Economic and Social Commission for Asia and the Pacific

CAPSA WORKING PAPER No. 81

The Status and Prospect of Feed Crops in Indonesia

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United Nations
ESCAP

UNESCAP-CAPSA

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Objectives

CAPSA promotes a more supportive policy environment in member countries to enhance the living conditions of rural poor populations in disadvantaged areas, particularly those who rely on secondary crop agriculture for their livelihood, and to promote research and development related to agriculture to alleviate poverty in the Asian and Pacific region.

Functions

1. Coordination of socio-economic and policy research on secondary crops.
2. Networking and partnership with other international organizations and key stakeholders.
3. Research and analysis of trends and opportunities with regard to improving the economic status of rural populations.
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“UNESCAP-CAPSA: Centre for Alleviation of Poverty through Secondary Crops’ Development in Asia and the Pacific”

WORKING PAPER 81

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UNESCAP-CAPSA
Centre for Alleviation of Poverty
through Secondary Crops' Development
in Asia and the Pacific

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Foreword

During the last few decades a rapid increase has occurred in the demand for meat, milk and eggs throughout the world. This increase is attributed not only to increases in population but to a large increase in per capita consumption connected to changes in lifestyles and to economic growth.

By 2002, in general, the increasing demand for livestock products will equal or exceed the demand for food from direct plant origin (cereals, vegetables and pulses). This process is known as "the Livestock Revolution".

Coarse grains, pulses, roots and tuber crops are very important components of farming systems in Asia and the Pacific. Feed is one of the important end products of CGPRT crops.

Responding to this need, UNESCAP-CAPSA implemented a research project "Prospects of Feed Crops in Southeast Asian Countries (FEEDSEA)" in collaboration with partners from four Southeast Asian countries namely: Indonesia, Malaysia, the Philippines and Thailand. It is a continuation of the research project "Prospects of Feed Crops in South Asia (FEED)" conducted from 2001 to 2003 with the participation of four countries in South Asia, namely: India, Nepal, Pakistan and Sri Lanka.

It is my pleasure that the third output of this project **The Status and Prospect of Feed Crops in Indonesia** is now available to the public. This volume covers topics such as investigating and identifying opportunities for improvements in rural income through new and different utilization of CGPRT crops in the feed industry in Indonesia.

I thank Dr. Dewa Ketut Sadra Swastika and his team for their earnest and fruitful work. Dr. Budiman Hutabarat, Senior Researcher, Indonesian Center for Agricultural Socio Economic Research and Development (ICASERD), and Dr. Erna Maria Lokollo provided useful comments and guidance at various stages of the study as the regional advisor and programme leader respectively. I also thank Mr. Matthew L. Burrows for his editing services throughout the publication of the report, and Ms. Agustina Mardyanti for typing and formatting the final document. I would like to express my highest appreciation to the Government of Japan for funding the project.

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J.W. Taco Bottema
Director
UNESCAP-CAPSA

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We believe that with the comments and inputs of all parties mentioned above, the quality of this report has improved and will be more useful for readers, policy makers and other users. We also expect this report to inspire other researchers to design a more comprehensive study for those subjects that have been excluded from this study.

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Executive Summary

Coarse grains, pulses, roots and tuber (CGPRT or secondary) crops are versatile crops and they can provide an extraordinary range of end uses; not only as food for direct human consumption, but also as materials for a diverse range of end products, including industrial uses. Feed is one of the alternative end products of secondary crops, which is the reason why UNESCAP-CAPSA implemented a study on the role of secondary crops as components of feed. The study analyzed the trends and projections of supply and demand for feed crops from 1988-2015 and evaluated the strengths, weaknesses, opportunities and threats in developing the feed crop sector in Indonesia. From these analyses, relevant policy recommendations promoting the sustainable development of feed crop farming were formulated

Results of the study revealed that demand for corn, rice and soybean is to increase in the coming decade. Growth in the demand for feed crops, as a derived demand, is hinged on the rise in meat, poultry, egg and their products' production. This trend can be attributed to the increasing consumption of meat, poultry, eggs and dairy products which was brought about by rapid urbanization, rising income and changes in consumer tastes and preferences.

Domestic production of maize contributes more than 90 per cent to domestic maize supply. Less than 10 per cent of maize supply comes from imports indicating that maize supply is highly dependent on domestic production. For more than three decades (1970-2001), maize production has shown significant growth (3.97 per cent per annum) despite the harvested area growing at only a very low rate. The high production growth of maize is attributed to the significant improvements in yield (3.57 per cent/year), indicating good technological progress, especially the increasing use of hybrids. The rapid growth in production, however, has failed to satisfy domestic demand, causing a rapid increase in net imports. Net maize imports increased from 18.9 thousand tons in 1980 to about 944.8 thousand tons in 2001; an average rate of 20.47 per cent per year. The import peak occurred in 2000, when net imports reached 1.24 million tons.

