is the labour potential that can be used as production input on the supply side. Based on the notion above, Mangahas contended that population, real disposable income and agricultural commodity price levels are the main explanatory variables in an agricultural output demand function.

Amang (1987) supported Mangahas view that demand in each sector is the function of population, relative price of food commodities and income. However, neither author considered total stock and total exports as components of total demand. Nasol (1970) derived all components of total demand in direct consumption, final stock and total export. Two components that are generally considered to determine final stock are the final stock of government and the private sector, while two components that are generally considered in direct consumption are food consumption and non-food consumption.

Commodity price is also a determinant of the consumption function. Moutou *et al.* (1998) said that food consumption trends created by changing prices, demographics, technology and consumer habits affect demand for grain-based food products. Another determinant factor that should be covered in the consumption function is preference. According to Rae (1997), food demand patterns are known to change as a country's level of economic development changes. The trend is towards declining consumption of traditional staples (rice and root crops) and increasing consumption of other foods. Rae (1997) further stated the latter initially involves increased consumption of non-traditional cereals (for example wheat products) followed by increased consumption of high-protein foods such as animal products. In addition, Larson (1998) mentioned that because preferences cannot be directly measured, factors that may be correlated are often added to the analysis. These variables (e.g., household size. ethnic origin, and education) serve as proxies for preferences and may help explain distinctive consumption patterns in some areas.

Labis (1973) noted that total consumption of a commodity is a function of its price and other commodities' price. This notion is formulated as:

$$Ci_t = f(Pi_t, Pj_t, \ldots Pn_t, Y_t); \; i = 1, \ldots, n. \tag{4.33}$$

where:

Ci_t	= Total consumption of i^{th} commodity
P_t	= Price of i^{th} commodity
$Pj_t.Pn_t$	= Prices of other commodities, and
Y_t	= Income.

In his study, Labis did not include population as a determinant in the consumption function. On one hand, high population can be considered as a core factor. which determines the purchasing power of consumers. On the other hand, a high population can reduce the per capita income of farmers, although it provides the labour force for the production, so that farmers can conduct their cultivation more intensively. Furthermore, Labis (1973) stated that the behaviour of demand varies with time. Benu (1996) concluded that population, taste and preferences, changes in income and price fluctuations determine the variation of demand behaviour.

A demand function of a particular commodity can be derived from the maximisation analysis of the utility function (Henderson and Quandt 1980, Koutsoyiannis 1982). If we assume that the utility function of consumers for two commodities Q_1 and Q_2 are:

$$U = q_1 q_2 \tag{4.34}$$

where:

q_1 = Total consumption of Q_1
q_2 = Total consumption of Q_2

The budget constraint of consumers is:

$$Y_0 = p_1 q_1 + p_2 q_2 \tag{4.35}$$

where:

Y_o = Consumer's income
p_1 = Price of Q_1
p_2 = Price of Q_2

Maximising equation (4.34) subject to equation (4.35) can be expressed in the Lagrange function as (Henderson and Quandt 1980, p.13):

$$V = q_1 q_2 + \phi (Y_0 - p_1 q_1 - p_2 q_2) \tag{4.36}$$

where:

ϕ = An undetermined multiplier

The first order condition of the equation (4.36) can be reached, if the first derivative of q_1; q_2 in the equation (4.36) is equal to zero.

$$\delta V/\delta q_1 = q_2 - p_1 \phi = 0 \tag{4.37}$$

$$\delta V/\delta q_2 = q_1 - p_2 \phi = 0 \tag{4.38}$$

$$\delta V/\delta \phi = Y_o - p_1 q_1 - p_2 q_2 = 0 \tag{4.39}$$

The demand functions of both commodities can be estimated by solving q_1 and q_2 in equations (4.37),(4.38), and (4.39)

$$q_1 = Y_o/2p_1 \tag{4.40}$$

$$q_2 = Y_o/2p_2 \tag{4.41}$$

Equations (4.40) and (4.41) show that the demand for a particular commodity is a function of consumer income and the price of a commodity. Further, Koutsoyiannis (1982) stated that demand of a particular commodity is the function of the price of a commodity, the price of other commodities, consumer income (aggregate) and trend of preference. Koutsoyiannis (1982) expressed the demand function of a particular commodity in the form of a constant-elasticity demand function as:

$$Q_x = b_0 P_x^{b1} P_0^{b2} Y^{b3} e^{b+1} \quad (4.42)$$

where:

Q_x	= Quantity demand of commodity X
P_x	= Price of commodity X
P_o	= Price of other commodities
Y	= Aggregate consumer's income
e^{b-1}	= Trend of preference
b_1	= Price elasticity of demand
b_2	= Cross elasticity of demand
b_3	= Income elasticity of demand

Using multiple regression analysis can solve the estimation of the above model. However. Benu (1996) in his analysis of the demand for rice in East Nusa Tenggara province of Indonesia found that price does not significantly influence total demand for rice. According to Benu (1996), rice – the favourite food commodity in West Timor - is the basic primary food, so that bargaining does not apply to the demand for this commodity. The correlation coefficient of demand and price was only about 0.25. Benu (1996) also found that an increase in per capita income did not have a significant influence on the total demand for rice in East Nusa Tenggara province of Indonesia. The correlation coefficient of income and total demand was only about 0.10.

4.5. Discussion

In the review of literature there appears to be two types of techniques that can be used to analyse the phenomena of agricultural production as well as farmers' welfare in West Timor. These are the Computable General Equilibrium (CGE) model and the Partial Equilibrium model. CGE model offers some advantages and has been used broadly. It has a normative power to solve the problem of interdependence among various economic factors in open economic system. General equilibrium models attempt to describe the whole economy and particularly the inter-sectoral linkages (Nielsen 1999). The CGE model has normative power for policy recommendations on such issues as tax policy and foreign liberalization. But it has some disadvantages when applied in a small open economy region (Capros *et al.* 1990).

Farmers in West Timor usually conduct their farming traditionally and their first priority is to provide food for their families. Hence, there is limited market orientation in their activities. This means that there are some difficulties involved in efficiency and the resource augmenting aspects of external trade activities. According to Barlow and Gondowarsito (1991) the remoteness of East Nusa Tenggara province from the Indonesian heartland of Java is certainly a key feature, and significantly adds to the high cost of trade already imposed by poor internal infrastructure. This feature is also reflected in the restricted flow of information from outside, where local people generally tend to be conservative and slow to appreciate the merits of possible new ventures. Again, remoteness makes it difficult to open up new inter-island or international markets, to secure the "linkage" basic to underpinning a satisfactory producer-consumer relationship. These linkages entail such aspects as mutual information flows and confidence, and are of major significance in projects involving substantial outside export or imports. Based on the perspective of West Timor's economy, it can be concluded that the partial equilibrium model is more suitable in analysing the agricultural production and farmers' welfare in West Timor than the CGE model. Moreover, there were problems with data availability excluding the use of CGE modelling in this research.

In the review of the econometric method in Section 4.2.1, it was found that Koyck's Geometric Lag Scheme Model is one of the most popular of the distributed lag models in applied research. However, there are some difficulties that arose with Koyck's assumptions. Koyck's distributed lag model assumes that the weights (lag coefficients) are declining continuously following the pattern of a geometric progression (Koutsoyiannis 1978, Gaspersz 1991). Koyck's geometric-lag scheme implies that more recent values of *X* (independent variable) exert a greater influence on *Y* (dependent variable) than remoter values of *X*. However, the appearance of the lagged dependent variable among the explanatory variables has other undesirable consequences. First, in the new formulation of Koyck's model, the error term is autocorrelated, despite the fact that the error term of the original model (*U*) is serially independent. Second, the lagged variable Y_{t-1} is not independent of the error term v. Third, autocorrelation of v_t, superimposed on the value of Y_{t-1}, which are interdependent with the error term v, renders the Ordinary Least Squares (OLS) estimates not only biased, but also inconsistent in large samples. Fourth, the combined violation of two assumptions of the OLS method impairs the power of the Durbin-Watson statistic in detecting autocorrelation (Gaspersz 1991, Koutsoyiannis 1978).

Nerlove attempted to avoid the estimation difficulties which arise with Koyck's assumptions. Nerlove's model has a similar formulation to Koyck's model. Both models include the same variables (Yt, Xt, $Yt-1$), but the error term of the 'partial adjustment model' does not involve any autoregressive scheme in the u's, as does Koyck's. In the Nerlove's model the disturbance term has no direct connection with its own previous value, so that it can be assumed that the new error term ($vt + \delta ut$) is not autocorrelated. Furthermore, in the 'partial adjustment model' the coefficient ($1 - \delta$) of the lagged Y_{t-1} has a clear economic meaning, since it involves δ, the adjustment coefficient. Information about δ (i.e., the length of the adjustment period) may be obtained from firms.

Based on the review of the agricultural production function, it can be seen that there are four factors that have a significant role in determining the production of agriculture. These are: first, technical factors including climatic conditions, irrigation channels and innovations in technology, second, economic factors including labour (quantity and skills), capital, price of inputs, price of outputs, interest rates, purchasing power, amount of credit and marketing system; third, social factors including population together with birth rate, mortality, and migration, level of education and health condition; and finally, government policies in relation to agricultural development, such as floor price, ceiling price and the agricultural intensification and extensification programs. Consequently, theoretically, these factors have to be considered in constructing the agricultural production function. However, this research faced problems of data availability at the regional level, and therefore only selected factors were used in constructing the agricultural production function. These are climatic conditions, irrigation channels, technological trends, price of inputs, price of outputs, interest rates, amount of credit, marketing system, total population, level of education and the government policy in the agricultural intensification program.

As mentioned in Section 4.2, there are two approaches that can be used in the study of the agricultural marketing systems, i.e. a macro approach or a micro approach. A macro approach deals with the aggregate flow of food products and services from initial agricultural production until they are in the hand of consumers. A micro approach deals with the individual (firm) flow of goods and services to consumers and accomplishing the objectives of that particular firm.

To get information about the performance of all business activities involved in the forward flow of food and fibre from farm producers to consumers (without accomplishing the objectives of that particular firm), this research will use a macro approach in its analysis of the role of the marketing system in the agricultural development in West Timor. Therefore some aggregate data published by the local government will be used to evaluate the performance of the agricultural marketing system in West Timor. Among marketing aspects, marketing institutions (especially cooperatives), and buying and selling, may be used to evaluate the performance of the marketing system.

Cooperatives are a legal socio-economic institution in Indonesia under Indonesian law. According to Royer (1995), cooperatives hold promise as a means for coordinating product differentiation at the farm level and capturing profits for producers from the later stages of the market channel, where the amount of processing, value-add and product differentiation are the greatest. According to IFPRI (1994), physical capital wears out; social capital does not. The more it is used the better it gets. If common-property institutions do not survive, their absence will lead to an even greater acceleration of the destruction of natural resources. However, Fulton *et al.* (1995) found in their research that equity redemption in cooperatives has limited the ability of cooperatives to grow. The need for cooperatives to redeem the equity accumulated in the organisation leads to a reduction in the growth rate that cooperatives can sustain. The development of cooperatives in West Timor has achieved the objectives of institutional development in rural areas. Cooperatives have been included as a part of formal institution development for economic activities and as an institution to support other development programs in rural areas. The cooperative aspect that was used as the explanatory variable in the production function is the number of cooperatives based on the level of sufficiency.

With regards to the review of the agricultural demand function, there are several factors that have a significant role in determining demand for agricultural production. These are taste and preference, the pattern of consumption, per capita income, the price of good, the price of substitution and complementary goods, total population, purchasing power of consumers, and the quantity supply of commodity.

Although there is no specific demand function in this research, some important factors can be selected to construct the agricultural production function. They are taste and preference, per capita income, the price of commodity including substitution and complementary prices, and total population. It should be noted that although there is wide diversity in the sources of food crops in West Timor (rice, maize, cassava, and many kind of legumes), the high population and the pattern of consumption of particular commodities (rice and maize) determine the over-demand of some food products (Benu 1996).

4.6. Concluding Remarks

Since the goal of the study is to describe agricultural production and farmers' welfare with respect to the influence of the socio-economic, technical and policy factors in agricultural development, the econometric technique will be used as the method of analysis.

Based on the perspective of West Timor's economy, it can be concluded that the partial equilibrium model is more suitable for analysing the agricultural production and farmers' welfare in West Timor than CGE model. Although the partial equilibrium model has some limitations in obtaining a comprehensive result, these limitations can be reduced through some mathematical adjustments.

Technical, social, economic, and policy factors that determine the agricultural production function include rainfall, irrigation, agricultural technological progress, capital, labour, farmers' per capita income, agricultural credit, interest rates, the price of agricultural products, the price of agricultural inputs, agricultural marketing institutions, health and education conditions, farmer population including birth rate, mortality and migration, agricultural development programs, and other socio-economic programs.

Technical, and socio-economic factors that were identified as determinants of the agricultural demand function are the price of agricultural products, the price of other products (competitive and substitution), per capita income, real disposable income, total population, and taste and preference.

CHAPTER 5

DESCRIPTION OF RESEARCH METHODOLOGY

5.1. Introduction

This chapter is devoted to a description of the research methodology followed in this study. Section 5.2 presents five assumptions regarding food crop production, tree crop production, livestock production, output of the agricultural sector and per capita income. Section 5.3 presents the data requirements of the research based on the five hypotheses that have been formulated.

The research method is presented in Section 5.4 which includes a sub-section on data gathering, modelling procedures, and analytical procedures. The predominantly agricultural economy of West Timor is characterized by small-scale fragmented farming and the use of traditional technology. This condition is a major problem in improving productivity and the welfare of farmers. In order to get a complete picture of this condition, a simultaneous equations model was constructed to capture the technical, socio-economic, and policy factors that determine agricultural production in West Timor. The detailed structural equation model, as well as the definition and background of the variables are outlined in the sub-section on modelling procedures. Likewise the mathematical and statistical justification of the model formulation and estimation procedures is explained. Validation procedures are also discussed in this sub-section.

Finally, this chapter concludes with an overall review of the choice of model and description of the research methodology.

5.2. Assumptions

There are five areas of interest in the assumptions, in regards to food crops, tree crops and livestock production, agricultural sector output, and per capita income. These are set out as follows:

a. The food crops production of West Timor is determined by the price of rice, amount of credit, price of nitrogen fertiliser, farmer population growth, rainfall, total cost per hectare of rice cultivation, total cost per hectare of maize cultivation, the size of irrigated area, total food crops harvested area, food crop productivity and the intensification program.

b. The tree crops production of West Timor will be determined by the amount of credit, farmer population growth, the number of cooperatives, the price of coffee, the interest rate of credit, the price of nitrogen fertiliser, days of rainfall, tree crops harvested area, and tree crops productivity.

c. Livestock production in West Timor will be determined by the price of cattle meat, the price of live cattle, days of rainfall, the interest rate of credit, total per capita income, the price of rice, the output of the agricultural sector, the total population, livestock productivity and total livestock consumption.

d. The per capita income of farmers in West Timor will be determined by the level of inflation, total food crops production, total tree crops production, livestock production, the price of rice, gender ratio, number of family planning clinics and farmer population growth.

e. The output of the agricultural sector of West Timor as well as farmers' per capita income could be accelerated through increasing the size of irrigated area, increasing the amount of agricultural credit, reducing the rate of total population growth, reducing the cost per hectare for crop cultivation, increasing the number of cooperatives, and increasing the price of commodities at the farm gate.

5.3. Data Requirements

The literature on aggregation of models has focused on two separate but closely related issues; namely the "aggregation problem" and the "model selection problem" (van Garderen *et al.* 2000). The first issue attempts to derive conditions under which macro models will reflect and provide interpretable information on the underlying behaviour of the micro units (households and firms). The second issue is concerned with the problem of choosing between the aggregate and the disaggregate specifications when the object of interest is prediction of the aggregate (or macro) phenomena.

Since the objectives of the research are to derive conditions under a particular macro model and to predict the aggregate phenomena, this research is confronted with both issues. This research uses secondary data (time series) from 1979 to 1998 published by the local government and also primary data gathered from personal interviews and other sources of research.

Based on the assumptions formulated, the main data required for this research are: food crops harvested area, food crops production, food crops productivity, tree crops harvested area, tree crops production, tree crops productivity, livestock inventory, livestock productivity, livestock consumption, the output of the agricultural sector, farmer population, farmer population growth, price of rice, amount of credit, price of fertiliser, rainfall, total cost per hectare of food crops cultivation, the size of irrigated area, number of cooperatives, price of coffee, interest rates, price of live cattle, price of cattle meat total per capita income, the level of inflation, gender ratio and number of family planning clinics.

5.4. Research Method

5.4.1. Data gathering

The data gathered for analysis of the model are secondary data published by the Department of Agriculture, the Department of Communication and Transportation, the Department of Education, the Department of Industry and Trade, the Department of Cooperatives, the Department of Meteorology and Geophysics, the Committee of Family Planning, the Committee of Regional Development Planning, the Central Bank of Indonesia, and the Central Bureau of Statistics.

As the Central Bureau of Statistics is the only department with the authority to gather data published by government institutions, a formal link with this institution was developed to gain access to all data needed in this research. Following a formal letter from the University of Nusa Cendana (another government institution) requesting assistance, the Central Bureau of Statistics of East Nusa Tenggara province provided a small team consisting of eight officers, all experts in data collection, to gather the data needed for this research.

Three coaching meetings were conducted before the team gathered data for the variables from either government institutions or the Central Bureau of Statistics itself. During the time of data gathering, meetings were carried out to check and re-check the validity of the data. The final meeting was held after four months of data gathering. All data gathered were time series data from 1979 to 1998 and categorised based on the four districts of West Timor (Kupang, TTS, TTU and Belu). The data can be categorised into four areas, as set out in Table 5.1.

Table 5.1. Variables gathered for the research

Categories			
Technical	**Economic**	**Social**	**Policy**
Food crops harvested (ha)	Farmers' per capita income (Rp/capita)	Population growth (%)	Special Intensification Program in agriculture
Food crops production (tonnes)	Output of agricultural and non-agricultural sectors (Rp)	Farmer population	Program of *Tanam Sekali Lagi Tanam*
Food crops productivity (tonnes/ha)	Regional income and Total per capita income (Rp)	Farmer population growth (%)	Program of *GEMPAR*
Tree crops harvested (ha)	Level of inflation and interest rates (%)	Number of labour force	Program of *Operasi Nusa Makmur*
Tree crops production (tonnes)	Amount of agricultural credit (Rp)	Total population	Seven Strategies Program
Tree crops productivity (tonnes/ha)	Total cost per hectare of food crops cultivation (Rp)	Gender ratio (%)	Program of *Tiga Batu Tungku*
Rainfall (mm & frequency)	Price of food crops commodities at the producers, consumers and national levels (Rp)	Number of family planning clinics (number)	
Number of hand tractors (unit)	Price of tree crops commodity at the producer, consumer and national levels (Rp)	Amount of public transportation (number)	
Livestock inventory (livestock unit)	Price of livestock commodities at the producer, consumer, and national levels (Rp)	Length of road (km)	
Livestock productivity (livestock unit)	Number of livestock consumed, slaughtered, and exported (livestock unit)	Number of cooperatives (number)	
Irrigated area (ha)	Price of fertiliser, cooking oil, sugar, salt, kerosene, soap, textile, cement and gold (Rp)		
	Total per capita income (Rp/capita)		
	Total volume of export and import (tonnes)		

As set out in Table 5.1, the data of technical variables that have been collected are food crops harvested area, food crops production, food crops productivity, tree crops harvested area, tree crops production, tree crops productivity, rainfall, number of hand tractors, livestock inventory, livestock productivity and irrigated area.

It should be noted that the data of food crops are the aggregated data of six main foodstuffs in West Timor, i.e. rice, maize, cassava, peanuts, green peas and sweet potatoes. The data of tree crops are the aggregated data of six dominant tree crops in West Timor i.e. coconut, coffee, cashew, candlenut, kapok and areca nut. And the data of livestock are the aggregated data of five dominant livestock in West Timor, i.e. cattle, horse, goat, pig and poultry.

The data of economic variables that have been collected are farmers' per capita income, output of agricultural sector, output of non-agricultural sector, regional income, total per capita income, level of inflation, interest rate, amount of agricultural credit, total cost per hectare of food crops cultivation, price of food crops commodities at producers level, price of food crops commodities at consumers level, price of food crops commodities at national level, price of tree crops commodities at producers level, price of tree crops commodities at consumers level, price of tree crops commodities at national level, price of livestock commodities, number of livestock consumed, number of livestock slaughtered, number of livestock exported, price of fertiliser, price of cooking oil, price of salt, price of kerosene, price of soap, price of textile, price of cement, price of gold, total per capita income, total volume of exports and total value of imports.

The data of social variables that have been collected are total population, population growth, farmer population. farmer population growth, number of labour force, gender ratio, number of family planning clinics, amount of public transportation, length of roads and the number of cooperatives.

The data of policy variables that have been collected are special intensification program, program of *Tanam Sekali Lagi Tanam*, program of *Gempar*, program of *Operasi Nusa Makmur*, the seven strategies program, and program of *Tiga Batu Tungku*. These are the special programs that have been initiated by the local as well as the central governments since the beginning of 1970 to improve people's welfare.

Below is a detailed list of the data requirements and their availability or otherwise. To collect all the data needed in this research, the author has visited all the institutions at the district, provincial and even national level such as: The Statistical Office, Bureau of Planning and Finance, The Central Bank of Indonesia, Division of Food Crops - Department of Agriculture, Division of Plantation - Department of Agriculture, Division of Livestock-Department of Agriculture, Regional Development Planning Agency, Department of Labour, Department of Education, Department of transportation and Communication, Department of Cooperative, etc. However, not all data needed in this research are available. As will be noted below, some data sets were incomplete. In some cases, proxies had to be used to generalise the available data over a wider area or over a longer time period. In other cases, proxies unavailable or data constraints were severe, and the variables were excluded from the model.

1. *Farmer's education level.* As far as the author is aware, no institution at the provincial level has ever collected this data. Actually, data on the education level in rural areas can be used as a proxy for farmers' education level. The author has tried to collect this data, however, this data is available only for the last five years and at the provincial level.

2. *Farmers' life expectancy.* Neither the Department of Health nor the Committee of Family Planning has collected this data for the study area. The author has tried to collect the data on life expectancy in rural areas as a proxy for farmers' life expectancy. However, the data is available at the provincial level only. So, it is difficult to split the aggregate data at the provincial level for West Timor only.

3. *Purchasing power* and *calorie consumption.* These data are not available either at the provincial level or at the district level. The author has no choice to use

any proxy for purchasing power and calorie consumption at the West Timor level.

4. *Amount of rural public transportation*. The data on public transportation are available for total public transportation only. So it is difficult to split the total number of public transportation for the rural public transportation only.

5. *Level of inflation* for each district. The data on the level of inflation are available for Kupang city only. Actually the author can use these data as a proxy for West Timor, but there is a huge difference in price between Kupang city (as the capital city of NTT) and all other cities in West Timor.

6. Time series data of *pasture carrying capacity*. As far as the author is aware of, the Agricultural Department has never calculated these data.

7. Time series data of *forage availability*. As far as the author is aware of, the Department of Agriculture has never calculated these data either.

8. *Consumer price index*. These data is available for Kupang city only. Actually the author can use this data as a proxy for West Timor, but it is available for the period 1990-1998 only.

9. *Number of agribusiness firms*. The author has tried to collect these data, but it is available for the last five years only. The concept of *agribusiness firms* itself was introduced in NTT Province in the early 1990s.

10. *Cost of transportation*. The author has tried to collect these data, but it is available for the period 1990-1993 only. Due to the inconsistency in the statistical recording system at the provincial level, data is available for the three years only. The author has no other choice to use any proxy for these data.

11. *Number of agricultural extension workers*. Due to poor filing systems by the local government, data is available for the last five years only.

12. *The size of the technical, semi-technical, and traditional irrigated areas.* A complete data set of irrigated areas is available for the total irrigated area only. It is completely recorded for aggregated data only, while disaggregated data which is recorded by the technical department is available for a couple of years only so that it cannot be used in the model of analysis.

13. *Price of pesticide.* This data is available for the last eight years and at the provincial level only. Actually this data has been collected at the provincial level, but it is recorded by the Trading Department according to the trademark only. It is also provided without detail explanation of the type of pesticide. So, it is nonsense to make aggregation without complete information of the type and the size of pesticide.

5.4.2. Modelling procedure

5.4.2.1. Choice of model

According to Austin *et al.* (1998), the choice of model may be made via an empirical approach, motivated by relationships found in the data, or a mechanistic approach in which pre-existing knowledge and theory are incorporated into the model. Large-scale economic models and models based on expert knowledge are primarily mechanistic. In this study, the linear models described have features of both mechanistic and empirical approaches. Some empirical indicators such as the linearity test (*scatter plot*), coefficients of determination, the result of both *t*-tests and *F*-tests, and correlation coefficients have been considered in choosing the linear model rather than the non-linear model.

This research uses a partial equilibrium approach to analyse socio-economic and technical factors that have determined agricultural production as well as farmers' welfare in West Timor. As far as can be ascertained, this model is the first macro economic model of West Timor of this kind. Roberts (1999, p.5) mentions at the second annual conference on global economic analysis that:

'If they are available and if they answer the right question, economic analysis and quantitative methods will be invaluable tools in achieving a

wide, active and positive participation, especially by developing countries...'

The following structural equations have been constructed based on the theoretical background that has been described above. Detailed constructions of the structural equations with respect to agricultural production and farmers' welfare are:

Food Crops

Harvested Area:

$$\text{ADT} = \beta_0 + \beta_1\text{PRMT} + \beta_2\text{CRT} + \beta_3\text{PZNT} + \beta_4\text{POPGT} + \beta_5\text{RFT} + \beta_6\text{TCRT} + \beta_7\text{D}_1 + \beta_8\text{ADT}_1 + \text{U}_1 \quad (5.1)$$

where:

ADT	= Food crops harvested area in t^{th} year (1000 ha)
PRMT	= Market margin of rice price in t^{th} year (Rp/kg)
CRT	= Amount of credit in t^{th} year (Rp. 10 million)
PZNT	= Price of nitrogen fertiliser at farm gate in t^{th} year (Rp./kg)
POPGT	= Farmer population growth in t^{th} year (%)
RFT	= Rainfall in t^{th} year (mm)
TCRT	= Total cost per hectare of rice cultivation in t^{th} year (Rp. million)
D_1	= Dummy variable 1 (1 for the year that the "supra special intensification program" took place and 0 for others)
ADT_1	= Harvested area of food crops in t^{th} –1 year (1000 ha)
U_1	= Random variable

Productivity:

$$\text{QPDT} = \beta_0 + \beta_1\text{ART} + \beta_2\text{ADT} + \beta_3\text{TCMT} + \beta_4\text{QPDT}_1 + \text{U}_2 \quad (5.2)$$

where:

QPDT	= Food crops productivity *in* t^{th} year (1000 tonne/ha)
ART	= Irrigation area in t^{th} year (ha)
ADT	= Food crops harvested area in t^{th} year (1000 ha)
TCMT	=Total cost per hectare of maize cultivation in t^{th} year (Rp.million)
$QPDT_1$	= Food crops productivity in t^{th}-1 year (1000 tonne/ha)
U_2	= Random variable

Production:

$$QDT = ADT \times QPDT \quad (5.3)$$

where :

QDT	= Total production of food crops in t^{th} year (1000 tonne)
ADT	= Food crops harvested area in t^{th} year (1000 ha)
QPDT	= Food crops productivity in t^{th} year (1000 tonne/ha)

Tree Crops

Harvested Area:

$$\begin{aligned} APT = {} & \beta_o + \beta_1 CRT + \beta_2 POPGT + \beta_3 COT + \beta_4 NPCFT \\ & + \beta_5 RT + \beta_6 APT + U_3 \end{aligned} \tag{5.4}$$

where:

APT	= Tree crops harvested area in t^{th} year (1000 ha)
CRT	= Amount of credit in t^{th} year (Rp. 10 million)
$POPGT$	= Farmer population growth in t^{th} year (%)
COT	= Number of cooperative in t^{th} year (frequency)
$NPCFT$	= Price of coffee at national level in t^{th} year (Rp.million/tonne)
RT	= Interest rate of credit (%)
APT_l	= Tree crops harvested are in t^{th}-1 year (1000 ha)
U_3	= Random variable

Productivity:

$$\begin{aligned} QPPT = {} & \beta_o + \beta_1 NPCFT + \beta_2 APT + \beta_3 PZNT + \beta_4 DRFT \\ & + \beta_5 QPPT_1 + U_4 \end{aligned} \tag{5.5}$$

where:

$QPPT$	= Tree crops productivity in t^{th} year (1000 tonne /ha)
$NPCFT$	= Price of coffee at national level in t^{th} year (Rp.million/tonne)
APT	= Tree crops harvested area in t^{th} year (1000 ha)
$PZNT$	= Price of nitrogen fertiliser at farm gate in t^{th} year (Rp./kg)
$DRFT$	= Days of rainfall in t^{th} year (frequency)
$QPPT_l$	= Tree crops productivity in t^{th} –1 year (1000 tonne /ha)
U_4	= Random variable

Production:

$$QPT = APT \times QPPT \tag{5.6}$$

where:

QPT	= Total production of tree crops in t^{th} year (1000 tonne)
APT	= Tree crops harvested are in t^{th} year (1000 ha)
$QPPT$	= Tree crops productivity in t^{th} year (1000 tonne /ha)

Livestock

Productivity:

$$LPRT = \beta_o + \beta_1 PCTMT + \beta_2 PCTT + \beta_3 DRFT + \beta_4 RT + \beta_5 LCT + \beta_6 LPRT_1 + U_5 \quad (5.7)$$

where:

LPRT	= Livestock productivity in t^{th} year (million livestock unit)
PCTMT	= Price of cattle meat at consumers level t^{th} year (1000 Rp/ kg)
PCTT	= Price of live cattle at farm gate in t^{th} year (1000 Rp/head)
DRFT	= Days of rainfall in t^{th} year (frequency)
RT	= Interest rate of credit (%)
LCT	= Livestock consumption in t^{th} year (million livestock unit)
$LPRT_1$	= Livestock productivity in t^{th} –1 year (million livestock unit)
U_5	= Random variable

Consumption:

$$LCT = \beta_o + \beta_1 PCTMT + \beta_2 TPIT + \beta_3 LPRT + \beta_4 PRT + \beta_5 OAT + \beta_6 TPOPT + \beta_7 LCT_1 + U_6 \quad (5.8)$$

where:

LCT	= Livestock consumption in t^{th} year (million livestock unit)
PCTMT	= Price of cattle meat at consumers level t^{th} year (1000 Rp/ kg)
TPIT	= Total per capita income in t^{th} year (billion Rp.)
LPRT	= Livestock productivity in t^{th} year (million livestock unit)
PRT	= Price of rice at farm gate in t^{th} year (Rp./kg)
OAT	= Output of agricultural sector in t^{th} year (billion Rp.)
TPOPT	= Total population in ^{tth} year (people)
LCT_1	= Livestock consumption in t^{th}-1 year (million livestock unit)
U_6	= Random variable

Production:

$$LPT = LPRT \times [LIT_1 - LCT]/(1 - LPRT) \quad (5.9)$$

where:

LPT	= Livestock production in t^{th} year (million livestock unit)
LIT1	= Livestock inventory in t^{th} - 1 year (million livestock unit)
LPRT	= Livestock productivity in t^{th} year (million livestock unit)
LCT	= Livestock consumption in t^{th} year (million livestock unit)

Farmer's Per Capita Income

Agricultural sector output:

$$OAT = \beta_0 + \beta_1 IFT + \beta_2 QDT + \beta_3 QPT + \beta_4 POPGT + \beta_5 PIT + \beta_6 PRT + U_7 \qquad (5.10)$$

where :

OAT	= Output of agricultural sector in t^{th} year (billion Rp.)
IFT	= General inflation index (%)
QDT	= Total production of food crops in t^{th} year (1000 tonne)
QPT	= Total production of tree crops in t^{th} year (1000 tonne)
POPGT	= Farmer population growth in t^{th} year (%)
PIT	= Farmer's per capita income in t^{th} year (billion Rp.)
PRT	= Price of rice at farm gate in t^{th} year (Rp./kg)
U_7	= Random variable

Farmer Population Growth :

$$POPGT = \beta_0 + \beta_1 XRT + \beta_2 OAT + \beta_3 FPCT + \beta_4 QDT + \beta_5 LPT + \beta_6 POPGT_1 + U_8 \qquad (5.11)$$

where :

POPGT	= Farmer population growth in t^{th} year (%)
XRT	= Gender ratio in t^{th} year (people)
OAT	= Output of agricultural sector in t^{th} year (billion Rp.)
FPCT	= Number of family planning clinics in t^{th} year (frequency)
QDT	= Total production of food crops in t^{th} year (1000 tonne)
LPT	= Livestock production in t^{th} year (million livestock unit)
$POPGT_1$	= Farmer population growth in t^{th} –1 year (%)
U_8	= Random variable

Farmer Per Capita Income:

$$PIT = OAT/POPT = OAT/\{[POPGT(POPT_1)]/100\} + POPT_1 \qquad (5.12)$$

where:

PIT	= Farmer's per capita income in t^{th} year (billion Rp.)
OAT	= Output of agricultural sector in t^{th} year (billion Rp.)
POPT	= Farmer population in t^{th} year (people)
$POPT_1$	= Farmer population in t^{th} –1 year (people)

5.4.2.2. Definition of variables

Based on the model, there are four general categories of variables, namely endogenous, exogenous, and lagged endogenous and identity variables. This research used eight endogenous variables, 21 exogenous variables, seven lagged endogenous variables and four identity variables. The following list gives a definition and background to each variable according to the category.

Endogenous Variables

- Food crops harvested area is the total harvested area of seven dominant food crops in West Timor, namely paddy, maize, cassava, peanuts, green beans, soybean and sweet potatoes in the t^{th} year.
- Food crops productivity is the total food crops production divided by total food crops harvested area in the t^{th} year.
- Tree crops harvested area is the total harvested area of seven dominant tree crops in West Timor, namely coconuts, coffee, areca nuts, cashews, cloves, candlenuts and kapok in the t^{th} year.
- Tree crops productivity is the total tree crops production divided by total tree crops harvested area in the t^{th} year.
- Livestock production is the total production of three dominant large livestock types (cattle, buffalo and horses), two dominant small livestock types (goats and pigs), and poultry (chicken) in t^{th} year. This variable is counted in "livestock units" and has been calculated based on the formula:

$$LPT = LCT + (LIT - LIT1) \tag{5.13}$$

where:

LPT = Livestock production in the t^{th} year.
LCT = Livestock consumption in the t^{th} year.
LIT = Livestock inventory in the t^{th} year.
$LIT1$ = Livestock inventory in the $t^{th} - 1$ year.

- *Livestock consumption* is the total consumption of livestock slaughtered and exported. This variable is counted in "livestock units" and has been calculated based on the assumption that (a) only two year olds or more of large livestock have been slaughtered as well as exported, (b) only one year olds or more of small livestock have been slaughtered as well as exported, and (c) only 0.5 year olds or more of poultry have been slaughtered as well as exported.

- *The output of the agricultural sector* is the total output of three sub-sectors in the agricultural sector. These are the food crops, tree crops, and livestock sub-sectors. This variable has been deflated by the inflation level.
- *Farmer population growth* is calculated based on the formula:

$$POPGT = \{(POPT - POPT1)/POPT1\} \times 100 \tag{5.14}$$

where:

POPGT	= Farmers' population growth in the t^{th} year.
POPT	= Farmer population in the t^{th} year.
POPT1	= Farmer population in the t^{th}-1 year.

Exogenous Variables

- *Total per capita income* is the per capita income of all people (farmers and non-farmers) in West Timor in the t^{th} year. It is calculated from the total regional income in the t^{th} year divided by total population in the same year. This variable has been deflated by the inflation level.
- *Regional income* is the gross domestic product, which is derived from the sum of gross value added of all industrial origins including the repayment service of production, factor (wages, income, industrial surplus), reduction and gross indirect tax. This variable has been deflated by the inflation level.
- *Inflation level* is the level of general inflation in Kupang City in the t^{th} year. This level of inflation is used as the indicator of the inflation level in West Timor in the same year.
- *The livestock inventory* is the total population of large livestock (cattle, buffalo, and horses), small livestock (goats and pigs) and poultry (chickens) in the t^{th} year. The data for this variable is calculated in "livestock units". The Directorate of Livestock Enterprises of Indonesia (1995) has given some detailed calculations of the *"livestock units"* as presented in Table 5.2.

Table 5.2. Level of livestock units in Indonesia

Livestock	Age	Livestock Unit
Cattle, Buffalo, Horses	> 2 years	1.00
	1 – 2 years	0.50
	< 1 year	0.25
Goats/Sheep	> 1 year	0.14
	0.5 - 1 year	0.07
	< 0.5	0.04
Pigs	> 1 year	0.40
	0.5 - 1 year	0.20
	< 0.5 year	0.10
100 Chickens	> 0.5 year	1.00
	0.6 – 0.5 year	0.50
	< 0.6 year	0.25

Source: Directorate of Livestock Enterprises of Indonesia 1995.

- The *market margin of rice* is the difference between the price at the producer's level and the consumer's level.
- The *amount of credit* is the total amount of agricultural credit given to farmers by all commercial banks in the t^{th} year.
- The *price of fertiliser* is the fertiliser price at the farm gate in the t^{th} year.
- *Rainfall* is the intensity of rainfall in the t^{th} year. This variable is counted in "millimetres" (mm).
- *Days of rainfall* is the frequency of rainfall in the t^{th} year. This variable is counted in "days".
- The *total cost per hectare of rice cultivation* is the average "Rupiah" that has been spent by farmers to cultivate one hectare of paddy in the t^{th} year.
- The *total cost per hectare of maize cultivation* is the average "Rupiah" that has been spent by farmers to cultivate one hectare of maize in the t^{th} year.
- The *Supra Special Intensification Program* is the program that has been run by the local government since 1990 to increase food crops production, especially paddy. This program is the advanced program of intensification.
- The *size of irrigated area* is the total area of wetland irrigated in the t^{th} year.

- The *number of cooperatives* is the total number of cooperatives in West Timor in the t^{th} year.
- The *interest rate* is the average interest rate of credit that has been decided by all commercial banks in West Timor in the t^{th} year.
- The *price of coffee* is the price at the national level in the t^{th} year.
- The *price of cattle meat* is the average price in the public market in all cities of West Timor.
- The *price of livestock* is the average price at the farm gate in all districts of West Timor.
- The *price of rice* is the average price at the farm gate in all districts of West Timor.
- *Gender ratio* is the ratio of males to females of West Timorese farmers in the t^{th} year.
- The *number of family planning clinics* is the number of clinics supporting the family planning program in West Timor.

Identity Variables

- *Food crops production* is the total production of seven dominant food crops in West Timor, i.e., paddy, maize, cassava, peanut, green bean, soybean and sweet potato in the t^{th} year.
- *Tree crops production* is the total production of seven dominant tree crops in West Timor, namely coconuts, coffee, areca nuts. cashews, cloves, candlenuts and kapok in the t^{th} year.
- *Livestock productivity* is calculated based on the formula:

$$LPRT = LPT/LIT \qquad (5.15)$$

where:

$LPRT$ = Livestock productivity in the t^{th} year.
LIT = Livestock inventory in the t^{th} year.
LPT = Livestock production in the t^{th} year.

- *Farmers' per capita income* is calculated from the total output of the agricultural sector in the t^{th} year divided by farmer population in the same year. The current data on farmer per capita income have been deflated to get the real data of farmers' per capita income. In this research, *farmers' welfare* is represented by farmers' per capita income. In other words, farmers' per capita income in the t^{th} year is used as an indicator of farmers' welfare in the same year. There are many indicators which could be used to evaluate the welfare of a society, such as per capita income, the level of education, life expectancy, purchasing power, calorie consumption and even the amount of public transportation and hospitals accessed. However, due to problems with data availability and continuity of other indicators at the regional level, this study only deals with per capita income as the indicator of welfare

Lagged Variables

- *Lagged food crops* harvested area is the total harvested area of seven dominant food crops in West Timor, namely paddy, maize, cassava, peanuts, green beans, soybean and sweet potatoes in the t^{th-1} year.
- *Lagged food crops* productivity is the total food crops production divided by total food crops harvested area in the t^{th-1} year.
- *Lagged tree crops* harvested area is the total harvested area of seven dominant tree crops in West Timor, namely coconuts, coffee, areca nuts, cashews, cloves, candlenuts and kapok in the t^{th-1} year.
- *Lagged tree crops* productivity is the total tree crops production divided by total tree crops harvested area in the t^{th-1} year.
- *Lagged livestock production* is the total production of three dominant large livestock types (cattle, buffalo and horses), two dominant small livestock types (goats and pigs), and poultry (chicken) in t^{th-1} year.
- *Lagged livestock consumption* is the total consumption of livestock slaughtered and exported in t^{th-1} year.
- *Lagged farmer population growth* is farmer population growth in t^{th-1} year.

5.4.3. Analytical procedure

5.4.3.1. Model identification

Model identification refers to the problem of model formulation rather than of model estimation or appraisal (Gaspersz 1991, Koutsoyiannis 1978). A model is identified if it is in a unique statistical form, enabling unique estimates of its parameters to be subsequently made from sample data. Koutsoyiannis (1978) stated further that an econometric model is frequently in the form of a system of simultaneous equations. The model may be said to be complete if it contains at least as many independent equations as endogenous variables. A system of the structural analysis equation is categorised as *identified* if and only if all equations in the system are identified. If one or more of its equations are *not identified*, the system is also not identified (Intrilligator 1978).

In econometric theory two possible situations of identifiability are traditionally distinguished, that is (1) equation under-identification and (2) equation identification, which can consist of exact identification or over-identification. An equation is under-identified if its statistical form is not unique. A system is under-identified when one or more of its equations are under-identified. If an equation has a unique statistical form, it can be said that it is identified. It may be exactly identified or over-identified, but in both cases it is identified. A system is identified if all its equations are identified.

The implications of the identification of a model are: (1) if an equation (or a model) is identified. it is possible to estimate all its parameters using econometric techniques; and (2) if an equation is identified, its coefficient can, in general, be statistically estimated. In particular, if the equation is exactly identified, the appropriate method to be used for its estimation is the method of indirect least squares (Koutsoyiannis 1978). If the equation is over-identified, indirect least squares cannot be applied, because it will not yield a unique estimate of the structural parameters (Koutsoyiannis 1978). Instead, other methods that can be used in this case, for example two stage least squares (2SLS), three stage least squares (3SLS), or maximum likelihood methods (Koutsoyiannis 1978, Gaspersz 1991).

The methods of two stage least squares is a single-equation method which is applied to one equation of the system at a time. It has provided satisfactory results for the estimates of the structural parameters and has been accepted as the most important of the single-equation techniques (Koutsoyiannis 1978, Gaspersz 1991).

The three stage least squares is a system method that is applied to all the equations of the model at the same time and gives estimates of all the parameters simultaneously (Koutsoyiannis 1978, Gaspersz 1991). This method was developed as a logical extension of the two stage least squares method. It involves the application of the method of Least Squares in three successive stages.

The maximum likelihood method consists of the limited information maximum likelihood (LIML) and the full information maximum likelihood (FIML) methods. The former is a single equation method, being applied to one equation at a time, while the latter is a system method, i.e., a method which is applied to all the equations of the model contemporaneously and provides estimates of all the structural parameters at the same time (Koutsoyiannis 1978). Both methods are quite complicated, especially the FIML which requires complete specification of the model and a large amount of data. The LIML was used frequently before the development of two stage least squares methods.

The order condition of the identification of a model is the total number of variables (endogenous and exogenous) excluded from it must be equal to or greater than the number of endogenous variables in the model less one (Koutsoyiannis 1978, Gaspersz 1991). The order condition of identification might be symbolically expressed as

$$(K-M)\geq(G-1) \qquad (5.16)$$

where:

K	= number of total variables in the model (endogenous and predetermined)
M	= number of variables (endogenous and exogenous), included in a particular equation.
G	= total number of equations (endogenous variable)

The model is under-identified if $(K\text{-}M) < (G\text{-}1)$. the model is exactly - identified if $(K\text{-}M) = (G\text{-}1)$ and over-identified if $(K\text{-}M) > (G\text{-}1)$.

Based on the theoretical criteria above, it can be concluded that the model is over-identified. The model consists of eight endogenous variables, 21 exogenous variables and seven lagged endogenous variables. Generally, there are eight structural equations and four identity equations. All of the equations in the model can be solved by using the 2SLS, the 3SLS, the LIML or the FIML.

5.4.3.2. Model estimation

The statistical analytical technique to be used to estimate the structural equation is selected based on the resources available and the goal of the analysis. The goal of analysis in this study is to get the parameters of estimation that can fulfil the criteria of economics, statistics and econometrics. According to Koutsoyannis (1978), there are three criteria that can be used to evaluate the result of the estimation. First, economic *a priori* criteria, which are determined by economic theory. Second, statistical criteria that are determined by statistical theory. Third, econometric criteria that are determined by econometric theory. The economic *a priori* criteria are determined by the principles of economic theory and refer to the sign and the size of the parameters of economic relationships. The statistical criteria are determined by statistical theory and aim at the evaluation of the statistical reliability of the estimates of the parameters of the model. The most widely used statistical criteria are the correlation coefficient and the standard deviation of the estimates. The econometric criteria are set by econometrics theory and aim at the investigation of whether the assumptions of the econometric method employed are satisfied or not in a particular case. In other words, a method that will be used in estimating the parameters of the model is a method that provides (i) a proper sign (and size) of the parameters based on the economic theory; (ii) a significant influence of the parameters based on the statistical theory, (iii) a high coefficient of determination; and (iv) no violation of the econometric assumptions such as autocorrelation and multicolinearity.

5.4.3.3. Model validation

The last objective of an econometric method is the evaluation of policy. This objective refers to the situation where policy makers have to choose a policy from a set of policy alternatives (Intrilligator 1978). According to Koutsoyiannis (1978), the accuracy of forecasting of the reduced form parameter is an important factor in the evaluation of policy alternatives.

A systematic measure of the forecasts obtained from an econometric model has been suggested by Theil (1962), as cited by Koutsoyiannis (1978). This measure is called The Inequality Coefficient and is defined by the expression:

$$U^2 = \frac{\sum (P_t - A_t)^2 / n}{\sum A_t^2 / n} \tag{5.17}$$

or

$$U = +\sqrt{\frac{\sum (P_t - A_t)^2 / n}{\sum A_t^2 / n}} \tag{5.18}$$

where:

P_t = Predicted (forecast) change in the dependent variable
A_t = Actual (realised) change in the dependent variable

The above formula is used to test the forecasting power of the model. The values that the inequality coefficient assumes are between 0 and ∞ $(0 \leq U \leq \infty)$. The smaller the value of the inequality coefficient, the better is the forecasting performance of the model (Koutsoyiannis 1978).

If $P_t = A_t$, then $U = 0$ meaning that the model has attained perfect forecasts. If $P_t = 0$, then $U = 1$, and the model forecasts are no better than a "naïve" zero-change prediction. If $U > 1$, the predictive power of the model is worse than a zero-change prediction. Thus if $U > 1$ it is preferable to accept the zero-change extrapolation that $Y_{t+1} = Y_t$, that is, to assume that there will be no change in the value of the independent variable between the periods t and $t+1$ (Koutsoyiannis 1978).

The numerator of the inequality coefficient is the root mean square prediction error (RMS prediction error) and is the important term in this measure. The denominator is simply a way for achieving the independence of U from the unit of measurement of the variables. The numerator can be decomposed into three terms, each showing a different source of forecasting-error.

$$1/n \sum (P_t - A_t)^2 = (\overline{P} - \overline{A})^2 + (S_p - S_a)^2 + 2(1 - r_{PA}) S_P S_A \tag{5.19}$$

$\overline{P}$ and $\overline{A}$ are the means of prediction and actual values, $\overline{P} = 1/n\sum P_t$ and $\overline{A} = 1/n\sum A_t$. S_P and S_A are the standard deviations of predictions and realisations.

$$S_P^2 = 1/n\sum(P_t - \overline{P})^2 \quad (5.20)$$

and

$$S_A^2 = 1/n\sum(P_t - \overline{A})^2 \quad (5.21)$$

r_{PA} is the correlation coefficient of predicted and realised changes. That is:

$$r_{PA} = \frac{\sum(P_t - \overline{P})(A_t - \overline{A})}{nS_P S_A} \quad (5.22)$$

A useful way to present the various sources of the forecast error is to divide each component by the total forecast-variation $\sum(P_t - A_t)^2/n$. In this way, each component is a proportion of total prediction error. This procedure leads to the following inequality proportions.

Bias proportion,

$$U_M = \frac{(\overline{P} - \overline{A})^2}{\sum(P_t - A_t)^2/n} \quad (5.23)$$

Variance proportion,

$$U_S = \frac{(S_P - S_A)^2}{\sum(P_t - A_t)^2/n} \quad (5.24)$$

Co-variance proportion,

$$U_C = \frac{2(1 - r_{PA})S_P S_A}{\sum(P_t - A_t)^2/n} \quad (5.25)$$

Clearly,

$$U_M + U_S + U_C = 1 \quad (5.26)$$

UM is the bias proportion showing a systematic error, which is used to measure deviation of the forecasting mean value from the actual mean value. According to Intrilligator (1978), the best value of *UM* lies between 0.1 and 0.2. If the value of *UM* is bigger than 0.2, the model should be corrected because of the systematic bias. *US* is the proportion of variance which is used to analyse the replication level of the model because of the change in the endogenous variable. Large values of *US* mean the actual series value will fluctuate too much, while the predicted series value will not. In this condition, the model should be corrected. *UC* is the proportion of variance which is used to measure the unsystematic error. If *UC* is bigger than zero, the error is perfectly distributed.

The least squares error can be written in three other components i.e., *UM*, *UR*, and *UD*.

$$U_R = \frac{n(S_P - r_{PA} S_A)^2}{\sum (P_t - A_t)^2} \tag{5.27}$$

$$U_D = \frac{n(1 - r_{PA}^2)(S_A)^2}{\sum (P_t - A_t)^2} \tag{5.28}$$

UR is the regression component which shows the deviation of the actual regression from the predicted value. *UD* is the residual component which shows the unsystematic error. A model is perfect if *UM* and *UR* are small and *UD* is close to one.

The model can also be evaluated by examining the coefficient of determination (R^2). The high value of the R^2 indicates a large variation in the endogenous variable that can be explained by predetermined variables.

5.4.3.4. Model simulation

According to Intrilligator (1978), simulation is one approach to policy evaluation using an estimated econometric model. Two other approaches are the instrument-targets approach and the social-welfare-function approach.

Policy evaluation is closely related to forecasting, and, just as in the case of forecasting it will be assumed that the policy choice is quantitative, explicit, and unambiguous. In fact, forecasting and policy evaluation are interrelated in a feedback system. A forecast must be based, in part, on assumptions concerning the action of the relevant decision makers. Conversely, policy evaluation must be based, in part, on forecasts of the effects of policy choice.

Just as the forecasting use of econometrics distinguishes between short-term and long-term forecasts, the policy evaluation use also distinguishes between short-term and long-term policy. A basic issue in policy evaluation, in fact, is the time horizon of the plan. The type of policy evaluation to be stressed is that of short- term policy evaluation, namely that of choosing a policy at time T given the course of events up to and including time "t_1". The analysis can, however, be generalized to long-term policy, which is the choice of a policy for time t, t_1, t_2, ..., t_n, where n is the time horizon of the plan.

Assuming the vector of variables "$\boldsymbol{r}$" summarizes the policy variables to be chosen by the decision maker, the problem of policy evaluation in the short-term is that of choosing optimal value for these variables during the current period "t". The short-term optimal policy is $\boldsymbol{r}^*_t$. A long-term optimal policy would be summarized by the sequence of current and future values of policy variables. The long-term optimal policy is $\boldsymbol{r}^*_t$, $\boldsymbol{r}^*_{t+1}, \ldots, \boldsymbol{r}^*_{t+n}$, where n is the time horizon of the plan.

In general, simulation refers to the determination of the behaviour of a system via the calculation of values from an estimate of the system. The model is assumed to be sufficiently explicit so that it can be programmed for numeric study, typically using a computer.

In a simulation, data on the value of the policy and other exogenous variables, together with estimated values of parameters and stochastic disturbance terms, are used to calculate the values of the endogenous variables from the equation of the model.

There are several variables that were simulated in this research. These are the size of irrigated area, amount of credit, total population, level of inflation, cost of production, the price of crop produced, the price of livestock produced, interest rate and the number of cooperatives.

5.5. Concluding Remarks

In this study, the determinants of agricultural production of West Timor that will be used in the model include the number of cooperatives, the type intensification program, rainfall, the size of irrigated area, the area of land under intensification, total population, the price of crops, the price of fertiliser, the price of livestock, amount of credit, interest rates, cost of production and per capita income. In like manner, the per capita income of farmers is determined by the level of inflation, the production of food crops, the production of tree crops, the production of livestock, population growth and output of the agricultural sector. The linear simultaneous equation model was chosen for the estimation of agricultural production and farmers' welfare in West Timor in this study.

The model in this study consists of eight structural equations, four identity equations, eight endogenous variables, twenty-one exogenous variables and seven lagged endogenous variables.

The validation techniques used in the evaluation of this model were inequality coefficient, bias proportion, variance proportion, co-variance proportion, regression component, residual component and coefficient of determination.

CHAPTER 6

RESULTS OF THE STRUCTURAL ANALYSIS OF THE MODEL

6.1. Introduction

The results of the model estimation are presented in section 6.2. The model consists of eight endogenous variables: food crop harvested area, food crop productivity. tree crop harvested area, tree crop productivity, livestock productivity, livestock consumption, agricultural sector output and farmer population growth, 21 exogenous variables and seven lagged endogenous variables.

The discussion of the result of the structural analysis is presented in Section 6.3. This section contains the interpretation of the influence of the explanatory variables on food crop harvested area, food crop productivity, tree crop harvested area, tree crop productivity, livestock productivity, livestock consumption, the agricultural sector output and farmer population growth. Discussion of the elasticity coefficient of each explanatory variable with respect to the endogenous variable is presented in Section 6.4.

Concluding remarks of the overall analysis and the interpretation of the structural analysis as well as the elasticity coefficients are presented in section 6.5.

6.2. Results of the Model Estimation

The model was constructed to ascertain comprehensive information on agricultural production and farmers' welfare in West Timor. Agricultural production is categorized into food crops production, tree crops production and livestock production. At the same time, farmers' welfare is determined by farmers' per capita income derived from total agricultural sector output and farmer population growth.

The model is a linear simultaneous equation model consisting of eight structural equations and four identity equations. The model also consists of eight endogenous variables (food crops harvested area, food crops productivity, tree crops harvested area, tree crops productivity, livestock productivity, livestock consumption, agricultural sector output, and farmer population growth), 21 exogenous variables and seven lagged endogenous variables (except lagged agricultural sector output).

The model was estimated using the three stage least squares method (3SLS) for the time series data from 1979 to 1998. The estimation model used the computer software package Statistics Analysis System/Econometric Time Series (SAS/ETS) release 6.12.

The result of the model identification which consists of eight endogenous variables, 21 exogenous variables and seven lagged endogenous variables, showed that the model is over-identified. As mentioned in Section 5.4.3.2, theoretically, all equations in the model could be solved by using either the two stage least squares" technique (2SLS), the three stage least squares" technique (3SLS), the limited information likelihood" technique (LIML) or the full information likelihood" technique (FIML). However, because the last two techniques (LIML and FIML) are quite complicated and require a complete specification of the model as well as a large amount of data, only the first two techniques (2SLS and 3SLS) were used to estimate the model. According to Koutsoyiannis (1978), the 2SLS method is preferred because of its simplicity and also because there has been evidence that it yields better estimates than the maximum likelihood methods, especially for small samples. The parameter estimates from 3SLS are more efficient than those from 2SLS because it involves the application of the method of least squares in three successive stages. 3SLS is a straightforward extension of 2SLS. The first two stages are the same as 2SLS except that we deal with the reduced-form of all the equations of the system. The third stage involves the application of generalised least squares to a set of transformed equations. Some studies using both the 2SLS and 3SLS techniques have yielded good results in terms of the parameter estimation of the model (Sinaga 1989, Sison *et al.* 1978, Nainggolan and Suprapto 1987, Benu 1996). The results of the estimation of the 2SLS and 3SLS techniques can be seen in Table 6.1.

Table 6.1. Result of the estimation of 2SLS and 3SLS Methods

R2 system			2SLS					3SLS				
			0 989					0 989				
Endo-genous	**Predictor**	**Definition**	R^2	**F value**	**Para-meter**	***t* value**	***P* value**	R^2	**F value**	**Para-meter**	***t* value**	***P* value**
ADT		Food crops Harvested area	0 86	7 46			0 0023[c]	0 86	7.46			0 0023[e]
	Intercept				101 21	0 58	0.15[a]			86.48	1 57	0.15[a]
	PRMT	Market margin of rice price			-0 17	-1 12	0 29			-0.20	-1.54	0.15[a]
	CRT	Amount of Credit			0 04	1 16	0 27			0 06	1,92	0 08[c]
	PZNT	Nitrogen fertiliser price			0 20	0 13	0 29			0.22	1 48	0 17[a]
	POPGT	Farmer population growth			3.34	1 45	0 18[d]			3 90	1 97	0.08[c]
	RFT	Rainfall			0 02	1 48	0.17[d]			0.03	2 06	0 07[c]
	TCRT	Cost / hectare of rice cultivation			-17 8	-0 44	0 67			-16 88	-0 50	0 63
	D_1	Intensification program			20 35	1 36	0 20			12.77	1 03	0 33
	ADT_1	Lag food crops harvested area			-0 002	-0 01	0 99			0 02	0 05	0.96

Where:

a = significant at 20 % of significant level
b = significant at 15 % of significant level
c = significant at 10 % of significant level
d = significant at 5 % of significant level
e = significant at 1 % of significant level

Table 6.1. Continued

Endo-genous	Predictor	Definition	2SLS R^2	2SLS F value	2SLS Para-meter	2SLS t value	2SLS P value	3SLS R^2	3SLS F value	3SLS Para-meter	3SLS t value	3SLS P value
QPDT		Food crop productivity	0 82	15 81			0 0001[c]	0 82	15 81			0 0001[e]
	Intercept				0 89	1 88	0 08[c]			0 86	2 22	0 04d
	ART	Irrigation area			0 19	3 88	0 002[e]			0 19	4 95	0 0002[e]
	ADT	Food crops harvested area			0 04	1 31	0 21			0 004	1 51	0 15[a]
	TCMT	Cost/ hectare of maize cultivation			-6 32	-1 71	0 11[b]			-6 15	-1 96	0 07[c]
	$QPDT_1$	Lag Food crops Productivity			0 03	0 23	0 82			0 07	0 62	0 55
APT		Tree crops harvested area	0 83	10 11			0 0004[e]	0 83	10 11			0 0004[e]
	Intercept				17 74	3 45	0 005[e]			19 50	4 031	0 002[e]
	CRT	Amount of credit			0 006	1 05	0 31			0 007	1 24	0 24
	POPGT	Farmer population growth			-0 44	-1 33	0 21			-0 50	-1 60	0 32
	COT	Number of Cooperatives			0 08	4 22	0 001[d]			0 08	4 44	0 001[e]
	NPCFT	Coffee price at national level			0 07	0 14	0 89			0 38	0 74	0 48
	RT	Interest rate of credit			-0 42	-1 64	0 13[b]			-0 46	-1 86	0 09[c]
	APT_1	Lag Tree crops harvested area			-0 41	-1 55	0 15			-0 49	-2 01	0 07[c]
QPPT		Tree crops productivity	0 77	8 70			0 0008e	0 77	8 70			0 0008[c]
	Intercept				0 74	3 98	0 002[e]			0 76	4 83	0 0003[e]
	NPCFT	Coffee price at national level			0 009	0 58	0 57			0 004	0 26	0 80
	APT	Tree crops harvested area			-0002	-3 67	0 003[e]			-0 02	-4 56	0 0005[e]
	PZNT	Nitrogen fertiliser price at farm gate			0 001	3 80	0 002[e]			0 001	5 00	0 0002[e]
	DRFT	Days of rainfall			-0 001	-0 79	0 44			-0 001	-0 78	0 45
	$QPPT_1$	Lag Tree crops Productivity			0 07	0 39	0 71			0 003	0 12	0 99

Where:

a = significant at 20 % of significant level
b = significant at 15 % of significant level
c = significant at 10 % of significant level
d = significant at 5 % of significant level
e = significant at 1 % of significant level

Table 6.1. Continued

Endo-genous	Predictor	Definition	2SLS R^2	2SLS "F" value	2SLS Para-meter	2SLS "t" value	2SLS Proba-bility	3SLS R^2	3SLS "F" value	3SLS Para-meter	3SLS "t" value	3SLS Proba-bility
LPRT		Livestock productivity	0.30	0.87			0.55	0.30	0.87			0.55
	Intercept				0.25	3.50	0.004[c]			0.27	4.32	0.001[d]
	PCTMT	Meat price at consumers level			-0.003	-0.68	0.51			-0.01	-1.84	0.09[c]
	PCTT	Cattle price at farm gate			-0.0001	-1.14	0.28			-0.0001	-0.98	0.35
	DRFT	Days of rainfall			-0.001	-1.23	0.24			-0.001	-2.19	0.05[c]
	RT	Interest rate of credit			-0.001	-0.58	0.58			-0.0003	-0.16	0.88
	LCT	Livestock consumption			0.89	1.64	0.13[c]			1.00	2.21	0.05[c]
	$LPRT_1$	Lag Livestock productivity			-0.35	-1.13	0.28			-0.38	-1.44	0.17[a]
LCT		Livestock consumption	0.78	5.50			0.006[e]	0.78	5.50			0.006[e]
	Intercept				-0.14	-0.95	0.36			-0.16	-1.13	0.28
	PCTMT	Cattle meat price at consumers level			0.00006	0.02	0.99			-0.001	-0.23	0.82
	TPIT	Total/capita income			0.00001	0.08	0.94			0.0001	1.13	0.28
	LPRT	Livestock productivity			0.04	0.24	0.82			0.13	0.37	0.15[a]
	PRT	Rice price			0.00002	0.83	0.43			0.00003	1.39	0.19[a]
	OAT	Agricultural sector Output			-0.0001	-0.38	0.71			-0.0004	-1.59	0.14[b]
	TPOPT	Total population			0.00000	1.06	0.31			0.24	1.29	0.22
	LCT_1	Lag Livestk Consump.			0.22	0.57	0.58			0.11	0.33	0.75
OAT		Agricultural sec Output	0.98	776.7			0.0001[e]	0.98	776.7			0.0001[e]
	Intercept				-36.22	-9.89	0.0001[e]			-38.48	-1.94	0.0001[e]
	IFT	General inflation			-0.11	-0.74	0.47			-0.10	-0.88	0.40
	QDT	Total production of food crops			0.008	0.98	0.35			0.01	1.38	0.19[a]
	QPT	Total production of tree crops			1.57	2.38	0.04[d]			1.94	3.71	0.003[e]
	POPGT	Farmer population growth			0.79	1.98	0.07[c]			0.79	2.34	0.04[d]
	PIT	Farmer's /capita income			1.05	53.2	0.0001[e]			1.05	64.69	0.0001[e]

Where:

a = significant at 20 % of significant level
b = significant at 15 % of significant level
c = significant at 10 % of significant level
d = significant at 5 % of significant level
e = significant at 1 % of significant level

Table 6.1. Continued

Endo-genous	Predictor	Definition	2SLS R²	2SLS "F" value	2SLS Para-meter	2SLS "t" value	2SLS Proba-bility	3SLS R²	3SLS 'F' value	3SLS Para-meter	3SLS "t" value	3SLS Proba-bility
	PRT	Rice price			0 01	1 88	0 85			0 01	1 63	0 13[b]
POPGT		Farmer population growth	0 49	1 92			0 16[a]	0 49	1 92			0 16[c]
	Intercept				17 85	1 18	0 26			22 89	1 72	0 11[b]
	XRT	Gender ratio			-12 22	-0 85	0 41			-16 58	-1 32	0 21
	OAT	Agricultural Sector Output			-0 007	-1 17	0 27			-0 01	-1 48	0 16[a]
	FPCT	Number of family planning clinics			0 04	0 38	0 71			0 04	0 38	0 71
	QDT	Food crops Production			0 003	0 41	0 69			0 004	0 75	0 47
	LPT	Livestock production			-43 87	-2 03	0 07[c]			-49 25	-2 47	0 03[d]
	$POPGT_1$	Lagged Farmer population Growth			-0 005	-0 02	0 98			-0 13	-0 64	0 53

Where:

a = significant at 20 % of significant level
b = significant at 15 % of significant level
c = significant at 10 % of significant level
d = significant at 5 % of significant level
e = significant at 1 % of significant level

The 'goodness' of an econometric model is judged customarily according to at least three desirable criteria: (i) Theoretical plausibility - the model should be compatible with the postulates of economic theory. It must describe adequately the economic phenomena to which it relates; (ii) Explanatory ability - the model should be able to explain the observations of the actual world. It must be consistent with the observed behaviour of the economic variables whose relationship it determines; and (iii) Accuracy of the estimates of the parameters - the estimates of the coefficients should be accurate in the sense that they should approximate as best as possible the true parameters of the structural model.

Based on the above criteria, it can be concluded that the 3SLS is a better technique for estimation of this particular model compared to the 2SLS, because the 3SLS produced more significant variables than 2SLS. It also produced more regression parameters which are compatible with the postulates of economic theory than 2SLS.

There are three advantages that the 3SLS technique had over the 2SLS technique. First, the 3SLS method produced more variables that had a significant influence on the endogenous variables at 5 per cent, 10 per cent and 20 per cent significance levels. Second, the 2SLS method did not produce a significant influence (the predictors) on food crops harvested area at 5, 10 or 15 per cent significance level. At the same time, the 3SLS method produced three variables that had a significant influence on food crops harvested area at 10 per cent significance level. Third, there was no variable produced by the 2SLS technique that had a significant influence on livestock consumption, whereas the 3SLS produced three variables that had a significant influence on livestock consumption at 20 per cent significance level.

The result of the parameter estimation of the model produced by either the 2SLS or the 3SLS methods show that the system coefficient of determination (R^2 system) is high (R^2 = 98.9 %). The coefficient of determination produced by either the 2SLS or the 3SLS methods is always the same. At the same time, the result of the analysis of variance (*F*-test) produced by the 3SLS method shows that, except for the structural equation of livestock productivity and farmer population growth, all other equations are highly significant at one per cent significance level (α = 1 %, P value < 0.001). We can say that overall regression in the model is significant. The result of the t-test of the parameter estimation under the 3SLS technique shows that there are 10 parameters that are significant at one per cent significance level, five parameters at 10 per cent significance level and nine parameters at 20 per cent significance level. Although commonly, 1 per cent, 5 present and 10 percent are normally used when assessing significance (especially when assessing the technical variables), other researchers have also used 15 per cent and 20 per cent significance level, especially when assessing the social-economic variables. For example, Sinaga (1989) used 15 percent significance level when assessing the influence of some economic variables on the Indonesian hardwood products industry. Benu (1996) used 20 percent significance level when assessing the influence of food price on the production and consumption of rice in East Nusa Tenggara province of Indonesia. In other words 15 per cent and 20 per cent significance level might be tolerated for social-economic variables.

There are five variables that had a significant influence on food crops harvested area. These are market margin of rice price (α=20%) amount of credit (α=10%), the price of nitrogen fertiliser (α=20%), farmer population growth (α=10%)

and rainfall (α=10%). At the same time three variables had a significant influence on food crops productivity. These are irrigated area (α=1%), food crops harvested area (α=20%) and total cost per hectare of maize cultivation (α=10%). The coefficient of determinations of the food crops harvested area equation and the food crops productivity equation were 86 per cent and 82 per cent, respectively. It can therefore be said that the predictors can explain about 86 per cent of the total variations of the food crops harvested area. At the same time, about 82 per cent of the total variation of the food crops productivity can be explained by the predictors.

There are three variables that had a significant influence on tree crops harvested area. These are the number of co-operatives (α=1%), interest rate (α=10%), and lagged tree crops harvested area (α=10%). At the same time, two variables had a significant influence on tree crops productivity. These are tree crops harvested area (α=1%) and the price of nitrogen fertiliser (α=1%). The coefficients of determination of the tree crops harvested area equation and the tree crop productivity equation were 83 per cent and 77 per cent respectively.

There are four variables that have a significant influence on livestock productivity. These are the price of cattle meat (α=10%), days of rainfall (α=10%), livestock consumption (α=10%) and lagged livestock productivity (α=20%). At the same time, four variables had a significant influence on livestock consumption. these are livestock productivity (α=20%), the price of rice (α=20 %), agricultural sector output (α=20%) and total population (α=25%). The coefficients of determination of the livestock productivity equation and the livestock consumption equation were 30 per cent and 78 per cent respectively.

The influence of the livestock productivity and total population on the livestock consumption are not highly significant Statistically, however, these level of significance can be tolerated, especially for socio-economic factors (Sinaga 1989, Benu 1996). The coefficient of determination of the livestock productivity is only 30 per cent, perhaps because the livestock productivity in West Timor is more determined by the physical factors such as precipitation and carrying capacity than socio-economic factors. Precipitation has included in the model. However, carrying capacity has not included in the model specification because it is not available as mentioned in Section 5.4.1.

There are five variables that had a significant influence on agricultural sector output. These are food crops production (α=20%), tree crops production (α=1%), farmer population growth (α=10%), farmers' per capita income (α=1%) and the price of rice (α=20%). At the same time, three variables had a significant influence on farmer population growth. These are gender ratio (α=25%), agricultural sector output (α=20%) and livestock production (α=10%). The coefficients of determination of the agricultural sector output equation and farmer population growth equation were 99 per cent and 49 per cent. The specification model of farmer population growth could not explain half of the variation because some explanatory variables (such as farmer's per capita income, level of education, tree crops production) have been dropped from the model to avoid serious *multicolinearity* problem. Although dropping some explanatory variables from the original function resulted in a lower R^2 value, the parameter estimates are unbiased because there is no serious multicolinearity in the final model of food crops harvested area.

6.3. Discussion of the Result of the Structural Analysis

The result of the analysis shows that the model has a high coefficient of determination for the system (R^2 = 98.9 %). The system has a single coefficient of determination for both 2SLS and 3SLS. This means only 1.1 % of the variation of the system cannot be explained by the variables in the system. The values of R^2 of all structural equations are between 30 per cent and 99 per cent. Except for the structural equation of livestock productivity, the *F-test* shows that all structural equations are significant at 20 per cent level of significance . The estimation of the model by the 3SLS method showed there is no serious *multicolinearity* problem in the model. The estimator in the presence of multicolinearity, remains unbiased. In fact, all the OLS assumptions are still met and the estimator remains its desirable properties. The main problem with multicolinearity is that the variances of the OLS estimates of the parameters of the collinear variables are quite large.

The *multicolinearity* problem has been tested using the coefficient of correlation among all predictors in a particular equation. The highest correlation coefficient between two predictors is 0.79. These are the correlation between total cost per hectare of rice cultivation and the dummy variable for the intensification program as well as the correlation between the dummy variable of intensification program and the lagged food crops harvested area. Although this correlation coefficient is quite high, it does not mean that there is a serious multicolinearity problem in the model. According to Kennedy (1998), an absolute correlation coefficient value of 0.8 to 0.9 indicates high correlation between two independent variables. As the relevant correlation coefficient in our model is slightly lower than 0.8, then we can assume that multicolinearity is not a serious problem in this case.

6.3.1. Food crops harvested area

The first structural equation explains the food crops harvested area in West Timor. The endogenous variable of food crops harvested area includes seven dominant food crops in West Timor, that is rice, maize, cassava, peanuts, green beans, sweet potatoes, and soybeans. The production of other food crops has not made a significant contribution to the economy of West Timor.

The original structural equation for food crops harvested area was constructed as a function of one endogenous variable (farmer population growth), 11 exogenous variables (marginal market price of rice, amount of credit, the price of nitrogen fertilizer, rainfall, intensification program, the size of irrigated area, the price of food crops commodities, number of tractors, total cost per hectare of rice cultivation and total cost per hectare of maize cultivation) and one lagged endogenous variable (lagged food crops harvested area).

However, some variables have been dropped from the original function based on the economic, statistics, and econometric criteria (see section 5.4.3.2). The prices of other food crops (corn, cassava, peanut and sweet potato) had been dropped from the original function because these variables generated problems of *multicolinearity* in the model. For the price variables, only the price of rice was retained in the final model. The number of tractors, the size of irrigation areas and number of cooperatives have been dropped from the function, because these variables have not shown a significant influence on the endogenous variable according to the size of the parameter estimation (zero) as well as the value of the *test*. Total cost per hectare of maize cultivation has been dropped from the function because this variable generates a contradictory sign of the parameter estimation. In other words, if the total cost per hectare of maize cultivation is included in the model, it generates a contradictory sign either for itself or for other variables. It is possible that this variable is the source of the multicolinearity problem in the model, hence was dropped in the final equation. Furthermore, West Timorese farmers use traditional maize cultivation mainly for food consumption, so harvested area of this commodity may not really depend on the cost per hectare. Rather, harvested area is more dependent on the technical factors such as the availability of land for cultivation and precipitation. Although dropping some explanatory variables from the original function resulted to a lower R^2 value, there is no longer a serious *multicolinearity* problem in the final model of food crops harvested area. Consequently. the explanatory variables that were selected to construct the final structural equation for food crops harvested area are the marginal market price of rice, amount of credit, the price of nitrogen fertiliser, farmer population growth, rainfall, the total cost per hectare of rice cultivation, the supra-intensification program and the lagged food crops harvested area.

The result of the estimation of the first structural equation is presented below. The value in the brackets is the probability of the regression parameter produced by SAS/ETS software. This value has to be compared with α. If the value in the bracket is smaller than α, then the parameter is significant at α.

$$
\begin{aligned}
ADT = {} & \underset{(0.1484)}{86.4831} - \underset{(0.1548)}{0.20068}\ PRMT + \underset{(0.0836)}{0.0636}\ CRT + \underset{(0.1706)}{0.2245}\ PZNT + \\
& \underset{(0.0774)}{3.9037}\ POPGT + \underset{(0.0667)}{0.0255}\ RFT - \underset{(0.6299)}{16.8839}\ TCRT + \\
& \underset{(0.3269)}{12.7714}\ D_1 - \underset{(0.9612)}{0.01840}\ ADT_1 + U_1
\end{aligned}
\qquad (6.1)
$$

$R^2 = 0.8565$; $F_{value} = 7.458$

where:

ADT	= Food crops harvested area in the t^{th} year (000 ha)
PRMT	= Marginal market price of rice in the t^{th} year (Rp/kg)
CRT	= Amount of credit in the t^{th} year (Rp 10 million)
PZNT	= Price of nitrogen fertiliser in the t^{th} year (Rp/kg)
POPGT	= Farmer population growth in the t^{th} year (%)
RFT	= Rainfall in the t^{th} year (mm)
TCRT	= Total cost per hectare of rice cultivation in the t^{th} year (Rp million)
D1	= Dummy variable 1 (1 for the year that the "supra special intensification program" took place and 0 for others)
ADT_1	= Harvested area of food crops in the t^{th} –1 year (000 ha)

It can be said that the model for food crops harvested area is quite good, based on the result of the analysis of variance (Anova). The *F-test* showed that the model is highly significant at one per cent level of significance (prob.>F = 0.002), and the coefficient of determination (R^2) is about 85.6 percent.

There are five variables that have a significant influence at various levels of significance on the food crops harvested area in West Timor, these are the market margin of rice (α = 15 %), amount of credit (α = 10 %), the price of nitrogen fertiliser (α = 20 %), farmer population growth (α = 10 %) and rainfall (α = 10%).

The result of the structural analysis shows that the marginal market price of rice (the difference between the price at producer level and the price at consumer's level) has not had a significant influence on the food crops harvested area at 10 per cent level of significance, but has a significant influence on the food crops harvested area at 20 per cent level of significance. If the marginal market price of rice increases by one Rupiah, food crops harvested area will decrease by approximately 0.2 ha. Rice is one of the dominant food crops in West Timor, so that if there is a large difference between the price received by the producer and that paid by the consumer, farmers will not be motivated to increase their harvested area. Farmers may instead convert some of their land food crop cultivation to other cultivation, hereby reducing their food crops harvested area.

Agricultural credit is one of the determinant factors of the food crops harvested area. The result of the structural analysis shows that the amount of agricultural credit has a significant influence on the food crops harvested area at 10 per cent level of significance. Each Rp10 m increase in the amount of agricultural credit will increase the food crops harvested area by approximately 63.6 ha per year. The nominal amount of agricultural credit given to farmers in West Timor tends to increase each year. In 1980, Rp 2.5 m was released to farmers. This increased to Rp 3.6 m in 1990 and Rp 4.4 m in 1998. Credit has helped farmers overcome financial problems in paying for inputs needed for production, such as fertiliser and pesticide costs as well as wages for farm labour. These inputs of production are very important factors in food crop cultivation. Agricultural credit is also one of the packages of the agricultural development policy, known as the *Intensification Program* run by the Indonesian government since 1969.

One of the important inputs in food crop cultivation (especially in rice cultivation) is fertiliser. As has already been mentioned in the description of farming systems in West Timor, cultivation of maize and cassava is dominated by traditional methods, that is neither fertiliser nor pesticide is applied. Generally, modern inputs such as fertiliser, pesticide and quality seed are only applied in rice cultivation.

The structural analysis shows that the price of fertiliser has not had a significant influence on the total food crops harvested area at 10 per cent significance level It has a significant influence on the total food crops harvested area only at 20 per cent significance level. This result emphasises the fact that the total food crops harvested area is more determined by other factors, such as farmer population growth and rainfall, than economic factors. However, as food crop cultivation becomes more semi-intensive (see Section 3.8), higher external input use, particularly fertiliser is required. This imposes a problem because the purchase of external inputs requires the availability of cash. Like any other indicator of economic development, the price of fertiliser increases from year to year. In 1980, the price of nitrogen fertiliser was about Rp 80/kg, increasing to Rp 175/kg in 1990, and Rp 465/ kg in 1998. At the same time, the total food crops harvested area has also increased from 158 000 ha in 1980 to 190 000 ha in 1990 and 192 000 ha in 1998. These increases have determined either the sign or the size of the fertiliser price coefficient in the structural analysis. Results of the analysis indicate that each one Rupiah increase in the fertiliser price will increase the total food crops harvested area by 224.5 ha. As it has been mentioned before, that agricultural production is more determined by the technical factor than economic factor. In fact, the time series data show that the price of fertiliser has tended to increase since 1979, because the Indonesian government has reduced the subsidy for fertiliser each year. In 1980, the price of nitrogen fertiliser was Rp 80/kg, increasing to Rp 175/kg in 1990 and Rp 465/kg in 1998. At the same time, the food crops harvested area in West Timor tended to increase from year to year. This moving trend has determined the positive sign of parameter estimation.

Boserup (1970) mentioned that population is the main determinant factor in agricultural production. In this study, the most significant variable that has determined food crops harvested area in West Timor is farmer population growth. The structural analysis shows that farmer population growth has a significant influence on the food crops harvested area in West Timor at 10 per cent significance level. Results showed that a one per cent increase in farmer population growth per year would increase food crops harvested area by 3903.7 ha. This result is supported by Tweeten (1998). According to Tweeten, global food demand growth may exceed yield growth for several decades, bringing the higher commodity prices that are necessary to draw land and other conventional resources into food production.

Rainfall is another factor that has a significant influence on the total food crops harvested area. As mentioned in the description of the agricultural production systems in West Timor, the food crop cultivation in West Timor is really dependent on the weather condition. The statistical analysis shows that each 1 mm increase in rainfall will increase food crops harvested area by approximately 25.5 ha. This influence is significant at 10 per cent significance level (prob.>|t| = 0.067). In fact, although the annual rainfall tends to fluctuate from year to year, the total food crops harvested area still increased because of the intensification programs. Intensification programs provide good irrigation for food crops expansion. Both of these factors (rainfall and irrigation) are the indicators of water availability for crops cultivation.

6.3.2. Food crops productivity

The second equation shows the structural equation for food crops productivity in West Timor. The original structural equation of food crops productivity was constructed as a function of one endogenous variable (food crops harvested area), eight exogenous variables (the size of irrigated area, total cost per hectare of maize cultivation, amount of credit, the price of food crops commodities, the price of nitrogen fertiliser, the price of pesticide, number of tractors, total cost per hectare of rice cultivation) and one lagged endogenous variable (lagged food crops productivity).

After running the initial model, however, some variables were dropped from the original function. These are the amount of credit, rainfall, the price of food crops (rice, corn, cassava, sweet potatoes), the price of nitrogen fertilizer, the price of pesticide, number of tractors and the total cost per hectare of rice cultivation. The price of food crops, the price of nitrogen fertiliser and the price of pesticide were dropped from the original function because these variables generate multicolinearity problems in the model. The explanatory variable of the amount of agricultural credit and the number of tractors were also dropped from the original function because these variables have not shown a significant influence on the endogenous variable according to the size of the parameter estimation (zero) as well as the value of the *t-test*. The explanatory variable of total cost per hectare of rice cultivation was also dropped from the function because it generated a contradictory sign for the parameter estimation.

The final food crops productivity equation was therefore constructed as a function of one endogenous variable (food crops harvested area) and three predetermined variables (size of irrigated area, total cost per hectare of maize cultivation, and lagged variable of food crops productivity).

The result of the estimation of the third structural equation is set out below:

$$\begin{aligned} QPDT = {} & 0.8649 + 0.1884\,ART + 0.0038\,ADT - 6.1464\,TCMT + \\ & (0.0438) \quad (0.0002) \qquad (0.1524) \qquad (0.0701) \\ & 0.0701\,QPDT_1 + U_2 \\ & (0.5455) \end{aligned} \qquad (6.2)$$

$R^2 = 0.8187$; $F_{value} = 15.805$

where:

QPDT	= Food crops productivity in the t^{th} year (000 tonne/ha)
ART	= Irrigation area in the t^{th} year (ha)
ADT	= Food crops harvested area in the t^{th} year (000 ha)
TCMT	= Total cost per hectare of maize cultivation in the t^{th} year (Rp million)
QPDT1	= Food crops productivity in the t^{th}-1 year (tonne/ha)

The result of the structural analysis shows that there are three variables that have a significant influence on food crops productivity, namely the size of the total irrigated area, food crops harvested area, and total cost per hectare of maize cultivation. Firstly, the size of the total irrigated area has a significant influence on food crops productivity at one per cent significance level. In other words, the influence of irrigated areas on food crops productivity is significant at 99 per cent level of confidence. Each one ha increase in irrigated area will increase food crops productivity by approximately 190 tonnes. As has been described before, food crops production (productivity) in West Timor is really dependent on the amount and timing of rainfall. This factor is used as an indicator of water availability for crops. Another factor that can be used as the indicator of water availability is the area of irrigated land. This factor tends to be more representative of the water availability than the rainfall factor.

The model for food crop productivity is quite good based on the criteria of the analysis of variance (Anova) with the *F-test* highly significant at one per cent level of significance (prob.>F = 0.0001). In addition, the coefficient of determination (R^2) is about 81.9 per cent. It means that 81.9 per cent of the total variation of food crops productivity can be explained by all the explanatory variables in the model.

According to Momuat *et al.* (1995), water availability is one of the most critical factors determining farming practices in the region. Furthermore Benu *et al.* (1992) in their study on the regional development of East Nusa Tenggara province stated that water availability is the main constraint in regional economic development for agribusiness and industry. In addition, Barlow and Gondowarsito (1991) in their paper on socio-economic features and potential in the province of East Nusa Tenggara, stated that remedying the weak infrastructures in this region will often be a precondition to realising other avenues of socio-economic growth. One vital aspect of this is improving water supplies, which in itself both directly enhances land productivity and promotes better health and living standards. The main ways of improving water supplies are through wells, captured springs, dams, off-the roof tanks, submerged river pumps and irrigation.

Jha and Hojjati (1993) and Wanmali (1992) cited by Rola-Rubzen and Hardaker (1999), stated that empirical evidence shows that improved infrastructure has a positive effect on the adoption of yield-increasing inputs, thereby improving total production and the productivity of agriculture. According to Gonzales *et al.* (1993), investment in the expansion and improvement of irrigation in Indonesia has been the major contributor to growth in rice production. In addition to investment in new irrigation, the Indonesian government has made substantial investments in the rehabilitation of existing systems and in the development of tertiary distribution systems within existing systems.

The second variable that showed a significant influence on food crops productivity is the food crops harvested area. Results indicate that every 1000 ha increase in food crops harvested area will increase food crops productivity by approximately 4 tonnes per ha. However, it is only significant at 20 per cent significance level. Although the food crops harvested area has a significant influence on food crops productivity, the size of the regression coefficient is quite small. This result is caused by the fact that the expansion of a cultivated area is sometimes a "trade-off" with the increase of productivity if other production inputs such as labour and capital are constant. Increasing area of production often means expanding into more marginal land, or reducing the fallow phase in a rotation or carrying out some operations at less optimal times. As a consequence, however, one may reasonably expect average productivity to decline even though total production may increase.

The third variable to show a significant influence on food crops productivity is the total cost per hectare of maize cultivation. Results show that for each Rp1 m increase in the total cost per hectare of maize cultivation, a reduction of approximately

6 100 tonnes per ha in food crops productivity is expected to result. This result is significant at 10 per cent significance level (prob.>|t| = 0.07). Because farming in West Timor is predominantly of the shifting cultivation type, the main economic factor that will determine food crops productivity is the cost of production rather than profitability. The higher the cost of production, the less opportunity there is for farmers to increase production due to their financial situation. This condition has determined the negative sign of the total cost per hectare of maize cultivation.

6.3.3. Tree crops harvested area

The endogenous variable for tree crops harvested area represents seven dominant tree crops in West Timor. These are coconuts, coffee, cashews, areca nuts, cloves, candlenuts, and kapok. Production of other tree crops has not made a significant contribution to the economy of West Timor.

The original structural equation of tree crops harvested area was constructed as a function of one endogenous variable (farmer population growth), nine exogenous variables (amount of credit, number of cooperatives, the price of coffee, interest rates, the price of coconut, the price of nitrogen fertilizer, number of tractor, the size of irrigated area and rainfall) and one lagged endogenous variable (lagged tree crops harvested area). However, some explanatory variables have been dropped from the original function using the economic, statistical and econometric criteria. These are the price of coconuts, the price of fertiliser, the number of tractors, the size of the irrigated area, and rainfall. The price of coconuts and the price of fertiliser have been dropped from the function because these two variables generate multicolinearity problems in the model. At the same time the number of tractors, the size of the irrigated area and rainfall have been dropped from the function because these variables have not shown a significant influence on the endogenous variable according to the size of the parameter estimation (zero) as well as the value of the *t*- test.

The final structural equation for tree crops harvested area consists of six explanatory variables, that is five predetermined variables (amount of credit, number of cooperatives, the price of coffee at the national level, interest rates, and the lagged tree crops harvested area) and one endogenous variable (farmer population growth).

The result of the estimation of the third structural equation can be seen below:

$$\begin{aligned} APT = {} & 19.4995 + 0.0067\ CRT - 0.5035\ POPGT + 0.0823\ COT + \\ & (0.0017) \quad (0.2380) \quad (0.3161) \quad (0.0008) \\ & 0.3814\ NPCFT - 0.4556\ RT - 0.4857\ APT_1 + U_3 \\ & (0.4755) \quad (0.0874) \quad (0.0675) \end{aligned} \tag{6.3}$$

$R^2 = 0.8349$; $F_{value} = 10.111$

where:

APT	= Tree crops harvested area in the t^{th} year (000 ha)
CRT	= Amount of credit in the t^{th} year (Rp. 10 million)
POPGT	= Farmer population growth in the t^{th} year (%)
COT	= Number of cooperatives in the t^{th} year (number)
NPCFT	= the price of coffee at national level in the t^{th} year (Rp million/tonne)
RT	= the interest rate of capital credit in the t^{th} year (%)
APT_1	= Tree crops harvested area in the t^{th}-1 year (000 ha)

The model of tree crops harvested area is quite robust based on the analysis of variance (Anova) results, with the *F-test* highly significant at one per cent significance level (prob.>F = 0.002) and the coefficient of determination (R^2) about 83.5 per cent.

Considering the influence of agricultural credit on tree crops harvested area, results indicate that each Rp10 m increase in the amount of agricultural credit will increase tree crops harvested area by about 6.7 ha. However, based on the size of the regression coefficient and the significance results, it can be seen that the effect of agricultural credit on tree crops harvested area is not significant at 10 per cent significance level.

In fact, agricultural credit given to farmers in West Timor is dominated by short-term credit, which is more useful for food crop cultivation than for tree crop cultivation. Bathrick (1981, p. 18) stated that:

> *'Farmers in the developing countries are generally hampered by high interest costs of short-term crop loans...and the almost complete lack of*

source from which they can borrow the longer term loans. The unavailability of longer-term credit prevents them from improving and expanding their output'.

Agricultural credit in West Timor is one of the packages in the intensification program packages. However, this package has been designed more for seasonal food crop cultivation than the longer-term tree crop cultivation. Each farmer is allowed to take the intensification program packet for the current season, if he does not have any credit repayment owing from the last season. Barlow *et al.* (1990) stated that except for some official credit schemes for rice, most small farmers in West Timor could only gain access to the short-term credit at a high interest rate of 25 – 35 per cent, with brief loan periods of a few months. According to Barlow *et al.* (1990, p.20):

'Usually such loans are tied to clients on crop sale, where one condition imposed for collateral purposes is that products must be sold to the lender at harvest. Again, the long-term finance needed for productive investment in the tree crops which often take several years or more to reach maturity is just not available from private sources and the only capital comes from a few special government arrangements of limited applicability'.

According to Tweeten (1998), cereals receive special attention because they directly or indirectly (through livestock) supply well over half of all food energy which is essential as a buffer to stock and transport and is central to food security.

With regards to the effect of farmer population growth, the results show that for each one per cent increase in farmer population growth, there will be an approximate 500 ha reduction in tree crops harvested area. However the result is not significant at 10 or even 20 per cent level of significance.

The first explanatory variable that has a significant influence on tree crops harvested area is the number of cooperatives. The result of the structural analysis shows that for each additional increase in the number of cooperatives, there will be an increase of approximately 82.3 ha in the harvested area. This result is significant at the one per cent significance level. It can be determined from the data trend that both of these variables tend to increase from year to year. The number of cooperatives has increased from 136 units in 1980 to 275 units in 1990 and 359 units in 1998. At the same time, the tree crops harvested area has also increased from 16 310 in 1980 to 23 500 ha in 1990 and 28 990 ha in 1998.

The second explanatory variable that has a significant influence on tree crops harvested area is interest rate. The result of the structural analysis shows that for each one per cent increase in the interest rate will increase tree crops harvested area by about 455.6 ha. It is significant at 10 per cent significance level. This variable is perhaps more connected to non-agricultural credit rather than directly connected to agricultural credit. This can be understood as farmers in developing countries mostly use a kind of consumption credit (not the production credit). The middleman predominantly runs this type of credit scheme. Farmers tend to borrow less money if the interest rate is high, therefore even if it were possible to obtain long-term credit there is no motivation for farmers to increase their harvested area. Barlow *et al.* (1990) in their analysis of development in East Nusa Tenggara province found that lending was mostly informal with a high interest rate (25% - 30%) since there are few official government credit schemes and hardly any "*Bank Rakyat Indonesia* (BRI)" offices at the village level. Further, they said that these high interest rates imposed a high price on the cash which most farmers must borrow before adopting the new cash-intensive crop technologies, thus representing a major constraint to taking up new initiatives.

The third explanatory variable that has a significant influence on tree crops harvested area is the lagged variable of tree crops harvested area. This variable is only meaningful in the analysis of elasticity (the long-term elasticity) and in dynamic simulation analysis.

6.3.4. Tree crops productivity

The original structural equation for tree crop productivity was constructed as a function of one endogenous variable (tree crops harvested area), seven exogenous variables (the price of coffee, the price of nitrogen fertiliser, days of rainfall, the price of coconuts, the price of phosphate fertiliser, number of tractor and the size of irrigated area) and one lagged endogenous variable (lagged tree crops productivity). However, there are four explanatory variables that have been dropped from the original structural equation. These are the price of coconut, the price of phosphate fertiliser, the number of tractors and the size of irrigated area. The price of coconuts has been dropped from the original function because this variable generates *multicolinearity* problems in the model as shown by a highly correlation coefficient between coconut price and the price of coffee at the national level (r = 8.97). The price of phosphate fertiliser, the number of tractors, and the size of irrigated area have been dropped from the original function because these variables did not have a significant influence on the endogenous variable according to the size of the parameter estimation (zero) as well as the value of the *t-test*.

The final structural equation for tree crop productivity therefore consists of four predetermined variables (price of coffee at national level, price of nitrogen fertiliser, days of rainfall, and the lagged tree crops productivity) and one endogenous variable (the tree crops harvested area).

The result of the estimation of the fourth structural equation is presented below:

$$\begin{aligned} QPPT = \underset{(0.0003)}{0.7617} + \underset{(0.8005)}{0.0036}\ NPCFT - \underset{(0.0005)}{0.0230}\ APT + \underset{(0.0002)}{0.0013}\ PZNT - \\ \underset{(0.4476)}{0.0010}\ DRFT + \underset{(0.9868)}{0.0027}\ QPPT_l + U_4 \end{aligned} \qquad (6.4)$$

$R^2 = 0.7700$; $F_{value} = 8.704$

where:

QPPT	= Tree crop productivity in the t^{th} year (000 tonne/ha)
NPCFT	= Price of coffee at national level in the t^{th} year (Rp million/tonne)
APT	= Tree crops harvested are in the t^{th} year (000 ha)
PZNT	= Price of nitrogen fertiliser in the t^{th} year (Rp/kg)
DRFT	= Days of rainfall in the t^{th} year (number)
$QPPT_l$	= Tree crop productivity in the t^{th} –1 year (000 tonne/ha)

The model of tree crop productivity is quite good based on the criteria of the analysis of variance with the *F-test* significant at one per cent level of significance and R^2 equal to 77 per cent.

The result of the structural analysis shows that there are two explanatory variables that have a significant influence on the tree crop productivity in West Timor. Firstly, the tree crops harvested area has a significant influence on tree crop productivity at one per cent level of significance. The results show that every 1000 hectare increase in the area of tree crops harvested will reduce tree crop productivity by approximately 23 tonne. This condition is determined by the fact that the ability of farmers to increase the area of tree crops harvested is constrained by the lack of skills, capital, and other resources.

Secondly, the price of nitrogen fertiliser has a significant influence on the tree crop productivity. Each Rp. 1 increase in the nitrogen fertiliser price will increase the tree crop productivity by approximately 1.3 tonne per hectare. The effect of the price of nitrogen fertiliser on tree crops productivity is significant at one per cent significance level.

The result of the analysis shows a contradictory sign since the parameter of the estimation is positive. This result is determined by the fact that farmers use fertiliser in their crop cultivation only, especially for rice cultivation, so that the trend of nitrogen fertiliser price will influence the productivity of food crops more than tree crops. At the same time, the time series data shows that the price of fertiliser has tended to increase since 1979, because the Indonesian government has reduced the subsidy for fertiliser each year. In 1980, the price of nitrogen fertiliser was Rp 80/kg increasing to Rp 175/kg in 1990 and Rp 465 kg in 1998. At the same time, the tree crop productivity in West Timor tended to increase from year to year.

6.3.5. Livestock productivity

The endogenous variable for livestock productivity is estimated for six dominant livestock types in West Timor; namely cattle, buffalo, horse, goat pig and chicken. The original structural equation of livestock productivity was constructed as a function of one endogenous variable (livestock consumption), eight exogenous variables (the price of cattle meat, the price of live cattle, days of rainfall, the price of other meats, the price of other livestock, amount of credit, amount of public transportation, and farmer population) and one lagged endogenous variable (lagged livestock productivity). However, there are some explanatory variables that have been dropped from the original function. These are price of other meats, price of other livestock, amount of agricultural credit, amount of public transportation, and farmer population. The price of other meats and the price of other livestock have been dropped from the original function because these variables generate *multicolinearity* problems in the model. The amount of credit has been dropped from the function because this variable did not have a significant influence on the endogenous variable with regards to the size of the parameter estimate (zero) as well as the value of the *t-test*. Farmer population and the amount of public transportation have been dropped from the function because these variables generate a contradictory sign in the parameter estimation.

The final structural equation for livestock productivity consists of six explanatory variables. There are five predetermined variables (price of cattle meat, price of live cattle, days of rainfall, interest rates, and lagged livestock productivity) and one endogenous variable (livestock consumption).

The result of the estimation of the fifth structural equation is presented below:

$$\begin{aligned} LPRT = {} & \underset{(0.0010)}{0.2663} - \underset{(0.0903)}{0.0079}\ PCTMT - \underset{(0.3480)}{0.0001}\ PCTT - \underset{(0.0493)}{0.0012}\ DRFT - \\ & \underset{(0.8778)}{0.0003}\ RT + \underset{(0.0472)}{1.0044}\ LCT - \underset{(0.1745)}{0.3844}\ LPRT_1 + U_5 \end{aligned} \qquad (6.5)$$

$R^2 = 0.3021$; $F_{value} = 0.866$

where:

LPRT	= Livestock productivity in the t^{th} year
PCTMT	= Price of cattle meat in the t^{th} year (000 Rp/ kg)
PCTT	= Price of live cattle in the t^{th} year (000 Rp/head)
DRFT	= Days of rainfall in the t^{th} year (number)
RT	= Interest rate of capital credit in the t^{th} year (%)
LCT	= Livestock consumption in the t^{th} year (million livestock unit)
$LPRT_1$	= Livestock productivity in the t^{th} –1 year

Because livestock productivity in West Timor is dependent on the agro-climate and edaphic conditions rather than on socio-economic conditions, the livestock productivity model is not significant even at 20 per cent level of significance. Although the influence of predictors overall on the livestock productivity is not significant (*F-test*), some predictors have a significant influence on the livestock productivity in the partial analysis (*t-test*). These are price of cattle meat (α = 10 %), days of rainfall (α = 5 %), livestock consumption (α = 5 %) and lagged livestock productivity (α = 20 %). The size of the coefficient of determination is quite low at 30.21 per cent. Some variables that were expected to influence livestock productivity, however, were able to be included due to the lack of data. Some physical variables involved in the determination of livestock productivity in West Timor are difficult to collect as described in Section 5.4.1. These include the pasture carrying capacity, the availability of forage, etc.

The result of the structural analysis shows that some socio-economic variables that have been constructed in the function have a small negative effect on livestock productivity. However, as previously mentioned, the model results are insignificant. This result indicates that social economic factors have not really determined livestock productivity in West Timor. Other studies have also pointed to this. For example, Tweeten (1998) says that livestock and livestock products receive less attention, partly because livestock output depends heavily on crop output. Lawalu (1986), as cited by Kaunang (1989), in his research in East Nusa Tenggara province found that the farmer receives only 69 per cent of the Jakarta price and the margin cost as well as margin profit at the farm gate respectively is 45 per cent and 24 per cent per livestock unit.

Livestock productivity in West Timor has tended to plateau at least in the last 20 years. For example the livestock production in West Timor was about 0.12 million livestock units in 1980, 0.14 million livestock units in 1990 and 0.15 million livestock unit in 1998. Hertel *et al.* (1999) mentioned that competition for scarce labour and capital with rapidly growing manufacturing activities, as well as environmental constraints, have limited the expansion of livestock production, particularly in East Asia. Bamualim and Saramony (1995) suggested that the carrying capacity in West

Timor might have reached its climax. According to Ataupah (pers. comm. 1999) the main determining factor in livestock productivity in West Timor is the pasture carrying capacity that has been degraded from year to year because of overgrazing and erosion. Ataupah further stated that in 1980, cattle used to roam freely in a high capacity pasture with grass achieving a height of 75 cm. By 1990, the capacity of the pasture had become significantly degraded with grasses only achieving a height of approximately 25 cm and by 1999 grass pastures were only achieving a height of 10 cm. These comments clearly indicate an urgent need to improve the management system of grazing animals, particularly in some critical areas, toward an intensive system where sufficient feed reserves are developed to guarantee the quantity, quality and continuity of feed supplies.

Besides the livestock consumption variable, two other economic variables have small regression coefficients. These are the price of cattle meat and the price of live cattle. Only one economic variable (livestock consumption) has a significant influence on livestock productivity in West Timor at 10 per cent significance level (prob.>|t| = 0.047). The results indicate that every one million livestock unit increase in livestock consumption will increase livestock productivity by approximately one per cent. This result supports Cranfield *et al.* (1998) analysis, that demand side forces are in place to fuel such growth in livestock products trade in international markets. However, Kaunang (1987) in her research on the role of livestock as the basic sector in agricultural development of Kupang regency, found that the demand and supply transactions of livestock are at the farm gate. There is no price standardisation (floor price) and the bargaining position of the farmer is weak with respect to the "patron-client" relationship.

Days of rainfall is one of the technical factors that has a significant influence on livestock productivity, but also only with a very small regression coefficient. Each one day increase in days of rainfall per year will decrease livestock productivity by approximately 0.001. This effect is significant at 5 per cent significance level (prob.>|t| = 0.049. In fact, this factor should increase the capacity of pasture, but due to over grazing it is not highly significant. The negative sign of the parameter estimation is due to the fact that a high frequency of days of rainfall will actually exacerbate carrying capacity because there is increased "run-off" leading to erosion with poor pastures (Ataupah 1991).

6.3.6. Livestock consumption

The original structural equation for livestock consumption was constructed as a function of two endogenous variables (livestock productivity and the output of agricultural sector), seven exogenous variables (the price of cattle meat, total per capita income, the price of rice, total population, the price of other meat, the price of live cattle and regional income) and one lagged endogenous variable (lagged livestock consumption). However, some explanatory variables were dropped from the original function. These are the price of other livestock meats, the price of live cattle, and regional income. These variables generate multicolinearity problems in the model.

The final structural equation for livestock consumption consists of seven explanatory variables, that is five predetermined variables (price of cattle meat, total per capita income, price of rice, total population, and the lagged variable of livestock consumption) and two endogenous variables (livestock productivity and total agricultural sector output).

The result of the estimation of the sixth structural equation is presented below:

$$\begin{aligned} LCT = \ & \underset{(0.2826)}{0.1575} - \underset{(0.8230)}{0.001}\ PCTMT + \underset{(0.2839)}{0.0001}\ TPIT + \underset{(0.1527)}{0.1340}\ LPRT + \\ & \underset{(0.1925)}{0.00003}\ PRT - \underset{(0.1395)}{0.0004}\ OAT + \underset{(0.22227)}{0.2371}\ TPOPT - \\ & \underset{(0.7511)}{0.1079}\ LCT_1 + U_6 \end{aligned} \qquad (6.6)$$

$R^2 = 0.7777$; $F_{value} = 5.555$

where:

LCT = Livestock consumption in the t[th] year (million livestock unit)
PCTMT = Price of cattle meat in the t[th] year (000 Rp/ kg)
TPIT = Total per capita income in the t[th] year (billion Rp)

LPRT	= Livestock productivity in the t^{th} year
PRT	= Price of rice in the t^{th} year (Rp/kg)
OAT	= Output of agricultural sector in the t^{th} year (billion Rp)
TPOPT	= Total population in the t year (people)
LCT_l	= Livestock consumption in the t^{th}-1 year (million livestock unit)

The result of the analysis of variance shows that this model is significant at one per cent level of significance (prob.>F = 0.06) and the coefficient of determination is about 77.8 per cent. Based on this result, it can be said that the model for livestock consumption is good. Although the influence of explanatory variables all together on livestock consumption (*F-test*) is significant at one per cent level of significance, the influence of single explanatory variable (*t-test*) is not very significant. This is possible because while individually, variables may have a small influence on the dependent variable. interactions between and among independent variables may result to a significant impact on the dependent variable, overall.

The result of the structural analysis shows that only two variables have a significant influence on livestock consumption. They are livestock productivity and total population. Statistically, other explanatory variables are not significant enough to explain the effect of each variable on livestock consumption, with respect to the level of significance and the size of the regression coefficient. Overall, however, the model is significant.

Livestock consumption is more determined by total population rather than the price of (cattle) meat. This is supported by Mangahas (1972) who asserted that population is the main determinant of increases in agricultural product demand. Each Rp. 1000 increase in the price of cattle meat will only decrease livestock consumption by approximately 0.001 million livestock unit. The influence of the price on livestock consumption is not significant even at 25 per cent level of significance. On the other hand, each additional increase in the total population will increase livestock consumption by approximately 0.2 million livestock unit. However, the influence of the total population is only significant at 25 per cent significance level. Livestock consumption is also not influenced by the price of another complementary commodity (the price of rice) because of a small regression coefficient.

Another explanatory variable that has a significant influence on livestock consumption is livestock productivity. Each additional increase in the livestock productivity will increase livestock consumption by approximately 0.13 million livestock unit. This description will be more meaningful if we assume that the livestock market, (the domestic and intra Indonesian market) will always take the quantity of livestock supplied Statistically, this description is not significant at 10 per cent significance level. But is significant at 20 per cent level of significance.

6.3.7. The agricultural sector output

The original structural equation for agricultural sector output was constructed as a function of two endogenous variable (farmer population growth and livestock productivity), seven exogenous variables (the level of inflation, the price of rice, the output of non-agricultural sector, total cost per hectare of rice cultivation, total cost per hectare of maize cultivation, amount of public transportation and the level of education), and three identity variables (food crops production, tree crops production and farmers' per capita income). However, there are six explanatory variables that have been dropped from the original function. These are the level of education, the output of non-agricultural sector, livestock productivity, amount of public transportation, total cost of rice production and total cost of maize production. The output of the non-agricultural sector and the level of education have been dropped from the function because of *multicolinearity* problems. The explanatory variable of livestock productivity, amount of public transportation, and total costs of rice and maize production have also been dropped from the function because they generate a contradictory sign in the parameter estimation.

The final structural equation for agricultural sector output consists of six explanatory variables. These are two exogenous variables (inflation and price of rice), three identity variables (food crops production, tree crops production, and farmer's per capita income) and one endogenous variable (farmer population growth).

The result of the estimation of the eighth structural equation is presented below:

$$
\begin{aligned}
OAT = & -38.4752 \;-\; 0.1010\ IFT \;+\; 0.0099\ QDT \;+\; 1.9392\ QPT\ + \\
& (0.0001) \quad (0.3973) \quad (0.1931) \quad (0.0030) \\
& 0.7945\ POPGT \;+\; 1.0509\ PIT \;+\; 0.0075\ PRT \;+\; U_7 \\
& (0.0377) \quad (0.0001) \quad (0.1301)
\end{aligned} \qquad (6.7)
$$

$R^2 = 0.9847$; $F_{value} = 1180.053$

where :

OAT	= Output of agricultural sector in the t^{th} year (billion Rp)
IFT	= General inflation level (%)
QDT	= Food crops production in the t^{th} year (000 tonne)
QPT	= Tree crops production in the t^{th} year (000 tonne)
POPGT	= Farmer population growth in the t^{th} year (%)
PIT	= Farmers' per capita income in the t^{th} year (billion Rp)
PRT	= Price of rice in the t^{th} year (Rp/kg)

The result of the analysis of variance shows that this model is significant at one per cent significance level (prob.>F = 0.0001) and R^2 is about 98 per cent. Based on the result, it can be concluded that the model of the agricultural sector output is quite good.

The result of the structural analysis shows that the all five explanatory variables have a significant influence on agricultural sector output. Results show that for each one per cent increase in the level of inflation, the agricultural sector output will decrease by approximately Rp. 100 million. However, the influence of the inflation level is not significant at the 25 per cent significance level. The results show that inflation cannot be used as a stimulant for the economy of West Timor, especially in the agricultural sector. Rather, inflation has a negative effect on agricultural output, albeit the impact is not significant.

The first explanatory variable that has a significant influence on agricultural sector output is production of food crops. Results showed that each 1000 tonnes increase in the production of food crops will increase the agricultural sector output by approximately Rp. 10 million per year. This influence is significant at 20 per cent level of significance. Because the production of food crops is allocated more for domestic consumption rather than trading, its influence (the size of the regression coefficient) is not as significant as the influence of tree crops production.

The tree crops production is the second explanatory variable, which has a significant influence on agricultural sector output. For each 1000 tonne increase in tree crops production, agricultural sector output will increase by approximately Rp. 1.94 billion. The influence of the tree crops production is significant at one per cent significant level (prob.> |t| = 0.003).. This condition is determined by the fact that tree crops in West Timor are cultivated for cash rather than consumption, so that their production will influence economic growth more than the production of annual crops (see Section 3.8).

The third explanatory variable that has a significant influence on the agricultural sector output is farmer population growth. Each one per cent increase in farmer population growth will increase agricultural sector output by approximately Rp. 0.8 billion. This influence is significant at 10 per cent significance level (prob.>|t| = 0.04). This result supports the assumption that the increase in agricultural output has been determined by population pressure (see Section 2.3). Further support is given by Von Braun, *et al.* (1991) in their research about commercialisation in subsistence farming systems. These authors found that as person-land ratios grew, farmers tended to intensify the labour input per hectare, enabling them to increase crop yields and to reduce the decline in per capita subsistence production that accompanies population growth.

The fourth explanatory variable that has a significant influence on the agricultural sector output is farmers' per capita income. Each Rp.1 billion increase in farmers' per capita income will increase agricultural sector output by approximately Rp. 1.05 billion per year. The influence of farmers' per capita income on the agricultural sector output is significant at one per cent significance level. This variable also has a linear relationship with the agricultural sector output, so that each increase in farmers' per capita income will be accompanied by an increase in agricultural sector output.

The last explanatory variable that has a significant influence on the agricultural sector output is the price of rice. For each Rp. 1 increase in the price of rice, agricultural sector output will increase by approximately Rp. 7.5 million. This influence is not significant at 10 per cent significance level. It is significant at 15 per cent level of significance only. The increase of this price at the farm gate will determine farmers' earnings directly, and this will motivate farmers to increase their production. The increase in farmers' income has a linear positive impact on agricultural sector output as well.

6.3.8. Farmer population growth

The structural equation for farmer population growth is one of the structural equations (besides the agricultural sector output equation) that has been constructed to generate the identity equation of farmers' per capita income.

The original structural equation for farmer population growth was constructed as a function of one endogenous variable (the output of agricultural sector), three exogenous variables (gender ratio, number of family planning clinics, and the level of education), three identity variables (food crops production, tree crops production and livestock production) and one lagged endogenous variable (lagged farmer population growth). However, there are three explanatory variables that have been dropped from the original function. These are level of education, farmers' per capita income and tree crops production. The explanatory variables of level of education and farmers' per capita income have been dropped from the function because of the problem of *multicolinearity* in the model. The explanatory variable of tree crops production has been dropped from the function because it generates a contradictory sign in the parameter estimation. In fact, if tree crops production included in the model, it generates contradictory signs either for itself or for other explanatory variables. For example, the sign of the parameter estimations of the agricultural sector output as well as livestock production become positive. It is possible that this variable (tree crops production) is the source of multicolinearity in the model.

The final structural equation for farmer population growth consists of six explanatory variables. These are three predetermined variables (gender ratio, number of family planning clinics, and the lagged farmer population growth). two identity equations (food crops production and livestock production) and one endogenous variable (agricultural sector output).

The result of the estimation of the eighth structural equation is set out below:

$$\begin{aligned} POPGT = {} & 22.8864 - 16.5768\,XRT - 0.0086\,OAT + 0.0374\,FPCT + \\ & (0.1120) \quad (0.2122) \qquad (0.1649) \qquad (0.7137) \\ & 0.0044\,QDT - 49.2466\,LPT - 0.1329\,POPGT_1 + U_8 \\ & (0.4655) \qquad (0.0294) \qquad (0.5336) \end{aligned} \tag{6.8}$$

$R^2 = 0.4900$; $F_{value} = 1.922$

where :

POPGT	= Farmer population growth in the t^{th} year (%)
XRT	= Gender ratio in the t^{th} year (people)
OAT	= Output of agricultural sector in the t^{th} year (billion Rp)
FPCT	= Number of family planning clinic in the t^{th} year (number)
QDT	= Food crops production in the t^{th} year (000 tonne)
LPT	= Livestock production in the t^{th} year (million livestock unit)
$POPGT_l$	= Farmer population growth in the t^{th} –1 year (%)

Although the result of the *t-test* shows there are three explanatory variables that have a significant influence on farmer population growth, the result of the analysis of variance shows that the influence of explanatory variables altogether is only significant at 20 per cent significance level. Generally, it can be concluded that the model for farmer population growth is not good enough. The goodness of fit test shows that the coefficient of determination is about 49 per cent. Although by dropping some predictors from the function the coefficient of determination decreased, no serious *multicolinearity* problem emerged in the final model.

The first explanatory variable that has a significant influence on farmer population growth is the size of the gender ratio. each additional increase in the gender ratio will reduce farmer population growth by approximately 16.6 per cent. However, this result is not significant until 20 per cent significance level. It is only significant at 25 per cent significance level. This means that if the number of males outweighs the number of females, the growth in farmer population is predicted to be slower.

The last two explanatory variables that have significant influence on farmer population growth are the output of the agricultural sector and livestock production. Results indicate that a Rp. 1 billion increase in the agricultural sector output will reduce farmer population growth by approximately 0.01 per cent The influence of agricultural sector output on farmer population growth is not significant at 10 per cent significance level. It is significant at 20 per cent significance level. This result seems to indicate that an increase in the agricultural sector output is one of the ways to reduce the growth in farmer population. Although Boserup (1970) said that population is the main determinant factor in agricultural production, in fact, the relationship between these two variables might in fact be the reverse. That is, the determinant factor and the effect factor may be reversed. Population might be viewed as a source of development in agriculture, especially the source of increasing agricultural production in regions with low population density. At the same time, the agricultural output might take the role as a stimulant to reduce farmer population growth. The combination between the low population growth and the high agricultural production will determine the better welfare.

The influence of livestock production is significant at 10 per cent significance level (prob.>|t| = 0.03). Results show that each one million livestock unit increase in livestock production will reduce the growth of farmer population by approximately 49.24 per cent. In the interpretation of the parameter estimation, we could use either percentage (%) or unit of measurement (such as million livestock unit) as the unit of the interpretation. It means each one million livestock unit increase in livestock production will reduce the growth of farmer population by approximately 49.24 %. It can be said that an increase in livestock production will determine an increase in farmers' per capita income (remembering that livestock is cultivated for cash purposes), and increasing farmers' per capita income can be viewed as one of the ways to reduce the growth of farmer population.

One of the main explanatory variables that did not have a significant influence on farmer population growth is the number of family planning clinics. The cultural background of Timorese in that children are viewed as God's gifts determines this condition. A survey conducted by CIDA (1980) found that the program of family planning is hardly practiced among the rural Timorese. This can be explained by the fact that having many children is what is expected from every marriage. As is often stated in interviews, children are God's gifts which should be accepted. Another reason is that parents, and the whole clan for that matter, need sufficient manpower for protection in their old age and to ensure the survival of the clan. It is, therefore, a grace or blessing from God to have many children. A survey conducted by Hull et al. (1999) found that a family without children could be considered with contempt. Among the Dawan society of Timor, one who is infertile is considered to have inherited an ancestor's sin. Couples that have no children try hard to become fertile by asking the help of a shaman. If their endeavour is unsuccessful they will adopt their brothers' children or seek a new match.

A study conducted by the Research Institute of Nusa Cendana University in 1981, found that social knowledge of the family planning program is still low. The study found that only 36 per cent of 1000 respondents had been properly informed about information sources of family planning, objectives of the program, the kinds of contraceptives and where they are available, methods of contraceptives use and possible side effects (Patty 1981). The study also found most couples still expected to have 4 to 6 children, and still strongly believed that more children would increase their prosperity.

However, people in the large towns, who have a good education and good economic as well as social standing, received family planning programs as the rational way to improve their welfare in the future. So, family planning clinics are more meaningful for urban middle and higher-class people than urban lower class and rural people (farmers).

6.4. Discussion of the Elasticity Coefficients

The concept of elasticity indicates the degree of responsiveness (percentage) of the dependent factor (endogenous variable) as the independent factor (exogenous variable) changes by a very small amount. As mentioned in Section 4.2.1, the coefficient of regression that is derived from a linear function can be viewed as a component of the elasticity.

Multiplying the regression coefficient with the ratio between exogenous and endogenous variables can determine the short-term elasticity coefficient. A long-term elasticity coefficient of a linear function can be calculated by weighting a short-term elasticity with the regression coefficient of a lagged endogenous variable. Two main criteria for including variables in the analysis of elasticity are the size and the sign of the parameter estimation. The explanatory variables that will be included in the analysis of elasticity should have enough size as well as enough significant influence on the endogenous variable. The population growth factor in the three crops harvested area equation is included in the analysis it has enough size of the parameter estimation (0.5035). At the same time, all the lagged variables are excluded in the analysis because they will be considered in the long-term elasticity analysis. The elasticity coefficients of all explanatory variables that have significant influence on the endogenous variables are presented in Table 6.2.

Table 6.2. Short-term and long-term elasticity coefficients

Endogenous	Predictor	Definition	Significance level (*p-value*)	Elasticity coefficient	
				Short-term	Long-term
ADT		Food crops harvested area			
	PRMT	Market margin of rice price	0.15[a]	-0.42	-0.82
	CRT	Amount of agricultural credit	0.08[c]	0.07	1.80
	PZNT	The price of nitrogen fertilizer	0.17[a]	0.19	4.90
	POPGT	Farmer population growth	0.08[c]	0.05	1.29
	RFT	Rainfall	0.07[c]	0 23	5.93
QPDT		Food crops productivity			
	ART	Irrigation area	0.0002[e]	0.53	1.17
	ADT	Food crops harvested area	0.15[a]	0.22	0.48
	TCMT	Total cost /ha of maize cultivation	0.07[c]	-0.08	-0.18
APT		Tree crops harvested area			
	COT	Number of cooperatives	0.001[e]	0.88	0.94
	RT	Interest rate	0.09[c]	-0.34	-0.36
QPPT		Tree crops productivity			
	APT	Tree crops harvested area	0.0005[e]	-0.97	-0.97
	PZNT	The price of nitrogen fertilizer	0.0002[e]	0.54	0.54
LPRT		Livestock productivity			
	PCTMT	The price of cattle meat	0.09[c]	-0.20	-0.14
	DRFT	Days of rainfall	0.05[c]	-0.77	-0.56
	LCT	Livestock consumption	0.05[c]	0.65	0.47
LCT		Livestock consumption			
	LPRT	Livestock productivity	0.15[a]	0 21	0.23
	TPOPT	Total population	0.20[a]	3 13	3.44
OAT		Agricultural sector output			
	QDT	Food crops production	0.19[a]	0.03	-
	QPT	Tree crops production	0.003[e]	0.10	-
	POPGT	Farmer population growth	0.04[d]	0.01	-
	PIT	Farmer per capita income	0.0001[e]	1.03	-
	PRT	The price of rice	0 13[b]	0.02	-
POPGT		Farmer population growth			
	XRT	Gender ratio	0.20[a]	-8 17	-7.21
	OAT	Agricultural sector output	0.16[a]	-0 82	-0.72
	LPT	Livestock production	0 03[d]	-3 09	-2.73

Where:

a = significant at 20 % of significant level
b = significant at 15 % of significant level
c = significant at 10 % of significant level
d = significant at 5 % of significant level
e = significant at 1 % of significant level

6.4.1. Food crops harvested area

Generally, there are five variables that have a significant influence on the food crops harvested area. These are the market margin of rice price, amount of credit, price of nitrogen fertiliser, farmer population growth and rainfall. Table 6.2 shows that the short-term elasticity coefficient of these five explanatory variables is -0.42; 0.07; 0.19; 0.05 and 0.23, respectively. Whilst the long-term elasticity coefficient of these five explanatory variables are -0.82; 1.80; 4.90; 1.29 and 5.93, respectively. It can be seen that there are four variables that have a positive impact on food crops harvested area as they change by a very small amount. These are amount of credit, price of nitrogen fertiliser, farmer population growth and rainfall. The highest elasticity coefficient among these four variables is rainfall. If rainfall is understood as the indicator of water availability for crops, it can be concluded that the food crops harvested area might be increased through increasing the water availability for crops (rainfall is just one of the indicators of water availability) either in the short-term or in the long-term. The policy of nitrogen fertilizer price control cannot be considered as a good policy, because an increase in nitrogen fertilizer price can only be understood as the indicator of economic growth. It can be understood that an increase of a particular economic indicator (inflation) could be seen only as the *engine oil* in the economic growth. Both variables (the price of nitrogen fertiliser and food crops harvested area) increase in the same way as a result of the economic development. For example, the price of nitrogen fertiliser has increased from year to year because of the reduction in the subsidy for nitrogen fertilisers. At the same time, the total food crops harvested area has also increased significantly. In other words, the increase in food crops harvested area is determined more by technical factors than by economic factors. Benu (1996) found that the main policy that should be implemented to increase paddy-harvested area is in relation to water availability. The elasticity coefficient of his analysis for paddy production with respect to irrigation is 0.22 in the short-term and 0.27 in the long-term. This result supports the fact that water availability has a positive impact on (food) crops harvested area as it changes by a very small amount.

6.4.2. Food crops productivity

Generally, there are three explanatory variables that have a significant influence on food crops productivity. These are the size of the irrigated area, food crops harvested area, and total cost per hectare of maize cultivation. Table 6.2 shows that the short-term elasticity coefficients of these three variables are 0.53; 0.22; and -0.08, respectively, whilst the long-term elasticity coefficients are 1.17; 0.48; and -0.18, respectively. It can be seen that there are two variables that have a positive impact on food crops productivity. These are the size of irrigated area and food crops harvested area. The size of irrigated area has a bigger impact on food crops productivity. If the size of irrigated area is understood as the indicator of water availability for crops, this result supports the fact that irrigation is an important factor in the cultivation process. Based on the elasticity coefficients, it can be concluded that increasing the irrigated area is an important policy that can be taken to increase food crops productivity in West Timor either in the short-term or in the long-term. This result supports the result of food crops harvested area analysis that water availability is the main determinant factor in food crops production in West Timor. In relation to the negative elasticity coefficient of total cost per hectare of maize cultivation, it should be understood that because farming in West Timor is predominantly of the shifting cultivation type, the main economic factor that will determine food crops productivity is the cost of production rather than the profitability. The higher the cost of production, the less opportunity there is for farmers to increase productivity due to their financial situation.

6.4.3. Food crops production

Food crops production has been constructed as the identity equation of food crops harvested area and food crops productivity. Mathematically, the total food crops production can be calculated from food crops productivity multiplied by food crops harvested area. Because the relationship among these three variables is linear, the increase in food crops production is linearly proportional to increase food crops harvested area and productivity. One possible policy that could be taken to increase these three variables is increasing water availability for crops. In other words, the best policy that could be taken is increasing the amount of the irrigated area. This result supports the proposition that food crops production is more determined by agro-climate and edaphic factors than socio-economic factors. This result is further supported by Benu (1996) who concluded that technical factors have more determined paddy production than either input or output prices.

6.4.4. Tree crops harvested area

Generally, there are four explanatory variables that have a significant influence on the tree crops harvested area. These are number of cooperative and interest rates. Table 6.2 shows that the short-term elasticity coefficients of these two variables are 0.88; and -0.34 respectively, while the long-term elasticity coefficient of these two variables are 0.94; and -0.36 respectively. Either In the short-term or in the long-term, the only variable that has a positive impact on tree crops harvested is number of cooperatives. Because the number of cooperatives has the highest elasticity coefficient either in the short-term or in the long-term, it is one of the socio-economic policies that might be considered in increasing tree crops harvested. As described before, both of these variables (tree crops harvested area and the number of cooperatives) tend to increase significantly from year to year. In fact, a cooperative in West Timor (also in any part of East Nusa Tenggara province of Indonesia) is a legal institution at the farmer level. This institution has the role of helping farmers by either providing production inputs (fertiliser, insecticide, seed, etc.) or buying products.

Interest rate has a negative impact on the tree crops harvested area both in the short-term and in the long-term. It can be understood that farmers take less credit if the interest rate is high, therefore even it was possible to obtain long-term credit, there is no motivation for farmers to increase their harvested area. Barlow *et al.* (1990) in their analysis of development in East Nusa Tenggara province found that lending was mostly informal with a high interest rate (25% - 30%) since there are few official government credit schemes and hardly any "Bank Rakyat Indonesia (BRI)" offices at the village level. Further, they said that these high interest rates imposed a high price on the cash which most farmers must borrow before adopting the new cash-intensive crop technologies, thus representing a major constraint to taking up new initiatives.

6.4.5. Tree crops productivity

Generally, there are two explanatory variables that have a significant influence on tree crops productivity. These are tree crops harvested area and price of nitrogen fertiliser. Table 6.2 shows that the short-term elasticity coefficients of these two variables are -0.97 and 0.54, whilst the long-term elasticity coefficients of these variables are -0.97 and 0.54. The price of nitrogen fertilizer is the only variable that has a positive impact on the tree crops productivity, as it changes by a very small amount.

Although the price of nitrogen fertiliser has a positive elasticity coefficient, it cannot be recommended as the best policy that should be taken with respect to increasing tree crops productivity. The Indonesian government is now facing a crisis in budgeting because of the economic crisis since 1997, so it is difficult to increase fertiliser subsidies to reduce fertiliser prices. As described before, the phenomenon determining the increase of these two variables (tree crops productivity and nitrogen fertilizer price) is the trend of data. The price of nitrogen fertiliser has increased from year to year because of the reduction in fertiliser subsidies. At the same time, the tree crops productivity has tended to plateau at 0.4 tonne per hectare since 1979.

The negative impact of tree crops harvested area on the tree crops productivity either in the short-term or in the long-term is caused by the fact that the expansion of a cultivated area is sometimes a "trade-off" with the increase of productivity if other production inputs such as labour and capital are constant. Therefore the program of improving labour skill as well as increasing agricultural credit should support the agricultural extension program (as stated in the special program of *Tiga Batu Tungku*) especially for tree crops.

6.4.6. Tree crops production

Tree crops production has been constructed as the identity equation of tree crops harvested area and tree crops productivity. Total tree crops production has been calculated from tree crops productivity times tree crops harvested area. Because the type of relationship of these tree variables is linear, the increase in tree crops production will be linearly proportional with the increase of tree crops harvested area and productivity.

One possible policy that could be taken to increase tree crops production is increasing the number of cooperatives. But this policy will not be popular without improvement in the economic and structural function of cooperatives as a farmers' institution at the village level.

6.4.7. Livestock productivity

Generally, there are three explanatory variables that have a significant influence on livestock productivity in West Timor. These are the price of cattle meat, days of rainfall, and livestock consumption. Table 6.2 shows that the short-term elasticity coefficients of these three variables are -0.20, -0.77, and 0.65 respectively, whilst the long-term elasticity coefficients of these variables respectively are -0.14, -0.56, and 0.47. Livestock consumption is the only variable that has a positive impact on livestock productivity. Based on the elasticity coefficients, it can be concluded that one of the possible economic policies that can be taken to retain the livestock productivity level in West Timor is through reduction in the price of cattle meat. Rainfall is one of the climatic factor that should increased the capacity of pasture and further livestock productivity, hence the negative relationship was not expected. This result is perhaps due to over grazing. What is more, a high frequency of days of rainfall may actually exacerbate carrying capacity because there is increased 'run-off' leading to erosion with poor pasture (Ataupah 1991).

A high elasticity coefficient of livestock consumption might be understood only because of a positive linear relationship between livestock consumption and livestock productivity variables in the mathematical form.

6.4.8. Livestock consumption

There are two explanatory variables that have a significant influence on the consumption of livestock in West Timor. These are livestock productivity and total population. Table 6.2 shows that the short-term elasticity coefficients of these variables are 0.21 and 3.13, respectively, whilst the long-term elasticity coefficients of these variables are 0.23 and 3.44, respectively. The total population has a bigger impact on livestock consumption than livestock productivity, as it changes by a very small amount. It can be understood that the change of total population either in the short-term or in the long-term could increase total demand of livestock and its products. This result supports the result of some previous studies (Mangahas 1972, Amang 1987, Nainggolan and Suprapto 1987) that population is the main determinant in agricultural product demand. According to Rae (1997), the trend of the agricultural demand patterns is towards declining consumption of traditional staples (rice and root crops) and increasing consumption of high-protein foods such as animal products as a country's level of economic development and population change

It can be concluded that one of the economic policies that can be taken into consideration (based on the sign of the elasticity coefficient) to increase livestock consumption in West Timor is the increase of livestock productivity through improving technical aspects such as pasture capacity, forage availability and sanitation.

6.4.9. Livestock production

Livestock production has been constructed as the identity equation of livestock consumption and livestock inventory. Indeed, livestock production has been calculated from the sum of the livestock consumption and the change in the livestock inventory If we assume that the livestock consumption in the t^{th} year is given, increasing the livestock inventory change in the t^{th} year compared to the t^{th}-1 year is equivalent to an increase in livestock production. If livestock consumption is placed as a determinant factor (variable) in the livestock production function, the increase of livestock production might be created by reducing the price of livestock product. Another way to increase livestock consumption and then livestock production in West Timor is the increase of livestock productivity through improving technical aspects such as pasture capacity, forage availability and sanitation.

6.4.10. The agricultural sector output

All of the five explanatory variables in the structural equation have a significant influence on the agricultural sector output in West Timor. They are food crops production, tree crops production, farmer population growth, farmers' per capita income, and price of rice. Table 6.2 shows that the short-term elasticity coefficients of these variables are 0.03, 0.10, 0.01, 1.03, and 0.02 respectively.

It can be seen that the five variables have a positive impact on the agricultural sector output. However, based on the elasticity coefficients it can be concluded that the increase in tree crops production is one of the policies that could be taken to increase the agricultural sector output. The elasticity coefficient of food crops production is smaller than tree crops production because food crops are produced mainly for subsistence consumption and tree crops are for cash earning (NTADP 1992). The policy of increasing tree crops production is a popular policy because tree crops in West Timor are cultivated for cash rather than consumption, so that their production will have more influence on economic growth than the production of annual crops. At the same time, the positive impact of farmer population growth on the agricultural sector output is strengthening the proposition that the growth of population is a major determinant of technological change in agriculture and then agricultural production (Boserup 1970, Lele and Stone 1989)

In relation to the size of the elasticity coefficient, results point out that policies that would increase farmers' per capita income will increase agricultural sector output. Increasing farmers' per capita income by one per cent will result to a corresponding one per cent increase in agricultural sector output.

6.4.11. Farmer population growth

Generally, there are three explanatory variables that have a significant influence on farmer population growth. These are the size of the gender ratio, the agricultural sector output, and livestock production. Table 6.2 shows that the short-term elasticity coefficients of these three variables are -8.17, -0.82, and -3.09 respectively, whilst the long-term elasticity coefficients are -7.21, -0.72, and -2.73.

All three variables have a negative impact on farmer population growth However, based on the size of the elasticity coefficient, the gender ratio has the largest impact, either in the short-term or in the long-term, in reducing farmer population growth. The results indicate that if the number of males outweighs the number of females, the growth in farmer population is predicted to be slower. On the other hand, if the number of female outweighs the number of male, it can be predicted that population growth will increase. This condition is possible because in some case, bigamy is tolerated in the Timorese traditional society. The impact of livestock production on farmer population growth as it changes by a very small amount is consistent with the result of the structural analysis. It can be said that an increase of one per cent in livestock production will result to about 2.7 per cent decrease in population growth. It can be said that an increase in livestock production either in the short-term or in the long-term will determine an increase in farmers' per capita income (remembering that livestock are kept for cash purposes), and increasing farmers' per capita income can be viewed as one of the ways to reduce the growth of farmer population.

It can be concluded that if economic aspects have to be considered in the demographic policy of West Timor, the increase of either agricultural sector output or livestock production are alternative policies that could be taken to reduce the growth of farmer population. These policies will also have a positive impact on farmers' per capita income. Several studies that have proved a negative relationship between the rate of population and per capita income growth are Kelley and Schmidt (1994), Cuthbertson and Cole (1995), Anonymous (1997), Barlow (1998) and Robinson and Srinivasan (1999).

6.4.12. Farmer' per capita income

The farmers' per capita income has been constructed as the identity equation of the agricultural sector output and farmer population. The type of the relationship between farmers' per capita income and the agricultural sector output is linear. At the same time the type of the relationship between farmers' per capita income and farmer population is a reverse mathematical relationship. Mathematically, there are two possible ways to increase farmers' per capita income that is, increase agricultural sector output and/or reduce farmer population. In fact, the second way is difficult in practice. Therefore, the best possible way to increase farmers' per capita income is by increasing the agricultural sector output. Based on the interpretation of the elasticity coefficients, it can be suggested that the best policy that can increase the agricultural sector output as well as the farmers' per capita income is the increase of tree crops production. However, considering that local farmers have no adaptive management techniques to overcome the problem of rainfall fluctuation, it might be suggested that integration among food crops, tree crops and livestock is another policy that should be carefully considered by the local government. This policy could be handled systematically and consistently to render safe the food security program for the local people.

Another policy that can be suggested in relation to reducing farmer population growth as well as promoting farmers' per capita income is an increase in the family planning clinics' services in rural area by developing a better understanding among rural people about the program of family planning. This policy could be combined to stimulate an increase in farmers' per capita income.

6.5. Concluding Remarks

The result of the structural analysis in section 6.4 has been discussed in the previous sections. With the usual caveat as to the adequacy of the model used, the following main points emerged.

The result of the structural analysis shows that the model has a high R^2 value for the system. The result of the analysis of variance also shows that except for the structural equation of livestock productivity and farmer population growth. all other equations are highly significant at one per cent level of significance. At the same time the statistical "F-test" of the analysis of variance is significant for all structural equations.

Because farming in West Timor is predominantly of the shifting cultivation type, technical factors such as water availability and irrigation channels influence the production of agriculture more than economic factors such as the sale price of products and cost of inputs. The program of agricultural intensification that has provided some technical factors such as water, fertiliser and pesticides has a significant role in increasing the production of agriculture. However, it should be noted that some important technical factors are not involved in the analysis because of the unavailability of the quantitative data of these variables.

Because most farmers operate under the traditional farming systems, they are more concerned about the cost of production than the level of productivity. So, an increase in agricultural credit as well as a reduction in the cost of production will have a significant positive influence on the production of agriculture. Credit has helped farmers to overcome financial problems in relation to funds to pay for inputs needed for production such as fertiliser and pesticide costs as well as wages of farm labour. However, the agricultural credit that has been extended to farmers in West Timor is dominated by short-term credit, which is more useful for food crops cultivation than tree crops and livestock. Indeed, because many farmers in West Timor usually use production credit for consumption purposes, the agricultural credit scheme to farmers should be in one package with the policy of improving the supervision of credit implementation to accelerate production and welfare.

Total population influences livestock consumption more than the price of livestock product. At the same time, the price of livestock products has a minor influence on the total consumption of livestock. Although population is the main determinant of agricultural production, a high population density might reduce total agricultural sector output and farmers' per capita income. The growth of population and the availability of socio-economic institutions such as cooperatives at the village level, are two social factors that have a significant influence on agricultural production.

CHAPTER 7

IMPACT OF GOVERNMENT POLICIES

7.1. Introduction

Econometrics can provide numerical estimates and has become an essential tool for the formulation of sound economic policies. As described in the previous chapter, the elasticity coefficients might be interpreted for the formulation of the economic policy of the government. The knowledge of the numerical value of the elasticity coefficients is very important for the decision-making firms as well as policies for consideration of the government. Comparing the effects of the alternative policy decisions in the simulation analysis is important in the policy evaluation. Simulation using an estimated econometric model in the structural analysis is one approach to policy evaluation.

In general, simulation refers to the determinant of the behaviour of a system via the calculation of values from an estimate of the system. The model is assumed to be sufficiently explicit so that it can be programmed for numeric study, typically using a computer.

The results and interpretation of the simulation analysis are presented in this chapter. Section 7.2 presents the results of the validation as well as simulation of the model that was constructed in the previous section. Validation is an important stage in simulation analysis. Validation analysis evaluates the validity of the model before simulation analysis. Following this the results of simulation analysis are presented in Section 7.3. Section 7.3 contains information of the interpretation of each alternative scenario. There are six scenario alternatives that are simulated in this section. These are: (1) a 10 per cent increase in the size of irrigated areas, (2) a 10 per cent increase in the amount of credit, (3) a 35 per cent decrease in total cost per hectare of maize cultivation, (4) a 10 units increase in the number of cooperatives, (5) a 10 per cent increase in the price of live cattle at the farm gate, and (6) a 10 per cent increase in the price of rice at the farm gate.

These simulation scenarios are selected based on the results and interpretation of the structural analysis. All these six scenarios have a significant influence on agricultural production as well as farmers' welfare. The levels of simulation scenarios (percentage) were decided by trial and error. For example, the choice of decreasing total cost per hectare of maize cultivation was made because the structural analysis showed that this variable has a significant influence on food crops productivity at the 10 per cent significance level. While a 35 per cent reduction in cost was chosen as simulating several levels of reduction arbitrarily revealed that a 35 per decrease in total cost per hectare of maize cultivation is the minimum cost reduction needed for an increase in the total food crops production.

Concluding remarks of the overall simulation together with the implications of the result of the analysis are presented in Section 7.4.

7.2. Model Validation

Model validation is a critical step in examining the validity of all structural equations, before a model can be used for simulation. The criteria used to examine the validity of the model were the inequality coefficient (U), the bias proportion (U_M), the variance proportion (U_S), the Co-variance proportion (U_C), the bias of the slope of regression (U_R), and the non-systematic bias (U_D).

The values that the inequality coefficient assumes are between 0 and ∞ ($0 \leq U \leq \infty$). The smaller the value of the inequality coefficient, the better is the forecasting performance of the model (Koutsoyiannis 1978). U_M is bias proportion showing a systematic error, which is used to measure deviation of the forecasting mean value from the actual mean value. According to Intrilligator (1978), the best value of U_M lies between 0.1 and 0.2. If value of U_M is bigger than 0.2, the model should be corrected because of the systematic bias. U_S is the proportion of variance which is used to analyse the replication level of the model because of the change in the endogenous variable. Large values (almost one) of U_S mean the actual series value will fluctuate too much, while the predicted series value will not. In this condition, the model should be corrected. U_C is the proportion of variance which is used to measure the unsystematic error. If U_C is bigger than zero, the error is perfectly distributed. U_R is the regression component which shows the deviation of the actual regression from the predicted value. U_D is the residual component which shows the unsystematic error. A model is perfect if U_M and U_R are small ($UM < 2$ and UR close to zero) and U_D is close to one.

According to Koutsoyiannis (1978), a model is valid if the result of the values of U, U_M, U_R, and U_S are very small (almost zero), and the values of U_D and U_C are high (almost one).

The result of the validation analysis (Table 7.1) shows that the 11 variables (endogenous and identity) evaluated have a U_M value less than 0.2 (U_M< 0.2) and a small value of U_R, U_S, *and* U (almost zero). While, the values of U_D and U_C are high enough (almost one). Hence, it can be concluded that the model is quite valid and can therefore be used for simulation purposes. The complete simulation analysis of the 11 variables is presented in Section 7.3.2.

Table 7.1. Theil Forecast Error Statistic

Variable	Definition	Bias (U_M)	Reg (U_R)	Dist (U_D)	Var (U_S)	Covar (U_C)	U
APT	Tree crops Harvested area	0.00001	0.007	0.992	0.018	0.982	0.0434
QPPT	Tree crops productivity	0.00001	0.002	0.998	0.107	0.893	0.0708
ADT	Food crops harvested area	0.138	0.011	0.851	0.202	0.660	0.0487
QPDT	Food crops productivity	0.015	0.001	0.984	0.070	0.915	0.0310
LPRT	Livestock productivity	0.00001	0.224	0.776	0.005	0.995	0.0939
LCT	Livestock consumption	0.00001	0.025	0.975	0.017	0.982	0.0789
OAT	Agricultural sector output	0.002	0.047	0.951	0.052	0.945	0.0071
POPGT	Farmer population growth	0.001	0.249	0.749	0.005	0.994	0.3761
QDT	Food crops production	0.125	0.030	0.846	0.179	0.697	0.0665
QPT	Tree crops production	0.003	0.001	0.995	0.040	0.957	0.0540
LPT	Livestock production	0.001	0.220	0.779	0.013	0.985	0.0934
PIT	Farmer per capita income	0.186	0.231	0.899	0.125	0.897	0.2541

7.3. Model Simulation

7.3.1. Simulation scenarios

As mentioned in Section 3.2.1. since 1969 the Indonesian government introduced an intensification program in agricultural development to accelerate agricultural production. Through this program, the Indonesian government has spent a large amount in developing irrigation channels especially in Java. The irrigation development grew relatively rapidly through the early 1980s, but the completion of new service area especially in Java slowed significantly thereafter. This slow down was the result of budgetary cutbacks as well as the limited expansion of the irrigation land in Java. As a compensation for this slow down, the Indonesian government has concentrated more in developing irrigation channels outside Java (CIDA. 1980). At the same time, at the regional level of East Nusa Tenggara province, the local government has had five special programs in agricultural development that generally emphasize the increase of crop production through the increase in irrigated areas (The Government of East Nusa Tenggara Province of Indonesia. 1999). Through these special programs the area of irrigation in West Timor has increased at least 10 per cent in the last decade (Statistical Office of East Nusa Tenggara Province of Indonesia 1990-1998). By simulating a 10 per cent increase in the size of irrigated area, the effect of this scenario on the overall agricultural production of, as well as farmers' welfare in, West Timor can be shown. It is likely that this trend will continue and that a 10 per cent increase in irrigated area is likely because West Timor is one of the special development target regions in the Eastern Indonesia since the Indonesian government established the Ministry for the Development of Eastern Indonesia in 1990.

The scenario of increasing the amount of agricultural credit is one of the scenarios that could be simulated based on the result of the structural analysis as this variable has a significant influence on crops production. Indeed, the agricultural credit scheme is one of the packages in the intensification program that has been introduced by the Indonesian government since the early 1970s. The Indonesian government realized that the intensification program that promotes the use of technology package (fertiliser. pesticide and modern varieties) means nothing without providing credit to farmers.

The scenario of increasing the amount of agricultural credit is important because credit plays a crucial role in the modernisation of agriculture. At the same time, credit constraint is a primary determinant of technology adoption to improve agricultural production (Nerlove *et al* 1996), this is why credit has a significant role in the fight against poverty (Karmakar 1999).

The main government program to increase agricultural production is the program of intensification so far. As a part of the intensification program package, agricultural credit schemes are always released by the government every year to farmers to increase agricultural production. As mentioned in Section 3.6.1, the amount of the nominal agricultural credit given to farmers in West Timor tends to increase each year. It has increased by at least 20 per cent in the last decade (Statistical Office of East Nusa Tenggara Province of Indonesia 1990-1998). Considering the government budgetary cutbacks due to declining government revenue as well as the economic crisis, a 10 per cent increase in agricultural credit is a reasonable scenario to be simulated.

Total cost per hectare of maize cultivation was chosen as one of the simulated variables based on the consideration that this variable can be used as a tool for growth promotion (efficiency), especially in the agricultural sector. It was found in the simulation that a 10 per cent reduction in cost of production is not sufficient to increase maize production. Hence by simulating several levels of reduction arbitrarily in total cost per hectare of maize cultivation, it can be concluded that a 35 per cent decrease in total cost per hectare of maize cultivation is the minimum level of reduction needed for an increase in the total food crops production. Reducing cost per hectare of maize cultivation can be viewed as a tool of growth promotion if there is at least a 35 per cent reduction (efficiency) in total cost per hectare. Although reduction in total cost per hectare of maize cultivation could promote production, modelling results showed that the level of reduction below 35 per cent is not enough to increase food crops production significantly. By simulating the reduction of cost per hectare of maize cultivation at several levels, it was found that if the level of reduction were just below 35 per cent, it would promote food crops production by a very small amount. It can be assumed that farmers are hampered by a high cost of production in running their cultivation practices. A high cost of production is caused by the fact that farming in West Timor is predominantly of the shifting cultivation type, so if the activities are calculated economically, it will proof inefficiency in farmers' cultivation practices. Some sources of inefficiency in the shifting cultivation system that can be identified are (i) high labour use in the land preparation, planting and harvesting; (ii) high seeds used to reduce the high risk of failure and (iii) much money spent in the celebration parties of planting and harvesting.

The government might take a policy to reduce the cost per hectare of cultivation practices by promoting the program of intensification as well as the efficient cultivation practices for West Timor farmers to improve their skill. The government since the early 1970s actually has introduced this program, but it is more concentrated on rice commodity only. The program should be expanded for other commodities such as maize, cassava, etc.

As described in the discussion of the structural analysis, the availability of water supply for crops is a critical factor in increasing agricultural production. Together with the availability of credit to farmers, these two factors might improve the welfare of farmers. These two factors have been integrated in the intensification program package to increase agricultural production as well as farmers' welfare.

The scenario of increasing the number of cooperatives is chosen as one of the alternative simulations based on the consideration that the number of cooperatives has a positive significant influence on the production of agriculture. The result of the elasticity coefficient supports the result of the structural analysis in that the number of cooperatives could be increased to support agricultural production. As mentioned in Section 3.10, cooperatives are the only institution at village level that have been given legal status. Cooperatives are concerned both with supplying certain material inputs and handling the sale of commodities. This institution helps farmers by either providing production inputs (fertiliser, insecticide, seed, etc.) or buying products. As a result of the development of cooperatives as an economic institution at the regional level, the number of cooperatives in West Timor increased by at least 10 units per year in the last five years. It is likely that this trend will continue to support the agricultural development in West Timor since the Indonesian government has a Minister of Cooperatives and Small and Medium Enterprises. Thus a 10 unit increase in the number of cooperatives is likely because West Timor is one of the special development target regions in the Eastern Indonesia since the Indonesian government established the Minister of the Development of Eastern Indonesia in 1990.

One of the operational activities stated in the recent program of "Tiga Batu Tungku' of the East Nusa Tenggara government is to improve the agricultural marketing systems. Cooperatives could take a significant role in the agricultural marketing system to improve agricultural production as well as farmers' welfare in West Timor. If the government is really consistent in developing cooperatives together with the policy of improving the economic and structural function of cooperatives, it could help farmers in increasing agricultural production as well as farmer's welfare in West Timor.

The scenario of increasing the price of live cattle is simulated based on the assumption that an increase in this variable will stimulate an increase in farmers' welfare. This assumption is rational because cattle are a source of cash to West Timor farmers. As mentioned in Section 3.2.1 one of the main instruments of the Indonesian government price policy is the use of a farm-level floor price. The main goal of the floor price that has been set by the government every year is to protect farmers from a price drop below the rational level as well as to improve farmers' welfare. The price can drop below the rational level because of imperfect competition in the market. The rational level of the floor price is a minimum level of price that might create profit for farmers.

In fact. except for food crops commodities, the Indonesian government has not set yet the floor price of livestock and its products. If the effective floor price of livestock might be approached by the price of livestock at the farm gate, an increase in the price at the farm gate could be considered as an increase in the effective floor price. The scenario of a 10 per cent increase in the price of live cattle at the farm gate can be viewed as a 10 per cent increase in the effective floor price of live cattle. An increase in the price at the farm gate could be achieved by reducing the number of middlemen in the live cattle marketing systems as well as providing a good transportation systems (see section 3.10).

The scenario of increasing the price of rice is also simulated under the assumption that an increase in this variable will motivate farmers to increase their food crops production to support the program of food security as well as to increase farmers' welfare As mentioned in Section 3.2.1, agricultural production in Indonesia is influenced by government price policies on output. Although there is a tendency in the world trade to increase efficiency in the agricultural commodities marketing by reducing the level of government protection on the agricultural commodities prices, the Indonesian government is still taking a policy to protect some basic staples such as rice and maize to encourage farmers to produce more for domestic consumption. Maintaining stable commodity prices has encouraged agricultural production, especially of food crops.

An increase in the price at the farm gate could be considered as an increase in the effective floor price. An increase in the price at the farm gate could be achieved by reducing the number of middlemen in the agricultural commodities marketing systems as well as providing a good transportation systems and improving agricultural infrastructure.

7.3.2. Result of simulation analysis

Following the discussion in section 7.3.1, the six scenarios that were simulated are as follows:

Simulation 1 : 10 per cent increase in the size of irrigated area

Simulation 2 : 10 per cent increase in the amount of credit

Simulation 3: 35 per cent decrease in total cost per hectare of maize cultivation

Simulation 4 : 10 units increase in the number of cooperatives

Simulation 5 : 10 per cent increase in the price of live cattle

Simulation 6 : 10 per cent increase in the price of rice at farm gate

The result of the six scenarios for simulation is presented in Table 7.2. It can be seen in Table 7.2 that the six possible scenarios have given a positive impact on the output of agricultural sector as well as farmers' per capita income.

Table 7.2. Effect of the six scenarios of simulation on agricultural production and farmers' welfare (% change)

Variable	Definition	Simulation scenarios					
		1	2	3	4	5	6
		%					
APT	Tree crops Harvested area	-2.4	-1.5	-0.1	-1.5	-8.3	-7.9
QPPT	Tree crops productivity	3.0	2.1	0.2	2.1	14.0	13.6
ADT	Food crops harvested area	1.1	0.3	-3.3	0.3	0.2	-0.2
QPDT	Food crops productivity	40.7	41.0	4.0	41.0	34.6	34.5
LPRT	Livestock productivity	-1.1	-1.1	-0.3	-1.1	15.5	17.4
LCT	Livestock consumption	-1.7	-1.8	-0.4	-1.8	27.1	27.3
OAT	Agricultural sector output	1.6	1.6	0.1	1.6	1.1	1.2
POPGT	Farmer population growth	0.5	0.5	0.02	0.5	0.1	0.1
QDT	Food crops production	41.6	41.4	0.3	41.4	34.7	34.1
QPT	Tree crops production	0.6	0.6	0.7	0.6	5.6	5.7
LPT	Livestock production	-1.4	-1.7	-0.8	-1.7	14.7	17.2
PIT	Farmer per capita income	1.2	1.1	0.1	1.1	1.0	1.1

Where:

Simulation 1: 10 per cent increase in the size of irrigated area
Simulation 2: 10 per cent increase in the amount of credit
Simulation3: 35 per cent decrease in total cost per hectare of maize cultivation
Simulation 4: 10 units increase in the number of cooperatives
Simulation 5: 10 per cent increase in the price of live cattle
Simulation 6: 10 per cent increase in the price of rice

7.3.2.1. Ten per cent increase in the size of irrigated areas

Based on the result of the simulation analysis (Table 7.2) it can be seen that if the size of the irrigated area is increased by 10 per cent, there will be a 3.0 per cent increase in tree crops productivity and 2.4 per cent decrease in tree crops harvested area. Because the proportion of increase in tree crops productivity was bigger than the proportion of decrease in harvested area, the overall effect is a 0.6 per cent in total production of tree crops. This result supports the proposition and strengthens the result of the structural analysis that water availability is the main determinant in the agricultural production of West Timor. As mention Section 3.3 and Section 6.3.2, the most critical factors determining farming practices in the region are water availability (Barlow and Gondowarsito 1991, Benu *et al.* 1992 and Momuat *et al.* 1995). This result indicates that the policy of a 10 per cent increase in the size of the irrigated area has a positive impact on tree crops cultivation, under the assumption that other factors are constant. The production system in this region is influenced by climatic conditions, which is characterised by a limited annual rainfall. The agricultural sector of West Timor cannot be developed as productively as other regions because of its dry climate and long dry season as well as its limited irrigation infrastructure. The availability of water becomes a critical factor that might increase crops production of West Timor.

The policy of a 10 per cent increase in the size of irrigated areas resulted to a 1.1 per cent increase in food crops harvested area and 40.7 per cent increase in food crops productivity. Both of these increases further determined a 41.6 per cent increase in food crops production. The influence of the increase in the size of irrigated area is greater with food crops production than tree crops production because the production of food crops is more sensitive to water availability than tree crops production.

A 10 per cent increase in the size of irrigated area also determined a 1.1 per cent decrease in livestock productivity and a 1.7 per cent decrease in livestock consumption. Furthermore, an overall result of this policy is a 1.4 per cent decrease in livestock production. It can be concluded that livestock production in West Timor is more dependent on pasture capacity than on irrigation channels that are constructed for food crops cultivation only. Days of rainfall is one of the technical factors determining pasture capacity, but it is not too significant since over-grazing has become a big problem in West Timor. Indeed, under the assumption that capital (especially land) and technology are constant, there is a trade-off between expansion of food crops cultivation (because of the increase in the size of irrigated area) and traditional livestock cultivation in West Timor (see section 3.8.3). As mentioned in Section 3.8.3, the livestock production systems in West Timor are low in modern inputs and fully reflect the difficulties of the environment. Livestock roam freely without any intensive control by the farmer and with no supplements given by farmers. Livestock (cattle) really depend on pasture capacity, so the expansion of land cultivation because of water availability will reduce the opportunity to expand livestock production

Although a 10 per cent increase in the size of irrigated area determined a decrease in livestock production, this policy will increase the total agricultural sector output by 1.6 per cent per year because of the increase in either food crops production or tree crops production. At the same time, the growth of farmer population increased by approximately 0.5 per cent only, so that farmers' per capita income increased by 1.2 per cent per year. It is rational to say that the policy of increasing the size of irrigated area could be an effective policy to promote the agricultural production as well as farmers' welfare. However, this policy should be directed to improving crop productivity rather than to expanding crop cultivated area, especially in relation to the problem of a trade-off between crops cultivation and livestock cultivation.

Benu (1996), in his simulation analysis of paddy production in East Nusa Tenggara province of Indonesia found that an increase in irrigated area will determine an increase in producer's revenue, but suggested that the current irrigation channels be made more efficient rather than a new irrigation channel systems be developed. Indeed, the policy of de-bureaucratisation and re-structuring of the irrigation organisation is what is important to create efficiency in water management. In fact, according to CIDA (1980), irrigation development and water management in Indonesia is the responsibility of several agencies of the central and provincial government. The Department of Public Works (DPU) is primarily responsible for the construction of major public works. However, since 1998 this department has been be controlled by the provincial government as a part of the decentralisation policy. The Department of Public Works is divided into five divisions. These are Water Resources, Highways, Housing and Rural Developments, Administration and Maintenance, and General Engineering. The division of Water Resources is one of the major divisions within the Department of Public Work that undertakes the construction of main irrigation projects. There are six units under the sub-department of water resources development. These are: (a) planning and programming;(b) irrigation; (c) rivers; (d) swamps; (e) hydraulic engineering; and (f) purchasing and equipment.

The water resources division undertakes the investigation, survey, design, construction, and rehabilitation of small-scale irrigation projects that are selected and financed by the Directorate of Irrigation. The Department of Public Works in East Nusa Tenggara province plays a very important role and is involved with most of the construction works. However, the Water Resources Division is not a large organisation in East Nusa Tenggara province because it is involved in only small-scale development.

There is another division of water management that is not a part of DPU known as P3SA. However, it is directly under the jurisdiction of the chief of DPU who also acts as the project manager of P3SA. Besides these divisions within the Department of Public Works, there are some special projects, such as the irrigation project of Alor island and the irrigation project of Timor and Sumba island etc , that also have an important role in developing irrigation channels in East Nusa Tenggara province.

7.3.2.2. Ten per cent increase in the amount of credit

The result of the simulation analysis shows that a 10 per cent increase in the amount of agricultural credit will reduce tree crops harvested area by 1.5 per cent per year, but it will also increase tree crops productivity by 2.1 per cent per year. The overall result of this policy in the model is to increase total production of tree crops by about 0.6 per cent. Though, it should be noted that as a part of the intensification program packages in West Timor, agricultural credit has been more applied to food crops cultivation than tree crops cultivation.

The effect of agricultural credit on food crops cultivation is a 0.3 per cent increase in food crops harvested area and a 41.0 per cent increase in food crops productivity. The accumulation of these changes results in a 41.4 per cent increase in food crops production. However, it should be noted that there are a lot of farmers who still have credit arrears after the period of credit repayment. According to Karmakar (1999) in the competitive situation of a small quantum of financial resources in the third world, the poor are naturally outside the formal institutional market and are forced to resort to exploitative informal sources of credit such as moneylenders and traders. The latter are able to respond quickly and with great flexibility to pressing demands, exploit the poor and further compound their poverty. According to Zeller and Sharma (1998), in many developing countries, poor rural households face severe constraints when they seek credit from formal lending institutions. Formal financial services such as those offered by banks are often not available to those below the poverty line because of restrictions requiring that loans be backed by collateral. Barlow *et al.* (1990) stated that except for some official credit schemes for rice, most small farmers in West Timor could only gain access to short-term credit at a high interest rate of 25 – 35 per cent, with brief loan periods of a few months. As mentioned in Section 3.8.3, it seems to be difficult for farmers in rural areas to get access to credit run by some finance institutions. Indeed, there are many farmers who have used their agricultural credit for consumptive activities (such as wedding parties, burial parties, etc.) rather than productive activities due to the lack of proper supervision. According to Zeller *et al.* (1997) credit needs for production and consumption cannot be clearly distinguished in poor households where spheres of production and consumption are intertwined and often inseparable. Again according to Karmaker (1995) credit cannot be created merely by increasing the money supply, nor can capital be used for developmental proposes if farmers divert savings for consumption proposes. By combining additional labour with more capital, both production and productivity can be enhanced, i.e., more produce and more income.

Although a 10 per cent increase in the amount of agricultural credit has determined an increase in both tree crops production and food crops production, this policy determines also a decrease in livestock production by 1.7 per cent. This result can also be understood as the result of the effect of a trade-off between a crops cultivation expansion and the traditional livestock cultivation. The expansion of crops cultivation will reduce the opportunity to expand traditional livestock cultivation in West Timor. As mentioned in Section 3.8.3, the livestock production systems in West Timor are low in modern inputs and fully reflect the difficulties of the environment. Livestock roam freely without any intensive control by the farmer and with no supplements given by farmers. Livestock (cattle) mostly depend on pasture capacity, so the expansion of land cultivation will reduce the opportunity to expand livestock production.

The further effect of this policy is an increase in total agricultural sector output by 1.6 per cent per year. At the same time, the growth of farmer population increased by 0.5 per cent per year only, so that farmers' per capita income increased by approximately 1.1 per cent per year.

It can be concluded that a scenario of an increase in the agricultural credit scheme to farmers is a stimulant to promote the overall production of agriculture as well as farmer's welfare. However, because there are many farmers in West Timor who usually use the production credit for consumption proposes, the agricultural credit scheme to farmer should be in one package with the policy of improving the supervision of credit implementation to accelerate production and welfare.

7.3.2.3. Thirty-five per cent decrease in total cost per hectare of maize cultivation

The result of the simulation analysis shows that the scenario of 35 per cent decrease in total cost per hectare of maize cultivation will reduce tree crops harvested area by 0.1per cent and increase tree crops productivity by 0.2 per cent. Furthermore, this policy will increase total tree crops production by 0.7 per cent per year. This scenario will also reduce total food crops harvested area by 3.3 per cent per year, but the productivity will increase by 4.0 per cent per year, so that the total production of food crops will increase by 0.3 per cent per year. It can be assumed that a reduction in the cost of production will determine extra money that could be used to improve crops productivity by using fertiliser, pesticide and quality seeds in farmers' cultivation practices. However, an improvement in crops productivity is sometimes a "trade-off" with the expansion of crops harvested area if other production inputs such as labour and capital are constant. The effect of this scenario is negligible on livestock productivity, livestock consumption, and livestock production.

Furthermore, the effect of this scenario on the agricultural sector and farmer population would be a 0.1 per cent increase in the total agricultural sector output and 0.1 per cent increase in farmer population growth per year, so that farmers' per capita income would increase by 0.1 per cent per year.

It can be concluded that West Timor farmers are currently operating inefficiently, especially in food crops cultivation, such that they are hampered by high cost of production. A policy of reducing the cost of production is needed to promote the output of the agricultural sector as well as farmers' welfare. This policy could be implemented in West Timor by improving the program of intensification for dry-land cultivation. The main point of this policy is reducing the total cost of production by improving an efficient cultivation practices as well as by improving agricultural infrastructure. According to Rola-Rubzen and Hardaker (1999), poor rural infrastructure increases farmers' transaction cost and so hampers their ability to respond favourably to price and demand conditions. According to them, empirical evidence shows that infrastructure improvement has a positive effect on the adoption of efficient inputs to increase total production and productivity of agriculture. It is possible to increase the productivity of crops as well as farmers' welfare through this policy.

7.3.2.4. Ten per cent increase in the number of co-operatives

The result of the simulation shows that increasing the number of cooperatives by 10 units results in an increase in tree crops production by 0.6 per cent per year. Although an increase in the number of cooperatives tends to decrease tree crops harvested area (1.5%), the proportion of decrease is smaller than the proportion of increase in tree crops productivity so that there is an increase in tree crops production. The effect of this scenario on food crops is a 0.3 per cent increase in harvested area and a 41.0 per cent increase in productivity, so that would be a 41.4 per cent increase in production. The influence of the increase in the number of cooperatives on food crops production is more significant than on tree crops production because the role of cooperatives is more linked to the cultivation of food crops than tree crops. As described in Section 3.10, farmers are only included in the credit scheme of the intensification program packages if they become members of cooperatives. At the same time, the program of intensification promotes the use of a technology package (fertiliser, pesticide, modern varieties and land preparation) that is more applied in the cultivation of food crops than tree crops. Bano and Seran (1999) in their study on the role of cooperatives in candlenut marketing in TTU regency (one of the regencies in

West Timor) also found that cooperatives at the village level were not very involved in the cultivation or marketing of this commodity.

This scenario, however, indicates a decrease in livestock productivity (1.5%) and livestock consumption (1.8%) so that livestock production decreases by 1.7 per cent per year. Although cooperatives in West Timor have been given a legal status as a economic institution at the village level, the role of this institution in the livestock sub-sector is only in the transaction of buying and selling of live cattle, for which co-operative always takes fees. Cooperatives provide fertilizer, pesticide and credit schemes for crop cultivation but there are no provisions make for livestock production. This is another reason why farmers in West Timor run livestock, especially large livestock, in the traditional manner.

The further effects of a 10units increase in the number of cooperatives would be a 1.6 per cent increase in the agricultural sector output and a 0.5 per cent increase in the growth of farmer population. The increase of agricultural sector output is mostly contributed by the production of food crops as well as tree crops. Because the proportion of the increase in agricultural sector output is larger than the proportion of the increase in farmer population growth, it determines a 1.1 per cent increase in farmers' per capita income.

Although the result of the structural analysis shows that the influence of cooperatives on crop production is not too significant because of a small regression coefficient, the result of the simulation analysis emphasizes the importance of the role of economic institutions such as cooperatives, in agricultural development. The government has to consider the availability of economic institutions, such as cooperatives at the village level, and further to increase the performance of these institutions in helping farmers to overcome their problems in buying production inputs and selling products.

7.3.2.5. Ten per cent increase in the price of live cattle

The result of simulation analysis shows that a 10 per cent increase in the price of live cattle at the farm gate results to an increase in livestock productivity and livestock consumption by 15.5 per cent and 27.1 per cent respectively, so that livestock production will increase also by 14.7 per cent per year. It is possible that in some LDCs, as income increases, people are able to purchase more superior commodities (such as meat products). Hence, while meat price are increasing over time, consumption is also increasing. It can be concluded that an increase in the price of live cattle will motivate farmers to increases their overall livestock production.

This scenario simulation also determined an increase in food crops harvested area and food crops productivity by 0.2 per cent and 34.6 per cent, and food crops production by 34.7 per cent per year. This result indicates that an increase in cash income could also motivate farmers to increase their crop production.

With regards to tree crops, however, this simulation indicates an 8.3 per cent decrease in harvested area. It can be assumed that if all production factors, especially land, are constant, an increase in both food crops cultivation and livestock production will cause reduction in tree crops cultivated area. However, the productivity of tree crops also increased by 14.0 per cent through this policy, so that production will increase by 5.6 per cent per year.

Because of an increase in the production of food crops, tree crops, and livestock, the policy simulation has also determined an increase in agricultural sector output of 1.1 per cent per year. At the same time the growth of farmer population increased by 0.1 per cent only, so that farmers' per capita income increases by 1.0 per cent. This result indicates an increase in cash income could motivate farmers to increase their overall production.

It can be concluded that this scenario is one of the alternative policies that could be taken by the government, because it can create cash (capital) allowing farmers enough capital to expand their overall production of agriculture. If the growth in farmer population is not too high, an increase in overall production of agriculture will determine an increase in farmers' per capita income.

7.3.2.6. Ten per cent increase in the price of rice

The result of the simulation analysis shows that a 10 per cent increase in the price of rice determines an increase in both food crops productivity and tree crops productivity by 34.5 per cent per year and 13.9 per cent per year respectively. As these increases determine a reduction in food crops harvested area by 0.2 per cent and tree crops harvested area by 7.9 per cent, and the proportion of decrease is smaller than the proportion of increase in productivity, food crops production is increased by 34.1 per cent per year, while tree crops production is increased by 5.7 per cent per year. Although farming in West Timor is predominantly of the shifting cultivation type, an increase in cash income could also motivate farmers to increase their overall production.

The effect of this scenario on livestock is a 17.4 per cent increase in livestock productivity and a 27.3 per cent increase in livestock consumption, so that the production of livestock is increased by 17.2 per cent per year.

Because this scenario has determined an increase in the production of food crops, tree crops and livestock, the overall agricultural output increased by 1.2 per cent per year. With an increase in farmer population growth of only 0.1 per cent, the per capita income of farmer increased by 1.1 per cent per year. As mentioned in Section 3.2.1, rice is one of the dominant food crops of West Timor and source of income, so that the increase of rice price at the farm gate is expected to determine farmers' earnings directly, and this will motivate farmers to increase their production.

It can be concluded that the scenario of a 10 per cent increase in the price of rice at the farm gate is another possible economic stimulant for creating agricultural production as well as increasing farmers' welfare, under the assumption that other factors are constant. However, because there is a tendency in world trade to improve efficiency in the agricultural commodities marketing by reducing the level of government protection on the agricultural commodities prices, the Indonesian government should take the policy to achieve the effective level of price at the farm gate by reducing the number of middlemen rather than establishing a higher floor price. An effective level of price at the farm gate could also be achieved by improving infrastructure. According to Rola-Rubzen and Hardaker (1999), improvements in transportation systems help link rural areas' input and product market. Lower transport and storage costs mean better terms of trade for farmers and therefore can stimulate production and raise farm incomes.

Farmers' welfare might be improved by increasing the exchange rate of the agricultural product through the increase of the price at the farm gate.

7.4. Concluding Remarks

In this chapter the result of the simulation analysis of the various scenarios presented was discussed. With the usual caveat as to the adequacy of the model used, the following main point emerged.

The largest positive impact on the agricultural sector output as well as farmers per capita income is derived from the scenario of a 10 per cent increase in the size of irrigated area. The scenarios of increasing amount of agricultural credit and the number of co-operatives have also generated a large positive impact on the agricultural sector output, but with a high increase in farmer population growth. Two other scenarios that have a large impact on the agricultural sector output as well as farmers' per capita income are the scenario of a 10 per cent increase in the price of live cattle and the price of rice.

As the availability of water supply for crops is a critical factor, the policy of increasing the size of irrigated area should be handled by the local government as a part of the overall agricultural development program. At the same time, the policy of increasing the efficiency of current irrigation channels as well as de-bureaucratisation and re-structuring of the irrigation organisation is important to create efficiency in water management.

The policy of increasing amount of agricultural credit to farmers is needed to promote the output of agricultural sector. However, because farmers some time use the credit scheme for consumption purposes, the policy of increasing amount of agricultural credit scheme to farmer should be in one package with the policy of improving the supervision of credit implementation to accelerate production and welfare.

The availability of economic institution at the village level is important factor that has to be considered in economic development of West Timor. Cooperative could take a significant role in the agricultural marketing system to improve agricultural production as well as farmers' welfare in West Timor. The local government has to consider the availability of cooperatives at the village level, and further to increase the performance of this institution in helping farmers to overcome their problems in buying production inputs and selling products.

The welfare of farmers might be increased through the increase of the exchange rate of agricultural products. The policy of increasing the effective price of agricultural products at the farm gate could be taken by the government to increase the exchange rate of the agricultural products and then the welfare of farmers in West Timor. This policy might be achieved by improving infrastructure and is under the authority of the central government of Indonesia. Improvements in transportation systems help link rural areas' input and product market. Lower transport and storage costs mean better terms of trade for farmers and therefore can stimulate production and raise farm incomes.

CHAPTER 8

CONCLUSION AND RECOMMENDATION

8.1. Introduction

In this chapter, a summary of the thesis will be given. In particular, the inherent agricultural problem of the area will be discussed, followed by the research approach and findings of the study. The final section will give a list of recommendations and suggestions for further research.

8.2. Summary

Since the beginning of the 19th century, the agricultural activities in West Timor have been characterised by swidden slash and burn cultivation. The productivity of a shifting cultivation system is generally very low and fluctuates from year to year depending on the precipitation and the level of fertility of the cultivated area. The main orientation of West Timor farmers is how to fulfil their basic needs, thus they focus only on "on-farm" agriculture with low value adding. There is limited market orientation and there are some difficulties involved in efficiency and the resources augmenting aspects of external trade activities.

Because of its dry climate and long dry season as well as its limited irrigation infrastructure, the agricultural sector of West Timor is difficult to develop as productively as other regions. Unpredictable climatic and weather condition such as rainfall, thunderstorms, and winds aggravate the unfavourable agro-climatic and edaphic condition in West Timor. This condition is the main reason for the instability of agricultural production and is the main constraint in the agricultural development of West Timor.

Indeed, the quality of human resources in West Timor cannot mainly rely on economic development, especially to support the change from agriculture to industry. This deficiency has contributed to the loss and waste of human and physical resources. Other major constraints in the economic development of West Timor are physical isolation of hinterland, socio-cultural factors, and socio-psychology factors (which is caused by the lack of the quality of infrastructure and transportation), lack of motivation and ambition, imbalance of economic growth among regions, poor heath condition of people, lack of market information, and the weaknesses of government institution.

The agricultural sector of West Timor, however, is still the biggest contributor to the total gross domestic regional product of West Timor. The changing pattern of West Timor's economy has shown a good trend, but it was challenged by the economic crisis. The economic structure of West Timor is hampered by the slow growth of the primary sector and the secondary sector, and the too rapid growth of the tertiary sector.

As part of its development program, since the early 1970s, the local government has run five special programs to accelerate economic development, especially in the agricultural sector. In the 1980s, Nusa Tenggara Timur province reached food sufficiency status especially for maize. However, this region still faced the problem of low quality human resources, unfavourable agro-climatic and edaphic conditions. government budget constraints, and inconsistency in the development programs. The provincial government also supported the program of intensification that was introduced by the central government at the beginning of the 1970s to accelerate agricultural development. The intensification program promoted the use of a technology package (fertiliser, pesticide, modern varieties. etc), provided credit and fertiliser subsidies, an intensive extension program at the village level, and investment in irrigation development. This program has now been further extended to include economic institutions, such as cooperatives, developed for the village level.

The main problem in relation to agricultural development in West Timor, however. is that the agricultural production has increased significantly, however, the welfare of farmers has not increased as fast as that of non-farmers. While there is a good trend in the economic structure of West Timor, it does not mean that an unequal distribution of income between farmers and non-farmers is acceptable. The growth in income of West Timorese farmers has to be accelerated to eliminate the gap in income distribution between farmers and non-farmers. This target might be achieved if the agricultural development policies were run consistently by the local government. For this reason, an evaluation of the structure of agricultural production, as well as the welfare of the farmers of West Timor, is an important issue that merits investigation.

In this study, an econometric method was used to model the agricultural system in West Timor to evaluate the structure of the agricultural production as well as farmer's welfare in West Timor. A simultaneous equation consisting of eight structural and four identity equations was constructed for the analysis.

8.3. Findings and Policy Implications

8.3.1. Findings

As a result of the present study, several important findings regarding agricultural development and farmers' welfare in West Timor can be outlined.

Based from the background theoretical review, the agricultural production of West Timor can be determined by the number of cooperatives, the special intensification program. rainfall, the size of irrigated area, the size of intensification area. total population, the price of crops, the price of fertiliser, the price of livestock, amount of credit, interest rate. cost of production, the level of consumption, and per capita income. Per capita income of farmers is determined by the level of inflation, production of food crops, production of tree crops, production of livestock, population growth and output of the agricultural sector.

After the structural equations of the agricultural production as well as farmers' welfare were constructed, goodness of fit tests (such as coefficient of determination, the result of both "t-test" and "F-test") were used to analyse the models. The analysis showed that the Three Stage Least Square is the best technique for modelling the structure of agricultural production and farmers' welfare in West Timor. Due to the difficulty of data availability, the computable general equilibrium approach was not considered suitable. Hence the present study used partial equilibrium approach to analyse the research problem.

The result of the structural analysis shows that agricultural production in West Timor is determined more by technical factors than socio-economic factors, as most of farmers in this region are involved in subsistence farming whereby their most important concern are how to fulfil their basic food needs during the year. Therefore the agricultural development should be addressed more on the physical aspects (such as water irrigation, transportation and cultivation skill) than socio-economic aspects (such as subsidy and price).

As described in Section 6.3.1 and 6.3.2, two variables that have a significant influence on the food crops harvested area in West Timor are amount of credit, and rainfall. At the same time, two variables that have a significant influence on the food crops productivity are the size of the total irrigated area and total cost per hectare of maize cultivation. The size of irrigated area and rainfall has a significant influence on food crops production because water availability is one of the most critical factors determining crops production in the region. Because farming in West Timor is predominantly of the shifting cultivation type, the cost of production is the main economic factor that influences food crops productivity rather than the influence of profitability. Credit helps farmers to overcome their financial problems in relation to funds to pay for inputs needed for production, such as fertiliser and pesticide costs as well as wages for farm labour. These inputs of production are very important factors in food crops cultivation.

According to the result of the structural analysis (section 6.3.3 and 6.3.4), tree crops harvested area is influenced by the number of cooperatives and the interest rate. At the same time, tree crops harvested area and price of nitrogen fertiliser influence tree crop productivity. The cooperative has a major role in determining tree crops production because there are legal institution whose role is to help farmers either by providing inputs or by buying production outputs. The policy of providing cooperatives or facilitating the establishment of cooperatives at the village level is therefore a policy that merits consideration by the government.

Interest rates have a significant impact on tree crops harvested area because tree crops are a long-term enterprise that cannot survive with high interest rates. Currently, lending comes with high interest rates (25 % - 30 %) since there are few official government credit schemes at the village level. These high interest rates impose a high price on the cash which most farmers borrow before are able to adopt new cash-intensive crop technologies, thus representing a major constraint to taking up new initiatives. Although the price of nitrogen fertilizer has a significant influence on tree crops productivity, farmers use fertiliser more in food crops cultivation than in tree crops cultivation, so that nitrogen price will influence the productivity of food crops more than tree crops.

On the other hand, livestock productivity in West Timor is generally dependent on agro-climatic and edaphic conditions rather than socio-economic conditions. The number of days of rainfall is one of the technical factors that can have a significant influence on livestock productivity in West Timor (Section 6.3.5). However, due to over-grazing the amount of rainfall is not highly significant to the carrying capacity of pasture. In fact, a high frequency of days of rainfall will actually exacerbate carrying capacity because there is increased 'run-off" leading to erosion with poor pastures. Two economic variables that have influence livestock productivity in West Timor are the price of cattle meat and livestock consumption. Livestock productivity and total population are two variables that have a significant influence on livestock consumption in West Timor. As described in Section 6.3.6, although livestock consumption is determined more by livestock productivity than by total population, total population has a greater influence than the price of livestock product.

The result of the structural analysis also shows that the agricultural sector output of West Timor is influenced by the quantity of tree crops production, farmer population and farmers' per capita income (Section 6.3.7). The production of tree crops has a major role in determining the agricultural sector output of West Timor because tree crops in West Timor are cultivated for cash rather than consumption, so their production will influence economic growth more than the production of annual crops. The influence of farmer population on the agricultural sector output shows that the growth of the agricultural sector output is determined also by the growth of farmer population. At the same time, farmer population and the agricultural sector output are the main components in determining farmers' per capita income.

As described in Section 6.3.8, farmer population growth in West Timor is influenced by the gender ratio, food crops production and livestock production. The influence of food crops production and livestock production on farmer population growth shows that although population is the main determinant factor in agricultural production, the relationship between these two variables might in fact be vice versa. That is, the determinant factor and the effect factor may be reversed.

According to the result of the simulation analysis on the structural equation (Section 7.3.2.1), a policy of increasing the irrigated area would be the main stimulant in increasing crops production, agricultural sector output and farmers' per capita income. As the availability of water supply for crops is a critical factor, the policy of increasing the size of the irrigated area should be handled by the local government as a part of the overall agricultural development program. At the same time, a policy of increasing the efficiency of current irrigation channels as well as de-bureaucratisation and re-structuring of the irrigation organisation is what is important to create efficiency in water management.

As mentioned in Section 7.3.2.2 and 7.3.2.3, West Timor farmers are currently running an inefficient cultivation practice, especially in food crops, as they are hampered by a high cost of production. The policy of increasing amount of agricultural credit to farmers is needed to help farmer overcome their financial problem as well as promote the output of agricultural sector. Other helpful policies would be reducing the costs of production as well as increasing the skills and knowledge of farmers.

A policy of increasing the number of cooperatives has a positive impact on the output of the agricultural sector. Cooperatives are the only legal economic institution at the village level that play an important role in providing production inputs and in buying productions outputs. A policy of increasing the number of cooperatives at the village level, together with improving the structural and functional performance of this institution in helping farmers to buy production inputs and selling products can promote the growth of the agricultural sector output as well as farmers' per capita income.

Lastly, a policy of increasing the price of agricultural commodities at the farm gate has a positive impact on production. This policy can create a profit for farmers and further motivate them to increase their overall production. This policy might be implemented by reducing the number of middlemen in the marketing process of agricultural products as well as improving rural infrastructures.

It can be concluded that two main policies that could be taken by the government to promote the growth of the agricultural sector output and farmers' per capita income are increasing the size of irrigated area and increasing the amount of agricultural credit to farmers. These two policies together can create greater agricultural production and per capita income for farmers in comparison to other policies. However, as farmers sometimes use the credit scheme for consumption purposes, the policy of increasing the amount of agricultural credit should be in one package combined with a policy of improving the supervision of credit implementation to accelerate production and welfare.

8.3.2. Policy implications

As a result of the present study there are several aspects that could be recommended to the government regarding the policies of the agricultural development and farmers' welfare in West Timor.

The most important of these is probably the policy of integration among food crops, tree crops and livestock. As local farmers have no adaptive management techniques to overcome the problem of rainfall fluctuation, this policy needs to be carefully considered by the local government. These changes need to be handled systematically and consistently in order to safeguard food security for local people.

In order to reduce farmer population growth in West Timor, the local government needs to promote a program of increasing agricultural sector output. At the same time, two possible ways to increase agricultural output are increasing the size of irrigated area and the amount of credit extended to farmers. The policy of increasing the size of irrigated area should be in one package with the policy of increasing the efficiency of water use for agricultural activities. In the same way, the policy of increasing the amount of agricultural credit should be in one package with the policy of improving the supervising of credit implementation. These policies should be followed by the strategy of providing more family planning clinics at village level as well as improving their services. At the same time a program of developing a better understanding of rural people and their approach to family planning should be implemented.

Furthermore, in order to create a better agricultural marketing system in West Timor, the government should increase the number of cooperatives at the village level as well as improve their services to farmers. At the same time, the policy to reduce the number of middlemen in the marketing system by empowering the cooperatives should be taken. This could be achieved if the government emphasises the policy of improving the efficiency and effectiveness of cooperatives and improving the quality of human resources. Both of these policies might lead to better prices at the farm gate and further increase profits of farmers.

As described in Section 7.3.2.3, another possible technical policy that might be used as an instrument of growth promotion in West Timor, especially in the agricultural sector, is by reducing the cost of agricultural production. Two possible ways to reduce the cost of production are the policy of reducing the price of inputs at the farm gate by creating an efficient marketing system, and the policy of increasing the efficiency of cultivation practices by improving farmers' cultivation skill.

8.4. Conclusions and Areas for Future Research

There are several conclusions that might be reached regarding the agricultural production as well as farmers' welfare in West Timor. Some aspects could also be recommended to scientists who are interested in the agricultural development and in farmers' welfare issues in West Timor.

Because farming in West Timor is predominantly of the shifting cultivation type, technical factors such as water availability, pasture capacity and irrigation channels influence the production of agriculture more than economic factors such as the price of products and cost of inputs. The program of agricultural intensification that has provided some technical factors such as water, fertiliser and pesticides has a significant role in increasing the production of agriculture.

Most farmers in West Timor operate under the traditional farming systems, and they are more concerned about the cost of production than the level of productivity. Therefore, an increase in agricultural credit as well as a reduction in the cost of production will have a huge positive impact on the production of agriculture. Credit helps farmers to overcome financial constraints in relation to funds to pay for inputs needed for production, such as fertiliser and pesticide costs as well as wages of farm labour. However, the agricultural credit that has been extended to farmers in West Timor is dominated by short-term credit, which is more useful for food crops cultivation than tree crops and livestock. Indeed, because there are many farmers in West Timor usually use the production credit for consumption purposes, the agricultural credit scheme to farmer suggesting that credit provision should be considered together with policies on improving supervision of credit to accelerate production and welfare. Further research could be conducted in West Timor into the effectiveness of the credit implementation to increase agricultural production as well as the appropriate financial institutions that might run the agricultural credit scheme.

An increase in the size of irrigated area has the largest positive impact on the agricultural sector output as well as farmers per capita income. At the same time an increase in the amount of agricultural credit and the number of co-operatives also generated a large positive impact on the agricultural sector output, but with a high increase in farmer population growth. Another possible way of increasing the agricultural sector output as well as farmers' per capita income is the increase of farmer revenue through the increases in the prices of commodities at the farm gate The increase of the price at the farm gate could be achieved by improving rural infrastructures. The effect of rural infrastructures on the agricultural production and farmers' welfare is another possible area for further research that could be undertaken in West Timor.

The policy of increasing the size of irrigated area together with the policy of increasing the efficiency of current irrigation channels as well as de-bureaucratisation and re-structuring of the irrigation organization are needed to overcome the problem of water scarcity as well as to create efficiency in water management.

The availability of economic institution at the village level is an important factor that has to be considered in economic development of West Timor. Cooperatives could take a significant role in the agricultural marketing system to improve agricultural production as well as farmers' welfare in West Timor. The local government has to consider the availability of cooperatives at the village level, and ways to increase the performance of this institution in helping farmers overcome their problems in buying production inputs and selling products. The role of cooperatives in agricultural development is another possible further research that could be undertaken in West Timor.

There are some limitations of the theoretical background and the empirical aspect that could have affected findings. Firstly, the research uses Partial Equilibrium Model to deal with the issues of agricultural production as well as farmer's welfare. In fact, there often exist market interaction and thus market feedbacks. Computable General Equilibrium Model might cover this problem. Indeed, the form of economic model of welfare most commonly considered is one whose solution is reached through the equilibrium of a set of demand and supply. Secondly, The research uses the aggregative data of the agricultural production to deal with the issue of farm productivity. It can be predicted that the problem of aggregation might have affected findings. Thirdly, because of the problem of the unavailability of data at the regional level, the research could not record some important technical factors (pasture capacity, the availability of forages, land tenure problem, etc.), that could have influenced on the agricultural production as well as farmers' welfare in West Timor. These problems might have affected the imperfect figure of findings.

Further research in West Timor regarding farmers' welfare is strongly recommended. To get a comprehensive picture of farmers' welfare, the research should emphasise other indicators of welfare, such as the level of education, life expectation, purchasing power, calorie consumption, and the amount of public transportation and hospitals accessed. In so far as data of these welfare indicators at a macro level in West Timor are not available of, analysis using data pooling could be explored in future research.

In relation to the model of analysis, it is strongly recommended to supplement the standard model that has been developed in this research with estimation of simple models. Furthermore, a simple price integration analysis or a model of price transmission (marketing margin) can be developed in future research to cover the issue of inefficiency in the marketing system. Any lack of price integration revealed by such an analysis could be due to the lack of infrastructure facilities, and the lack of infrastructure facilities such as post harvest facilities (storage, packaging materials, etc.) also increases incidence of losses and deterioration of their produce thereby fetching lower prices.

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APPENDICES

Appendix 1: Series Data, 1979-1998

YEAR	ADT	ADT1	QPDT	QPDT1	QDT	APT	APT1	QPPT	QPPT1	QPT	ART	CRT	COT	RT
1979	156.02	153.49	1.40	1.49	218.82	16.36	16.04	0.44	0.44	7.19	5.00	18.12	94	12.30
1980	158.46	156.02	2.50	1.40	395.62	16.31	16.36	0.45	0.44	7.31	5.33	24.52	136	12.30
1981	171.22	158.46	2.76	2.50	473.26	16.22	16.31	0.46	0.45	7.46	5.33	182.93	158	12.30
1982	135.76	171.22	2.45	2.76	332.65	26.32	16.22	0.30	0.46	7.82	4.53	292.30	167	12.30
1983	147.54	135.76	2.41	2.45	356.24	15.57	26.32	0.45	0.30	7.03	6.56	220.80	180	12.30
1984	143.71	147.54	2.88	2.41	414.25	14.47	15.57	0.54	0.45	7.80	6.59	150.57	140	12.30
1985	157.48	143 71	2.76	2.88	434.15	16.76	14.47	0.44	0.54	7.32	6.97	102.68	181	19.50
1986	145.78	157.48	3.06	2.76	446.07	18.04	16.76	0.44	0.44	7.86	9.40	121.39	190	18.20
1987	154.19	145.78	3.62	3.06	558.02	21.62	18.04	0.40	0.44	8 67	10.11	94.84	218	19.00
1988	167.81	154.19	3.06	3.62	513.46	21.84	21.62	0.40	0.40	8.76	10.11	163.74	217	19.70
1989	179.22	167.81	3.73	3.06	668.62	23.12	21.84	0.49	0.40	11.39	10.11	266.94	265	19.30
1990	190.47	179.22	3.80	3.73	724.12	23.50	23.12	0.44	0.49	10.33	10.31	358.73	275	20.20
1991	212.85	190.47	3.49	3.80	742.61	24.15	23.50	0.43	0.44	10.36	10.31	300.27	287	22.30
1992	188.64	212.85	3.48	3.49	655.99	26.47	24.15	0.47	0.43	12.51	10.31	270.33	312	16.30
1993	180.97	188.64	3.38	3.48	611.08	27.40	26.47	0.46	0.47	12.68	10.31	21.73	313	11.80
1994	186.82	180.97	3.22	3.38	601 13	27.68	27.40	0.46	0.46	12.79	10.11	21.92	309	16.77
1995	196.92	186.82	3.22	3.22	634.91	27.65	27.68	0.48	0.46	13.25	10.11	25.00	326	16.86
1996	214.87	196.92	3 41	3.22	733.34	25.86	27.65	0.58	0.48	14 95	10.46	27.48	310	17.02
1997	208.83	214.87	3.67	3.41	766.06	26.12	25.86	0.83	0.58	21.81	11.40	26.19	331	18.49
1998	191.51	208.83	3.35	3.67	641.71	28.99	26.12	0.63	0.83	18.41	11.40	439.14	359	25.09

YEAR	PZNT	PRT	DRFT	RFT	OAT	OAT1	TPOPT	POPGT	POPGT1	POPT	POPT1	PIT	TPIT
1979	75.00	177.25	78	1216.25	33.61	29.31	965567	0.95	2.22	741071	734065	45.35	62.06
1980	82.50	171.75	78	1227.75	48.09	33.61	1007987	4 39	0.95	773628	741071	62.16	89.58
1981	82.50	266.25	103	1671.25	47.69	48.09	1033581	4.50	4.39	847121	773628	56.30	96.80
1982	82.50	337.50	69	1001.75	69.50	47.69	1051233	1.71	4.50	861589	847121	80.66	127.20
1983	100.00	328.75	91	1463.25	65.71	69 50	1066430	1.45	1.71	874044	861589	75.18	150.84
1984	115.00	400.00	94	1659.75	101.93	65.71	1090382	2.25	1.45	893675	874044	114.06	206.52
1985	100.00	451.25	89	1514.00	109.36	101.93	1114273	2.19	2.25	913257	893675	119.75	223.33
1986	125 00	500.00	83	1111.50	115.62	109.36	1142888	2.57	2.19	936709	913257	123.43	230.22
1987	146.25	472.50	91	1503.50	142.65	115.62	1160836	1.57	2.57	951419	936709	149.93	280.06
1988	146 25	593.75	90	1511.25	106.40	142.65	1180531	1.70	1.57	967562	951419	109.97	265.74
1989	156.25	400.00	87	1586 25	175.09	106.40	1197034	1 40	1.70	981087	967562	178.47	338.90
1990	175.00	606.25	80	1323.25	109 12	175.09	1251275	3.87	1.40	1019037	981087	107.08	307.37
1991	250.00	404.00	77	1234.00	218.57	109 12	1264685	1.07	3.87	1029957	1019037	212.21	442.48
1992	288.75	848.75	83	1315.75	246.49	218.57	1274084	0.83	1.07	1038489	1029957	237.35	520.37
1993	300.00	822 50	82	1327.25	292.89	246.49	1287882	0.76	0.83	1046395	1038489	279.90	678.03
1994	300.00	823.00	82	1695.25	356.96	292.89	1305012	0.13	0.76	1047744	1046395	340.69	827.47
1995	332.50	1051.75	117	2431.25	400.74	356.96	1320217	0.25	0.13	1050322	1047744	381.54	953.35
1996	368.75	1140.50	83	2350.50	451.43	400.74	1376181	2.33	0.25	1074795	1050322	420 01	1053.38
1997	417.75	1191.25	89	2077.66	574.13	451.43	1389371	1.23	2.33	1088015	1074795	527.69	1238.99
1998	463.50	1832.50	107	1890.00	275.80	574.13	1409028	1.28	1.23	1101928	1088015	250.29	583 86

YEAR	IFT	LCT	LCT1	LIT	LIT1	LPT	LPRT	LPRT1	PRMT	PCTMT	NPCFT	PCTT	FPCT	XRT	TCRT	TCMT	D1
1979	25.16	0.06	0.04	0.57	0 54	0.08	0.14	0.09	40	0.90	1.04	160.63	37.00	1.02	0.07	0.01	0
1980	12.85	0.05	0.06	0.59	0.57	0.07	0.12	0.14	57	0.99	1.21	165.00	35.00	1.06	0.12	0.01	0
1981	10.22	0.04	0.05	0.61	0.59	0.06	0.09	0.12	81	1.15	1.13	166.25	48.00	1.04	0.17	0.01	0
1982	9.44	0.05	0.04	0.68	0.61	0.12	0.18	0.09	52	1.19	1.08	160.00	40.00	1.02	0.23	0.02	0
1983	6.79	0.07	0.05	0.75	0.68	0.15	0.20	0.18	60	1.25	1.62	173.75	52.00	1.02	0.24	0.02	0
1984	5.08	0.09	0.07	0.78	0.75	0.11	0.14	0.20	70	1.54	1.83	168.75	52.00	1.01	0.25	0.02	0
1985	4.79	0.09	0.09	0.80	0.78	0.11	0.14	0.14	59	1.68	2.16	202.50	53.00	1.02	0.26	0.02	0
1986	11.32	0.10	0.09	0.85	0.80	0.15	0.18	0.14	45	1.84	3.66	231.25	56.00	1.02	0.27	0.04	0
1987	7.61	0.09	0.10	0.89	0.85	0.12	0.13	0.18	35	2.13	3.94	250.00	59.00	1.00	0.28	0.03	0
1988	5.39	0.10	0.09	0.92	0.89	0.13	0.14	0.13	56	8.13	2.67	268.75	60.00	1.01	0.29	0.03	0
1989	6.95	0.11	0.10	0.95	0.92	0 14	0.15	0.14	61	2.88	2.34	312.50	61.00	1.03	0.36	0.04	0
1990	7.40	0.12	0.11	0.98	0.95	0.15	0.16	0.15	69	3.13	1.98	337.50	66.00	1.05	0.48	0.04	1
1991	5.81	0.10	0.12	0.99	0.98	0.11	0.11	0.16	70	3.95	2.02	335.00	69.00	1.03	0.54	0.05	1
1992	7.02	0.08	0 10	1.08	0.99	0.18	0.16	0.11	50	3.99	1.93	350.00	71.00	1.04	0.61	0.05	1
1993	9.12	0.11	0.08	1.12	1.08	0.14	0.12	0.16	69	4.31	1.93	370.63	72.00	1.03	0.69	0.08	1
1994	6.52	0.09	0.11	1.19	1.12	0.16	0.14	0.12	99	4.83	3.12	382.50	72.00	1.03	0.84	0.06	1
1995	6.91	0.13	0.09	1.20	1.19	0.14	0.12	0.14	111	5.10	4.64	445.00	73.00	1.02	1.01	0.07	1
1996	7.30	0.11	0.13	1.27	1.20	0.18	0.14	0.12	140	6.15	5.51	527.50	78.00	0.89	1.22	0.07	1
1997	7.71	0.12	0.11	1.30	1.27	0.15	0.11	0.14	119	7.13	5.82	686.53	87.00	1.02	1.48	0.08	1
1998	62.58	0.16	0.12	1.33	1.30	0.19	0.14	0.11	313	8.29	6 74	783.11	83.00	1.02	1.64	0.09	1

Where:

ADT = Food crops harvested area in t^{th} year (1000 ha)
ADT_1 = Harvested area of food crops in t^{th} –1 year (1000 ha)
$QPDT$ = Food crops productivity in t^{th} year (1000 tonne/ha)
$QPDT_1$ = Food crops productivity in t^{th}-1 year (1000 tonne/ha)
QDT = Total production of food crops in t^{th} year (1000 tonne)
APT = Tree crops harvested area in t^{th} year (1000 ha)
APT_1 = Tree crops harvested area in t^{th}-1 year (1000 ha)
$QPPT$ = Tree crops productivity in t^{th} year (1000 tonne/ha)
$QPPT_1$ = Tree crops productivity in t^{th} –1 year (1000 tonne/ha)
QPT = Total production of tree crops in t^{th} year (1000 tonne)
ART = Irrigation area in t^{th} year (ha)
CRT = Amount of credit in t^{th} year (Rp. 10 million)
COT = Number of cooperative in t^{th} year (frequency)
RT = Interest rate of credit (%)
$PZNT$ = Price of nitrogen fertilizer at farm gate in t^{th} year (Rp./kg)
PRT = Price of rice at farm gate in t^{th} year (Rp./kg)
$DRFT$ = Day of rainfall in t^{th} year (frequency)
RFT = Rainfall in t^{th} year (mm)
OAT = Output of agricultural sector in t^{th} year (billion Rp.)
$OAT1$ = Output of agricultural sector in t^{th}-1 year (billion Rp.)
$TPOPT$ = Total population in t^{th} year (people)
$POPGT$ = Farmer population growth in t^{th} year (%)
$POPGT_1$ = Farmer population growth in t^{th} –1 year (%)
$POPT$ = Farmer population in t^{th} year (people)
$POPT_1$ = Farmer population in t^{th} –1 year (people)
PIT = Farmer's per capita income in t^{th} year (billion Rp.)
$TPIT$ = Total per capita income in t^{th} year (billion Rp.)
IFT = General inflation index (%)
LCT = Livestock consumption in t^{th} year (million livestock unit)
LCT_1 = Livestock consumption in t^{th}-1 year (million livestock unit)
LIT = Livestock inventory in t^{th} year (million livestock unit)
$LIT1$ = Livestock inventory in t^{th} - 1 year (million livestock unit)
LPT = Livestock production in t^{th} year (million livestock unit)
$LPRT$ = Livestock productivity in t^{th} year (million livestock unit)
$LPRT_1$ = Livestock productivity in t^{th} –1 year (million livestock unit)
$PRMT$ = Market margin of rice price in t^{th} year (Rp/kg)
$PCTMT$ = Price of cattle meat at consumers level t^{th} year (1000 Rp/ kg)
$NPCFT$ = Price of coffee at national level in t^{th} year (Rp. million/tonne)
$PCTT$ = Price of live cattle at farm gate in t^{th} year (1000 Rp/head)
$FPCT$ = Number of family planning clinics in t^{th} year (frequency)
XRT = Gender ratio in t^{th} year (people)
$TCRT$ = Total cost per hectare of rice cultivation in t^{th} year (Rp. million)
$TCMT$ = Total cost per hectare of maize cultivation in t^{th} year (Rp. million)
D_1 = Dummy variable 1 (1 for the year that 'supra special intensification program' took place and 0 for others)

Appendix 2: Result of The Two Stage Least Squares Analysis

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SYSLIN Procedure
Two-Stage Least Squares Estimation

Model: APT
Dependent variable: APT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	352.83784	58.80631	10.111	0.0004
Error	12	69.79254	5.81605		
C Total	18	422.63038			

Root MSE	2.41165	R-Square	0.8349
Dep Mean	22.53105	Adj R-SQ	0.7523
C.V.	10.70366		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	17.735948	5.144812	3.447	0.0048	Interc
CRT	1	0.005910	0.005615	1.053	0.3133	CRT
POPGT	1	-0.441922	0.332204	-1.330	0.2082	POPGT
COT	1	0.083894	0.019876	4.221	0.0012	COT
NPCFT	1	0.073623	0.539548	0.136	0.8937	NPCFT
RT	1	-0.421819	0.257698	-1.637	0.1276	RT
APT1	1	-0.408583	0.263555	-1.550	0.1470	APT1

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SYSLIN Procedure
Two-Stage Least Squares Estimation

Model: QPPT
Dependent variable: QPPT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	5	0.16497	0.03299	8.704	0.0008
Error	13	0.04928	0.00379		
C Total	18	0.21425			

Root MSE	0.06157	R-Square	0.7700
Dep Mean	0.48158	Adj R-SQ	0.6815
C.V.	12.78463		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	0.739841	0.186005	3.978	0.0016	Interc
NPCFT	1	0.009495	0.016273	0.584	0.5695	NPCFT
APT	1	-0.020045	0.005468	-3.666	0.0029	APT
PZNT	1	0.001123	0.000295	3.802	0.0022	PZNT
DRFT	1	-0.001217	0.001537	-0.792	0.4427	DRFT
QPPT1	1	0.073365	0.190507	0.385	0.7064	QPPT1

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SYSLIN Procedure
Two-Stage Least Squares Estimation

Model: ADT
Dependent variable: ADT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	8	9199.36681	1149.92085	7.458	0.0023
Error	10	1541.79383	154.17938		
C Total	18	10741.16064			

Root MSE	12.41690	R-Square	0.8565
Dep Mean	175.42368	Adj R-SQ	0.7416
C.V.	7.07823		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	101.210124	64.177839	1.577	0.1459	Interc
PRMT	1	-0.169069	0.151317	-1.117	0.2900	PRMT
CRT	1	0.043101	0.037146	1.160	0.2729	CRT
PZNT	1	0.197656	0.175302	1.128	0.2859	PZNT
POPGT	1	3.341966	2.308797	1.447	0.1784	POPGT
RFT	1	0.021307	0.014385	1.481	0.1694	RFT
TCRT	1	-17.796018	40.093266	-0.444	0.6666	TCRT
D1	1	20.349069	14.930708	1.363	0.2028	D1
ADT1	1	-0.002391	0.419936	-0.006	0.9956	ADT1

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SYSLIN Procedure
Two-Stage Least Squares Estimation

Model: QPDT
Dependent variable: QPDT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	4	2.85725	0.71431	15.805	0.0001
Error	14	0.63273	0.04520		
C Total	18	3.48998			

Root MSE	0.21259	R-Square	0.8187
Dep Mean	3.17105	Adj R-SQ	0.7669
C.V.	6.70412		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	0.896227	0.475639	1.884	0.0805	Interc
ART	1	0.191375	0.049267	3.884	0.0017	ART
ADT	1	0.004206	0.003216	1.308	0.2121	ADT
TCMT	1	-6.320592	3.703163	-1.707	0.1099	TCMT
QPDT1	1	0.033668	0.145992	0.231	0.8209	QPDT1

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SYSLIN Procedure
Two-Stage Least Squares Estimation

Model: LPRT
Dependent variable: LPRT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	0.00402	0.00067	0.866	0.5464
Error	12	0.00928	0.00077		
C Total	18	0.01329			

Root MSE	0.02781	R-Square	0.3021
Dep Mean	0.14053	Adj R-SQ	-0.0468
C.V.	19.78692		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	0.245589	0.070187	3.499	0.0044	Interc
PCTMT	1	-0.003531	0.005220	-0.676	0.5116	PCTMT
PCTT	1	-0.000097125	0.000085424	-1.137	0.2777	PCTT
DRFT	1	-0.000791	0.000643	-1.231	0.2421	DRFT
RT	1	-0.001478	0.002568	-0.576	0.5755	RT
LCT	1	0.888209	0.542548	1.637	0.1275	LCT
LPRT1	1	-0.353542	0.313377	-1.128	0.2813	LPRT1

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SYSLIN Procedure
Two-Stage Least Squares Estimation

Model: LCT
Dependent variable: LCT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	7	0.01203	0.00172	5.496	0.0064
Error	11	0.00344	0.00031		
C Total	18	0.01547			

Root MSE	0.01769	R-Square	0.7777
Dep Mean	0.09526	Adj R-SQ	0.6362
C.V.	18.56484		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	-0.145211	0.153429	-0.946	0.3643	Interc
PCTMT	1	0.000059672	0.003475	0.017	0.9866	PCTMT
TPIT	1	0.000009996	0.000124	0.080	0.9373	TPIT
LPRT	1	0 040374	0.171085	0.236	0.8178	LPRT
PRT	1	0.000021877	0.000026443	0.827	0.4256	PRT
OAT	1	-0.000105	0.000277	-0.381	0.7105	OAT
TPOPT	1	0.00180	0.000000170	1.063	0.3106	TPOPT
LCT1	1	0.216404	0.379951	0.570	0.5804	LCT1

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SYSLIN Procedure
Two-Stage Least Squares Estimation

Model: OAT
Dependent variable: OAT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	411503.90329	68583.98388	7768.759	0.0001
Error	12	105.93812	8.82818		
C Total	18	411609.84141			

Root MSE	2.97122	R-Square	0.9847
Dep Mean	205.69316	Adj R-SQ	0.9846
C.V.	1.44449		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	-36.717296	3.660702	-9.894	0.0001	Interc
IFT	1	-0.107462	0.144700	-0.743	0.4720	IFT
QDT	1	0.008116	0.008293	0.979	0.3471	QDT
QPT	1	1.573569	0.662019	2.377	0.0350	QPT
POPGT	1	0.790194	0.398524	1.983	0.0708	POPGT
PIT	1	1.054378	0.019819	53.201	0.0001	PIT
PRT	1	0.010770	0.005743	1.875	0.0853	PRT

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SYSLIN Procedure
Two-Stage Least Squares Estimation

Model: POPGT
Dependent variable: POPGT

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	6	38.28625	6.38104	1.922	0.1580
Error	12	39.84505	3.32042		
C Total	18	78.13129			

Root MSE	1.82220	R-Square	0.4900
Dep Mean	2.13053	Adj R-SQ	0.2350
C.V.	85.52826		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	17.85118[illegible]	15.100773	1.182	0.2600	Interc
XRT	1	-12.220961	14.453331	-0.846	0.4143	XRT
OAT	1	-0.007264	0.006222	-1.168	0.2657	OAT
FPCT	1	0.042551	0.111378	0.382	0.7091	FPCT
QDT	1	0.002638	0.006507	0.405	0.6924	QDT
LPT	1	-43.869569	21.641154	-2.027	0.0655	LPT
POPGT1	1	-0.004861	0.232562	-0.021	0.9837	POPGT1

Appendix 3:Result of The Three Stage Least Squares Analysis

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SYSLIN Procedure
Three-Stage Least Squares Estimation

Cross Model Covariance

Sigma	APT	QPPT	ADT	QPDT
APT	5.8160452439	-0.009807788	4.0071338045	-0.047018995
QPPT	-0.009807788	0.0037906307	-0.014605679	0.0062911635
ADT	4.0071338045	-0.014605679	154.17938303	-0.558726759
QPDT	-0.047018995	0.0062911635	-0.558726759	0.0451950025
LPRT	-0.006026944	-0.000132316	-0.112209711	-0.002237465
LCT	-0.013734388	0.0002316612	0.015183267	0.0004046456
OAT	2.0676651094	-0.052299593	8.3084971631	-0.322730375
POPGT	-0.171281026	0.0265804633	-5.950444727	0.0460977267

Sigma	LPRT	LCT	OAT	POPGT
APT	-0.006026944	-0.013734388	2.0676651094	-0.171281026
QPPT	-0.000132316	0.0002316612	-0.052299593	0.0265804633
ADT	-0.112209711	0.015183267	8.3084971631	-5.950444727
QPDT	-0.002237465	0.0004046456	-0.322730375	0.0460977267
LPRT	0.0007731638	-0.00004465	0.022094116	0.0029206843
LCT	-0.00004465	0.0003127751	-0.018352148	-0.011715876
OAT	0.022094116	-0.018352148	8.8281770016	0.310863442
POPGT	0.0029206843	-0.011715876	0.310863442	3.3204204434

Cross Model Correlation

Corr	APT	QPPT	ADT	QPDT
APT	1	-0.066054354	0.1338156181	-0.091709483
QPPT	-0.066054354	1	-0.019105256	0.4806511965
ADT	0.1338156181	-0.019105256	1	-0.211661131
QPDT	-0.091709483	0.4806511965	-0.211661131	1
LPRT	-0.089876779	-0.077289351	-0.324998628	-0.378508137
LCT	-0.322017401	0.2127558693	0.069141053	0.1076250866
OAT	0.2885564559	-0.285895328	0.2252028116	-0.510927313
POPGT	-0.03897614	0.2369246612	-0.262990302	0.1189974793

Corr	LPRT	LCT	OAT	POPGT
APT	-0.089876779	-0.322017401	0.2885564559	-0.03897614
QPPT	-0.077289351	0.2127558693	-0.285895328	0.2369246612
ADT	-0.324998628	0.069141053	0.2252028116	-0.262990302
QPDT	-0.378508137	0.1076250866	-0.510927313	0.1189974793
LPRT	1	-0.090797128	0.2674270597	0.0576437606
LCT	-0.090797128	1	-0.34924911	-0.363548325
OAT	0.2674270597	-0.34924911	1	0.0574166164
POPGT	0.0576437606	-0.363548325	0.0574166164	1

SYSLIN Procedure
Three-Stage Least Squares Estimation

Cross Model Inverse Correlation

Inv Corr	APT	QPPT	ADT	QPDT
APT	1.2516321725	-0.164314575	0.0228672632	0.0514878643
QPPT	-0.164314575	1.6238237088	-0.392882117	-0.833183967
ADT	0.0228672632	-0.392882117	1.5637015651	0.5507260119
QPDT	0.0514878643	-0.833183967	0.5507260119	2.0493583657
LPRT	0.2353472749	-0.381757992	0.77693096	0.7652032798
LCT	0.433800226	-0.465692536	-0.000986426	0.2335161834
OAT	-0.312757312	0.1455231466	-0.421851081	0.5405839538
POPGT	0.2496994186	-0.550956847	0.4187555059	0.1101224691

Inv Corr	LPRT	LCT	OAT	POPGT
APT	0.2353472749	0.433800226	-0.312757312	0.2496994186
QPPT	-0.381757992	-0.465692536	0.1455231466	-0.550956847
ADT	0.77693096	-0.000986426	-0.421851081	0.4187555059
QPDT	0.7652032798	0.2335161834	0.5405839538	0.1101224691
LPRT	1.632310317	0.1041229628	-0.371435496	0.1779766508
LCT	0.1041229628	1.5801837317	0.3480615645	0.6476812392
OAT	-0.371435496	0.3480615645	1.7339102086	-0.173546086
POPGT	0.1779766508	0.6476812392	-0.173546086	1.4724605397

Cross Model Inverse Covariance

Inv Sigma	APT	QPPT	ADT	QPDT
APT	0.2152033074	-1.106640249	0.0007636373	0.1004259115
QPPT	-1.106640249	428.37823989	-0.513917458	-63.65608993
ADT	0.0007636373	-0.513917458	0.0101420925	0.2086302268
QPDT	0.1004259115	-63.65608993	0.2086302268	45.344800313
LPRT	3.509615346	-222.9957747	2.2502642001	129.44815052
LCT	10.170909665	-427.6883793	-0.004491955	62.109164557
OAT	-0.043647369	0.7955011702	-0.011434324	0.8558199907
POPGT	0.0568207685	-4.910947673	0.0185076313	0.2842720707

Inv Sigma	LPRT	LCT	OAT	POPGT
APT	3.509615346	10.170909665	-0.043647369	0.0568207685
QPPT	-222.9957747	-427.6883793	0.7955011702	-4.910947673
ADT	2.2502642001	-0.004491955	-0.011434324	0.0185076313
QPDT	129.44815052	62.109164557	0.8558199907	0.2842720707
LPRT	2111.2088363	211.73597999	-4.495853216	3.5126164027
LCT	211.73597999	5052.1403729	6.623758094	20.097807821
OAT	-4.495853216	6.623758094	0.1964063711	-0.032054039
POPGT	3.5126164027	20.097807821	-0.032054039	0.4434560517

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SYSLIN Procedure
Three-Stage Least Squares Estimation

System Weighted MSE: 0.90458 with 96 degrees of freedom.
System Weighted R-Square: 0.9889

Model: APT
Dependent variable: APT

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SYSLIN Procedure
Three-Stage Least Squares Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	19.499546	4.837592	4.031	0.0017	Interc
CRT	1	0.006652	0.005356	1.242	0.2380	CRT
POPGT	1	-0.503486	0.314932	-1.599	0.1359	POPGT
COT	1	0.082301	0.018538	4.440	0.0008	COT
NPCFT	1	0.381356	0.517720	0.737	0.4755	NPCFT
RT	1	-0.455561	0.244770	-1.861	0.0874	RT
APT1	1	-0.485694	0.241686	-2.010	0.0675	APT1

Durbin-Watson 1.674

1st Order Autocorrelation 0.155

Model: QPPT
Dependent variable: QPPT

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SYSLIN Procedure
Three-Stage Least Squares Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	0.761736	0.157583	4.834	0.0003	Interc
NPCFT	1	0.003589	0.013916	0.258	0.8005	NPCFT
APT	1	-0.020979	0.004604	-4.557	0.0005	APT
PZNT	1	0.001269	0.000254	5.000	0.0002	PZNT
DRFT	1	-0.001003	0.001281	-0.783	0.4476	DRFT
QPPT1	1	0.002740	0.162686	0.017	0.9868	QPPT1

Durbin-Watson 2.205
1st Order Autocorrelation -0.112

Model: ADT
Dependent variable: ADT

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SYSLIN Procedure
Three-Stage Least Squares Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	86.483054	55.221809	1.566	0.1484	Interc
PRMT	1	-0.200679	0.130382	-1.539	0.1548	PRMT
CRT	1	0.063593	0.033090	1.922	0.0836	CRT
PZNT	1	0.224515	0.152069	1.476	0.1706	PZNT
POPGT	1	3.903696	1.983427	1.968	0.0774	POPGT
RFT	1	0.025512	0.012404	2.057	0.0667	RFT
TCRT	1	-16.883907	33.971215	-0.497	0.6299	TCRT
D1	1	12.771379	12.388860	1.031	0.3269	D1
ADT1	1	0.018397	0.368868	0.050	0.9612	ADT1

Durbin-Watson 2.368
1st Order Autocorrelation -0.255

Model: QPDT
Dependent variable: QPDT

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SYSLIN Procedure
Three-Stage Least Squares Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	0.864953	0.390379	2.216	0.0438	Interc
ART	1	0.188447	0.038043	4.954	0.0002	ART
ADT	1	0.003852	0.002545	1.513	0.1524	ADT
TCMT	1	-6.146380	3.134987	-1.961	0.0701	TCMT
QPDT1	1	0.070097	0.113126	0.620	0.5455	QPDT1

Durbin-Watson 2.919
1st Order Autocorrelation -0.468

Model: LPRT
Dependent variable: LPRT

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SYSLIN Procedure
Three-Stage Least Squares Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	0.266347	0.061702	4.317	0.0010	Interc
PCTMT	1	-0.007921	0.004300	-1.842	0.0903	PCTMT
PCTT	1	-0.000073026	0.000074765	-0.977	0.3480	PCTT
DRFT	1	-0.001228	0.000562	-2.187	0.0493	DRFT
RT	1	-0.000349	0.002221	-0.157	0.8778	RT
LCT	1	1.004470	0.454331	2.211	0.0472	LCT
LPRT1	1	-0.384409	0.266293	-1.444	0.1745	LPRT1

Durbin-Watson 1.959

1st Order Autocorrelation -0.020

Model: LCT
Dependent variable: LCT

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SYSLIN Procedure
Three-Stage Least Squares Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	-0.157472	0.139380	-1.130	0.2826	Interc
PCTMT	1	-0.000648	0.002829	-0.229	0.8230	PCTMT
TPIT	1	0.000120	0.000106	1.127	0.2839	TPIT
LPRT	1	0.134093	0.155759	0.374	0.1527	LPRT
PRT	1	0.000032723	0.000023571	1.388	0.1925	PRT
OAT	1	-0.000374	0.000235	-1.593	0.1395	OAT
TPOPT	1	0.237197	0.000000153	1.292	0.2227	TPOPT
LCT1	1	0.107915	0.331782	0.325	0.7511	LCT1

Durbin-Watson 2.306
1st Order Autocorrelation -0.155

Model: OAT
Dependent variable: OAT

The SAS System 15:01 Thursday, June 21, 2001

SYSLIN Procedure
Three-Stage Least Squares Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	-38.475162	3.223797	-11.935	0.0001	Interc
IFT	1	-0.101009	0.115077	-0.878	0.3973	IFT
QDT	1	0.009998	0.007250	1.379	0.1931	QDT
QPT	1	1.939238	0.523428	3.705	0.0030	QPT
POPGT	1	0.794453	0.340181	2.335	0.0377	POPGT
PIT	1	1.050880	0.016245	64.690	0.0001	PIT
PRT	1	0.007482	0.004604	1.625	0.1301	PRT

Durbin-Watson 2.639

1st Order Autocorrelation -0.322

Model: POPGT
Dependent variable: POPGT

The SAS System 15:01 Thursday, June 21, 2001

SYSLIN Procedure
Three-Stage Least Squares Estimation

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|	Variable Label
INTERCEP	1	22.886364	13 345115	1.715	0.1120	Interc
XRT	1	-16.576799	12.580086	-1.318	0.2122	XRT
OAT	1	-0.008607	0 005820	-1.479	0.1649	OAT
FPCT	1	0.037385	0 099514	0.376	0.7137	FPCT
QDT	1	0.004413	0.005854	0.754	0.4655	QDT
LPT	1	-49.246644	19.923947	-2.472	0.0294	LPT
POPGT1	1	-0.132896	0.207348	-0.641	0.5336	POPGT1

Durbin-Watson 2.047

1st Order Autocorrelation -0.043

Appendix 4: Result of the Theil Test

The SAS System 15:01 Thursday, June 21, 2001

MODEL Procedure
Simultaneous Simulation

Theil Forecast Error Statistics

	MSE Decomposition Proportions						Inequality Coef	
Variable	Corr (R)	Bias (UM)	Reg (UR)	Dist (UD)	Var (US)	Covar (UC)	U	Label
APT	0.907	0.000	0.007	0.992	0.018	0.982	0.0434	APT
QPPT	0.757	0.000	0.002	0.998	0.107	0.893	0.0708	QPPT
ADT	0.755	0.138	0.011	0.851	0.202	0.660	0.0487	ADT
QPDT	0.890	0.015	0.001	0.984	0.070	0.915	0.0310	QPDT
LPRT	0.451	0.000	0.224	0.776	0.005	0.995	0.0939	LPRT
LCT	0.841	0.000	0.025	0.975	0.017	0.982	0.0789	LCT
OAT	1.000	0.002	0.047	0.951	0.052	0.945	0.0071	OAT
POPGT	0.393	0.001	0.249	0.749	0.005	0.994	0.3761	POPGT
QDT	0.862	0.125	0.030	0.846	0.179	0.697	0.0665	QDT
QPT	0.948	0.003	0.001	0.995	0.040	0.957	0.0540	QPT
LPT	0.724	0.001	0.220	0.779	0.013	0.985	0.0934	LPT
PIT	0.943	0.186	0.231	0.899	0.125	0.897	0.2541	PIT

Appendix 5: Result of the Simulation Analysis

```
Data work.Timor; set work.Timor;
     ADT1 = Lag (ADT);
     QPDT1 = Lag (QPDT);
     APT1= Lag(APT);
     QPPT1= Lag(QPPT);
     LPRT1 = Lag (LPRT);
     LCT1 = Lag (LCT);
     ART = (0.1*ART)+ART;
   Run;
 Proc Model data=work.timor;
     Endogenous APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT;
     Exogenous  RT RFT DRFT CRT POPT COT D1
                NPCFT PZNT APT1 POPGT1 TCRT TCMT PRT
                QPPT1 PRT PRMT ART ADT1 QPDT1 PCTMT
                PCTT LPRT1 TPIT LCT1 IFT FPCT XRT;
     Parms a0 19.499546 a1 0.006652  a2 -0.503486  a3 0.082301  a4 0.381356
           a5 -0.455561  a6 -0.485694  b0 0.761736  b1 0.003589  b2 -0.020979
           b3 0.001269  b4 -0.001003  b5 0.002740    c0 86.483054  c1 -0.200679
           c2 0.063593  c3 0.224515  c4 3.903696  c5 0.025512  c6 -16.883907
           c7 12.771379  c8 0.018397  d0 0.864953  d1 0.188447  d2 0.003852
           d3 -6.146380  d4 0.070097  e0 0.266347  e1 -0.0079  e2 -0.0001
           e3 -0.001228  e4 -0.000349  e5 1.004470  e6 -0.384409  f0 -0.157472
           f1 -0.000648 f2 0.000120  f3 0.1340293  f4 0.000032723
           f5 -0.000374  f6 0.237197  f7 0.107915 g0 -38.475162   g1 -0.101009
           g2 0.009998   g3 1.939238  g4 0.794453  g5 1.050880  g6 0.007482
           h0 22.886364  h1 -16.576799 h2 -0.008607 h3 0.037385  h4 0.004413
           h5 -49.246644  h6 -0.132896;
    APT = a0 + a1*CRT + a2*POPGT + a3*COT + a4*NPCFT + a5*RT + a6*APT1;
    QPPT = b0 + b1*NPCFT + b2*APT + b3*PZNT + b4*DRFT + b5*QPPT1;
    ADT = c0 + c1*PRMT + c2*CRT + c3*PZNT + c4*POPGT + c5*RFT + c6*TCRT
        + c7*D1 + c8*ADT1;
    QPDT = d0 + d1*ART + d2*ADT + d3*TCMT + d4*QPDT1;
    LPRT = e0 + e1*PCTMT + e2*PCTT + e3*DRFT + e4*RT + e5*LCT + e6*LPRT1;
    LCT = f0 + f1*PCTMT + f2*TPIT + f3*LPRT + f4*PRT + f5*OAT + f6*TPOPT + f7*LCT1;
    OAT = g0 + g1*IFT + g2*QDT + g3*QPT + g4*POPGT + g5*PIT + g6*PRT;
    POPGT = h0 + h1*XRT + h2*OAT + h3*FPCT + h4*QDT + h5*LPT + h6*POPGT1;
    QDT = ADT * QPDT;
    QPT = APT * QPPT;
    LPT*(1-LPRT) = LPRT * (LIT1 - LCT);
    PIT = OAT/{[POPGT*POPT1]/100}+POPT1;
Solve APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT/Out=Sim Stats Theil;
Run;
```

The SAS System   16:40 Thursday, July 26, 2001

MODEL Procedure
Simultaneous Simulation

Descriptive Statistics

Variable	Actual Mean	Actual Std	Predicted Mean	Predicted Std	Label
APT	22.5311	4.8456	21.9994	4.4622	APT
QPPT	0.4816	0.1091	0.4958	0.0852	QPPT
ADT	175.4237	24.4281	177.2832	16.4557	ADT
QPDT	3.1711	0.4403	4.4630	0.4265	QPDT
LPRT	0.1405	0.0272	0.1389	0.0253	LPRT
LCT	0.0953	0.0293	0.0937	0.0272	LCT
OAT	205.6932	151.2191	209.0666	150.4244	OAT
POPGT	1.7384	1.0063	1.7474	1.4931	POPGT
QDT	63.3311	139.4755	797.5078	115.5010	QDT
QPT	10.9742	4.0678	11.0368	3.8064	QPT
LPT	0.1347	0.0341	0.1328	0.0371	LPT
PIT	193.6021	135.9104	195.8285	130.5902	PIT

```
Data Work.Timor; set work.Timor;
    ADT1 = Lag (ADT);
    QPDT1 = Lag (QPDT);
    APT1= Lag(APT);
    QPPT1= Lag(QPPT);
    LPRT1 = Lag (LPRT);
    LCT1 = Lag (LCT);
    CRT = (0.1*CRT)+CRT;
  Run;
```

```
Proc Model data=work.timor;
   Endogenous APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT;
   Exogenous  RT RFT DRFT CRT POPT COT D1
              NPCFT PZNT APT1 POPGT1 TCRT TCMT PRT
              QPPT1 PRT PRMT ART ADT1 QPDT1 PCTMT
              PCTT LPRT1 TPIT LCT1 IFT FPCT XRT;
  Parms a0 19.499546 a1 0.006652  a2 -0.503486  a3 0.082301  a4 0.381356
        a5 -0.455561  a6 -0.485694  b0 0.761736  b1 0.003589  b2 -0 020979
        b3 0.001269  b4 -0.001003  b5 0.002740   c0 86.483054  c1 -0 200679
        c2 0.063593  c3 0.224515  c4 3.903696  c5 0.025512  c6 -16.883907
        c7 12.771379  c8 0.018397  d0 0.864953  d1 0.188447  d2 0.003852
        d3 -6.146380  d4 0.070097  e0 0.266347  e1 -0.0079  e2 -0.0001
        e3 -0.001228  e4 -0.000349  e5 1.004470  e6 -0.384409  f0 -0.157472
        f1 -0.000648 f2 0.000120  f3 0.1340293  f4 0.000032723
        f5 -0.000374  f6 0.237197  f7 0.107915 g0 -38.475162   g1 -0.101009
        g2 0.009998   g3 1.939238  g4 0.794453  g5 1.050880  g6 0.007482
        h0 22.886364  h1 -16.576799 h2 -0.008607 h3 0.037385  h4 0.004413
        h5 -49.246644  h6 -0.132896;
  APT = a0 + a1*CRT + a2*POPGT + a3*COT + a4*NPCFT + a5*RT + a6*APT1;
  QPPT = b0 + b1*NPCFT + b2*APT + b3*PZNT + b4*DRFT + b5*QPPT1;
  ADT = c0 + c1*PRMT + c2*CRT + c3*PZNT + c4*POPGT + c5*RFT + c6*TCRT
       + c7*D1 + c8*ADT1;
  QPDT = d0 + d1*ART + d2*ADT + d3*TCMT + d4*QPDT1;
  LPRT = e0 + e1*PCTMT + e2*PCTT + e3*DRFT + e4*RT + e5*LCT + e6*LPRT1;
  LCT = f0 + f1*PCTMT + f2*TPIT + f3*LPRT + f4*PRT + f5*OAT + f6*TPOPT + f7*LCT1;
  OAT = g0 + g1*IFT + g2*QDT + g3*QPT + g4*POPGT + g5*PIT + g6*PRT,
  POPGT = h0 + h1*XRT + h2*OAT + h3*FPCT + h4*QDT + h5*LPT + h6*POPGT1;
  QDT = ADT * QPDT;
  QPT = APT * QPPT;
  LPT*(1-LPRT) = LPRT * (LIT1 - LCT);
  PIT = OAT/{[POPGT*POPT1]/100}+POPT1;
Solve APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT/Out=Sim Stats Theil;
Run;
```

The SAS System   16:45 Thursday, July 26, 2001

MODEL Procedure
Simultaneous Simulation

Descriptive Statistics

Variable	Actual Mean	Actual Std	Predicted Mean	Predicted Std	Label
APT	22.5311	4.8456	22.1976	4.5887	APT
QPPT	0.4816	0.1091	0.4916	0.0853	QPPT
ADT	175.4237	24.4281	175.9676	16.3704	ADT
QPDT	3.1711	0.4403	4.4722	0.3852	QPDT
LPRT	0.1405	0.0272	0.1389	0.0253	LPRT
LCT	0.0953	0.0293	0.0936	0.0272	LCT
OAT	205.6932	151.2191	209.0254	150.3053	OAT
POPGT	1.7384	1.0063	1.7474	1.0155	POPGT
QDT	563.3311	139.4755	796.4938	106.5930	QDT
QPT	10.9742	4.0678	11.0379	3.8061	QPT
LPT	0.1347	0.0341	0.1324	0.0371	LPT
PIT	193.6021	135.9104	195.5575	130.2307	PIT

```
Data work.Timor; set work.Timor;
      ADT1 = Lag (ADT);
      QPDT1 = Lag (QPDT);
      APT1= Lag(APT);
      QPPT1= Lag(QPPT);
      LPRT1 = Lag (LPRT);
      LCT1 = Lag (LCT);
      TCMT = TCMT-(0.35*TCMT);
    Run;

Proc Model data=work.timor;
      Endogenous APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT;
      Exogenous  RT RFT DRFT CRT POPT COT D1
                 NPCFT PZNT APT1 POPGT1 TCRT TCMT PRT
                 QPPT1 PRT PRMT ART ADT1 QPDT1 PCTMT
                 PCTT LPRT1 TPIT LCT1 IFT FPCT XRT;
      Parms a0 19.499546 a1 0.006652  a2 -0.503486  a3 0.082301  a4 0.381356
            a5 -0.455561  a6 -0.485694  b0 0.761736  b1 0.003589  b2 -0.020979
            b3 0.001269  b4 -0.001003  b5 0.002740   c0 86.483054  c1 -0.200679
            c2 0.063593  c3 0.224515  c4 3.903696  c5 0.025512  c6 -16.883907
            c7 12.771379  c8 0.018397  d0 0.864953  d1 0.188447  d2 0.003852
            d3 -6.146380  d4 0.070097  e0 0.266347  e1 -0.0079  e2 -0.0001
            e3 -0.001228  e4 -0.000349  e5 1.004470  e6 -0.384409  f0 -0.157472
            f1 -0.000648 f2 0.000120  f3 0.1340293  f4 0.000032723
            f5 -0.000374  f6 0.237197  f7 0.107915 g0 -38.475162   g1 -0.101009
            g2 0.009998   g3 1.939238  g4 0.794453  g5 1.050880  g6 0.007482
            h0 22.886364  h1 -16.576799 h2 -0.008607 h3 0.037385  h4 0.004413
            h5 -49.246644  h6 -0.132896;
     APT = a0 + a1*CRT + a2*POPGT + a3*COT + a4*NPCFT + a5*RT + a6*APT1;
     QPPT = b0 + b1*NPCFT + b2*APT + b3*PZNT + b4*DRFT + b5*QPPT1;
     ADT = c0 + c1*PRMT + c2*CRT + c3*PZNT + c4*POPGT + c5*RFT + c6*TCRT
           + c7*D1 + c8*ADT1;
     QPDT = d0 + d1*ART + d2*ADT + d3*TCMT + d4*QPDT1;
     LPRT = e0 + e1*PCTMT + e2*PCTT + e3*DRFT + e4*RT + e5*LCT + e6*LPRT1;
     LCT = f0 + f1*PCTMT + f2*TPIT + f3*LPRT + f4*PRT + f5*OAT + f6*TPOPT + f7*LCT1;
     OAT = g0 + g1*IFT + g2*QDT + g3*QPT + g4*POPGT + g5*PIT + g6*PRT;
     POPGT = h0 + h1*XRT + h2*OAT + h3*FPCT + h4*QDT + h5*LPT + h6*POPGT1;
     QDT = ADT * QPDT;
     QPT = APT * QPPT;
     LPT*(1-LPRT) = LPRT * (LIT1 - LCT);
     PIT = OAT/{[POPGT*POPT1]/100}+POPT1;
Solve APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT/Out=Sim Stats Theil;
Run;
```

The SAS System   18:53 Thursday, July 26, 2001

MODEL Procedure
Simultaneous Simulation

Descriptive Statistics

Variable	Actual Mean	Actual Std	Predicted Mean	Predicted Std	Label
APT	22.5311	4.8456	22.5018	4.6011	APT
QPPT	0.4816	0.1091	0.4823	0.0845	QPPT
ADT	175.4237	24.4281	169.6523	16.1606	ADT
QPDT	3.1711	0.4403	3.2964	0.3547	QPDT
LPRT	0.1405	0.0272	0.1401	0.0252	LPRT
LCT	0.0953	0.0293	0.0949	0.0273	LCT
OAT	205.6932	151.2191	205.8989	150.2028	OAT
POPGT	1.7384	1.0063	1.7387	1.9442	POPGT
QDT	563.3311	139.4755	564.9084	98.3648	QDT
QPT	10.9742	4.0678	11.0466	3.8067	QPT
LPT	0.1347	0.0341	0.1336	0.0372	LPT
PIT	193.6021	135.9104	193.7570	130.2401	PIT

```
Data Work.Timor; set work.Timor;
     ADT1 = Lag (ADT);
     QPDT1 = Lag (QPDT);
     APT1= Lag(APT);
     QPPT1= Lag(QPPT);
     LPRT1 = Lag (LPRT);
     LCT1 = Lag (LCT);
     COT = COT+10;
   Run;


Proc Model data=work.timor;
     Endogenous APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT;
     Exogenous  RT RFT DRFT CRT POPT COT D1
                NPCFT PZNT APT1 POPGT1 TCRT TCMT PRT
                QPPT1 PRT PRMT ART ADT1 QPDT1 PCTMT
                PCTT LPRT1 TPIT LCT1 IFT FPCT XRT;
   Parms a0 19.499546 a1 0.006652  a2 -0.503486  a3 0.082301  a4 0.381356
         a5 -0.455561  a6 -0.485694  b0 0.761736  b1 0.003589  b2 -0.020979
         b3 0.001269  b4 -0.001003  b5 0.002740   c0 86.483054  c1 -0.200679
         c2 0.063593  c3 0.224515  c4 3.903696  c5 0.025512  c6 -16.883907
         c7 12.771379  c8 0.018397  d0 0.864953  d1 0.188447  d2 0.003852
         d3 -6.146380  d4 0.070097  e0 0.266347  e1 -0.0079  e2 -0.0001
         e3 -0.001228  e4 -0.000349  e5 1.004470  e6 -0.384409  f0 -0.157472
         f1 -0.000648 f2 0.000120  f3 0.1340293  f4 0.000032723
         f5 -0.000374  f6 0.237197  f7 0.107915 g0 -38.475162   g1 -0.101009
         g2 0.009998   g3 1.939238  g4 0.794453  g5 1.050880  g6 0.007482
         h0 22.886364  h1 -16.576799 h2 -0.008607 h3 0.037385  h4 0.004413
         h5 -49.246644  h6 -0.132896;
   APT = a0 + a1*CRT + a2*POPGT + a3*COT + a4*NPCFT + a5*RT + a6*APT1;
   QPPT = b0 + b1*NPCFT + b2*APT + b3*PZNT + b4*DRFT + b5*QPPT1;
   ADT = c0 + c1*PRMT + c2*CRT + c3*PZNT + c4*POPGT + c5*RFT + c6*TCRT
         + c7*D1 + c8*ADT1;
   QPDT = d0 + d1*ART + d2*ADT + d3*TCMT + d4*QPDT1;
   LPRT = e0 + e1*PCTMT + e2*PCTT + e3*DRFT + e4*RT + e5*LCT + e6*LPRT1;
   LCT = f0 + f1*PCTMT + f2*TPIT + f3*LPRT + f4*PRT + f5*OAT + f6*TPOPT + f7*LCT1;
   OAT = g0 + g1*IFT + g2*QDT + g3*QPT + g4*POPGT + g5*PIT + g6*PRT;
   POPGT = h0 + h1*XRT + h2*OAT + h3*FPCT + h4*QDT + h5*LPT + h6*POPGT1;
   QDT = ADT * QPDT;
   QPT = APT * QPPT;
   LPT*(1-LPRT) = LPRT * (LIT1 - LCT);
   PIT = OAT/{[POPGT*POPT1]/100}+POPT1;
Solve APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT/Out=Sim Stats Theil;
Run;
```

The SAS System   16:48 Thursday, July 26, 2001

MODEL Procedure
Simultaneous Simulation

Descriptive Statistics

	Actual		Predicted		
Variable	Mean	Std	Mean	Std	Label
APT	22.5311	4.8456	22.1999	4.5807	APT
QPPT	0.4816	0.1091	0.4915	0.0849	QPPT
ADT	175.4237	24.4281	175.9675	16.2969	ADT
QPDT	3.1711	0.4403	4.4722	0.3849	QPDT
LPRT	0.1405	0.0272	0.1389	0.0253	LPRT
LCT	0.0953	0.0293	0.0936	0.0272	LCT
OAT	205.6932	151.2191	209.0254	150.3197	OAT
POPGT	1.7384	1.0063	1.7474	1.9154	POPGT
QDT	563.3311	139.4755	617.0761	105.7568	QDT
QPT	10.9742	4.0678	11.0378	3.8064	QPT
LPT	0.1347	0.0341	0.1324	0.0371	LPT
PIT	193.6021	135.9104	195.7317	130.2103	PIT

```
Data Work.Timor; set work.Timor;
     ADT1 = Lag (ADT);
     QPDT1 = Lag (QPDT);
     APT1= Lag(APT);
     QPPT1= Lag(QPPT);
     LPRT1 = Lag (LPRT);
     LCT1 = Lag (LCT);
     PCTT = (0.1*PCTT)+PCTT;

   Run;

Proc Model data=work.timor;
     Endogenous APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT;
     Exogenous  RT RFT DRFT CRT POPT COT D1
                NPCFT PZNT APT1 POPGT1 TCRT TCMT PRT
                QPPT1 PRT PRMT ART ADT1 QPDT1 PCTMT
                PCTT LPRT1 TPIT LCT1 IFT FPCT XRT;
   Parms a0 19.499546 a1 0.006652  a2 -0.503486  a3 0.082301  a4 0.381356
         a5 -0.455561  a6 -0.485694  b0 0.761736  b1 0.003589  b2 -0.020979
         b3 0.001269  b4 -0.001003  b5 0.002740   c0 86.483054  c1 -0.200679
         c2 0.063593  c3 0.224515  c4 3.903696  c5 0.025512  c6 -16.883907
         c7 12.771379  c8 0.018397  d0 0.864953  d1 0.188447  d2 0.003852
         d3 -6.146380  d4 0.070097  e0 0.266347  e1 -0.0079  e2 -0.0001
         e3 -0.001228  e4 -0.000349  e5 1.004470  e6 -0.384409  f0 -0.157472
         f1 -0.000648 f2 0.000120  f3 0.1340293  f4 0.000032723
         f5 -0.000374  f6 0.237197  f7 0.107915 g0 -38.475162   g1 -0.101009
         g2 0.009998   g3 1.939238  g4 0.794453  g5 1.050880  g6 0.007482
         h0 22.886364  h1 -16.576799 h2 -0.008607 h3 0.037385  h4 0.004413
         h5 -49.246644  h6 -0.132896;
   APT = a0 + a1*CRT + a2*POPGT + a3*COT + a4*NPCFT + a5*RT + a6*APT1;
   QPPT = b0 + b1*NPCFT + b2*APT + b3*PZNT + b4*DRFT + b5*QPPT1;
   ADT = c0 + c1*PRMT + c2*CRT + c3*PZNT + c4*POPGT + c5*RFT + c6*TCRT
        + c7*D1 + c8*ADT1;
   QPDT = d0 + d1*ART + d2*ADT + d3*TCMT + d4*QPDT1;
   LPRT = e0 + e1*PCTMT + e2*PCTT + e3*DRFT + e4*RT + e5*LCT + e6*LPRT1;
   LCT = f0 + f1*PCTMT + f2*TPIT + f3*LPRT + f4*PRT + f5*OAT + f6*TPOPT + f7*LCT1;
   OAT = g0 + g1*IFT + g2*QDT + g3*QPT + g4*POPGT + g5*PIT + g6*PRT;
   POPGT = h0 + h1*XRT + h2*OAT + h3*FPCT + h4*QDT + h5*LPT + h6*POPGT1;
   QDT = ADT * QPDT;
   QPT = APT * QPPT;
   LPT*(1-LPRT) = LPRT * (LIT1 - LCT);
   PIT = OAT/{[POPGT*POPT1]/100}+POPT1;
Solve APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT/Out=Sim Stats Theil;
Run;
```

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MODEL Procedure
Simultaneous Simulation

Descriptive Statistics

	Actual		Predicted		
Variable	Mean	Std	Mean	Std	Label
APT	22.5311	4.8456	20.6610	4.5287	APT
QPPT	0.4816	0.1091	0.5489	0.0860	QPPT
ADT	175.4237	24.4281	175.8447	16.6519	ADT
QPDT	3.1711	0.4403	4.2689	0.3860	QPDT
LPRT	0.1405	0.0272	0.1623	0.0257	LPRT
LCT	0.0953	0.0293	0.1211	0.0271	LCT
OAT	205.6932	151.2191	207.9147	150.4150	OAT
POPGT	1.7384	1.0063	1.7394	1.8479	POPGT
QDT	563.3311	139.4755	758.9760	107.3296	QDT
QPT	10.9742	4.0678	11.5910	3.8044	QPT
LPT	0.1347	0.0341	0.1545	0.0359	LPT
PIT	193.6021	135.9104	195.5768	130.0341	PIT

```
Data Work.Timor; set work.Timor;
     ADT1 = Lag (ADT);
     QPDT1 = Lag (QPDT);
     APT1= Lag(APT);
     QPPT1= Lag(QPPT);
     LPRT1 = Lag (LPRT);
     LCT1 = Lag (LCT);
     PRT = (0.1*PRT)+PRT;

   Run;

Proc Model data=work.timor;
     Endogenous APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT;
     Exogenous  RT RFT DRFT CRT POPT COT D1
                NPCFT PZNT APT1 POPGT1 TCRT TCMT PRT
                QPPT1 PRT PRMT ART ADT1 QPDT1 PCTMT
                PCTT LPRT1 TPIT LCT1 IFT FPCT XRT;
   Parms a0 19.499546 a1 0.006652  a2 -0.503486  a3 0.082301  a4 0.381356
         a5 -0.455561  a6 -0.485694  b0 0.761736  b1 0.003589  b2 -0.020979
         b3 0.001269  b4 -0.001003  b5 0.002740   c0 86.483054  c1 -0.200679
         c2 0.063593  c3 0.224515  c4 3.903696  c5 0.025512  c6 -16.883907
         c7 12.771379  c8 0.018397  d0 0.864953  d1 0.188447  d2 0.003852
         d3 -6.146380  d4 0.070097  e0 0.266347  e1 -0.0079  e2 -0.0001
         e3 -0.001228  e4 -0.000349  e5 1.004470  e6 -0.384409  f0 -0.157472
         f1 -0.000648 f2 0.000120  f3 0.1340293  f4 0.000032723
         f5 -0.000374  f6 0.237197  f7 0.107915 g0 -38.475162   g1 -0.101009
         g2 0.009998   g3 1.939238  g4 0.794453  g5 1.050880  g6 0.007482
         h0 22.886364  h1 -16.576799 h2 -0.008607 h3 0.037385  h4 0.004413
         h5 -49.246644  h6 -0.132896;
   APT = a0 + a1*CRT + a2*POPGT + a3*COT + a4*NPCFT + a5*RT + a6*APT1;
   QPPT = b0 + b1*NPCFT + b2*APT + b3*PZNT + b4*DRFT + b5*QPPT1;
   ADT = c0 + c1*PRMT + c2*CRT + c3*PZNT + c4*POPGT + c5*RFT + c6*TCRT
         + c7*D1 + c8*ADT1;
   QPDT = d0 + d1*ART + d2*ADT + d3*TCMT + d4*QPDT1;
   LPRT = e0 + e1*PCTMT + e2*PCTT + e3*DRFT + e4*RT + e5*LCT + e6*LPRT1;
   LCT = f0 + f1*PCTMT + f2*TPIT + f3*LPRT + f4*PRT + f5*OAT + f6*TPOPT + f7*LCT1;
   OAT = g0 + g1*IFT + g2*QDT + g3*QPT + g4*POPGT + g5*PIT + g6*PRT;
   POPGT = h0 + h1*XRT + h2*OAT + h3*FPCT + h4*QDT + h5*LPT + h6*POPGT1;
   QDT = ADT * QPDT;
   QPT = APT * QPPT;
   LPT*(1-LPRT) = LPRT * (LIT1 - LCT);
   PIT = OAT/{[POPGT*POPT1]/100}+POPT1;
Solve APT QPPT ADT QPDT LPRT LCT OAT POPGT QDT QPT LPT PIT/Out=Sim Stats Theil;
Run;
```

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MODEL Procedure
Simultaneous Simulation

Descriptive Statistics

Variable	Actual Mean	Actual Std	Predicted Mean	Predicted Std	Label
APT	22.5311	4.8456	20.7511	4.6255	APT
QPPT	0.4816	0.1091	0.5470	0.0839	QPPT
ADT	175.4237	24.4281	175.1606	16.0018	ADT
QPDT	3.1711	0.4403	4.2664	0.3839	QPDT
LPRT	0.1405	0.0272	0.1649	0.0249	LPRT
LCT	0.0953	0.0293	0.1190	0.0284	LCT
OAT	205.6932	151.2191	208.1615	150.4711	OAT
POPGT	1.7384	1.0063	1.7408	1.9749	POPGT
QDT	563.3311	139.4755	755.3707	104.5061	QDT
QPT	10.9742	4.0678	11.6019	3.8073	QPT
LPT	0.1347	0.0341	0.1578	0.0383	LPT
PIT	193.6021	135.9104	195.3543	130.0103	PIT