The discussion focuses on conventional manufactured feeds or concentrates that use secondary crops as raw materials. Among secondary crops maize is the most popular ingredient of manufactured feed in the world. In Indonesia, it makes up about 51 per cent of feed ingredients. No other crop in Indonesia can be used as an appropriate substitute for maize. Therefore, the production of manufactured feeds in Indonesia is highly dependant upon the supply of maize. Another feed ingredient is soybean meal, which is imported.

The general objective of the study was to take a closer look at the status and prospects of the domestic feed crop sector in Indonesia as they functionally relate with the expected growth of the local livestock industry. More specifically, the aims were to: 1. To analyze historical dynamics and future trends of supply and demand for feed and feed crops in Indonesia; 2. To evaluate potentials, weaknesses, opportunities and constraints for expanding feed crops in Indonesia; and 3. To formulate policy options to promote the sustainable development of feed crop farming in Indonesia.

In determining the prospects of the feed crop sector in Indonesia, knowing the impacts of non-market and market forces on the production and consumption of feed crops is vital. This is to establish the inter-related effects and the relationships between factors such as technological change, population and income, among others, on the supply and demand of feed crops. In addition, it was crucial to assess and evaluate whether the programmes of the feed crop sector are feasible from a managerial point of view. Hence, an analytical framework was developed based on the standard economic theory of supply and demand complemented by the management planning tool known as SWOT.

This comprehensive study on feed crops and the feed industry in Indonesia that also linked domestic and international market models provided some important highlights and conclusions. From these conclusions are derived some policy options and implications. Strategies, policy options and programmes have been developed as inputs for feed crop development in the future. In addition to the generic conclusions made, more detailed conclusions are broken down into 5 categories:

Domestic production: Area and yield are two variables that determine domestic maize production. The parameter estimates of the area response model showed that the area planted with maize was significantly determined by a lag of its own price, soybean price, peanut price and a dummy variable for the economic crisis. This indicates that an increase in the maize price of a given year would result in an increase in maize area the following year. In other words, maize farmers are not able to respond to increases in maize prices within the same year.

Domestic demand: The parameter estimates showed that the domestic demand for maize from the feed industry is negatively responsive to the price of soybean in the long run. This indicates that both commodities are complementary. Maize demand is also responsive to its own domestic price and significantly determined by its demand in the previous year. The economic crisis hampered the demand for maize from the feed industry. This was due to the closure of some small-scale poultry farms.

Domestic and international trade: The performance of the domestic feed industry is strongly influenced by various government policies, namely credit schemes, bank interest rates, input prices, and limited tariffs imposed by GOI, especially on imported maize. On the other hand, changes in the international market policy imposed by big maize producing countries like the USA, Argentina, Brazil etc., and WTO regulation have reduced agricultural subsidies as well as trade protection. This will encourage the domestic feed market as well as maize production to progressively integrate with the world market meaning that any international market change in maize or other feed ingredients will immediately affect the domestic market.

Projections to 2015: There needs to be some breakthroughs to improve the technology associated with maize farming, or the area planted with maize needs to be expanded in order to ameliorate maize production.

Policy implications: If GOI relaxes its policy intervention and protection for rice and sugarcane, maize production is predicted to grow faster than at present. The policy implications of this trend should be coupled with further inducement in R&D and enhanced maize production technology, especially the use of hybrid seeds and integrated crop management (ICM). Therefore, the GOI budget for R&D should be immediately tripled for maize research.

1. Introduction

1.1 Background

Coarse grains, pulses, roots and tuber (CGPRT or secondary) crops are versatile crops and they can provide an extraordinary range of end uses; not only as food for direct human consumption, but also as materials for a diverse range of end products, including industrial uses. Feed is one of the alternative end products of secondary crops, which is the reason why UNESCAP-CAPSA implemented a study on the role of secondary crops as components of feed.

In developing countries there has been a dramatic rise in the consumption of animal origin food products. This is the result of demand changes caused by changes in the diets of billions of people, through population growth, urbanization and income growth in these countries (Hutabarat, 2003). As the demand for animal products increases, feed grain utilization also increases because feed grains are raw materials for animal feed. Animal feed compositions are dominated by coarse grains, pulses, and root and tuber crops or the products of these crops. Therefore, there is an expansion of market opportunities for CGPRT, or secondary crops.

In terms of direct consumption, secondary crops are generally either income inelastic or have negative income elasticity. This implies that direct demand for secondary products declines as per capita income increases. This is why CGPRT products' prices and market opportunities generally decline over time in line with increases in per capita income. The rapidly emerging demand for animal origin food is translating into a rapid rise in demand for feed crops, creating a strong demand pull for the rapid expansion of secondary crop production in developing countries, particularly in Asia. This is beneficial to reverse the trend of secondary crop prices. On the other hand, more opportunities to expand feed crop farming may create a new dilemma for some developing countries with limited resources, particularly land and water. Expanding feed crops may reduce the production of staple food crops. Some governments may consider this as a threat to national food security (Hutabarat, 2003). Therefore, it is important to elucidate the real opportunities, constraints and policy options for developing feed crop farming in developing countries.

Among the secondary crops, maize is the most popular ingredient of manufactured feeds in the world, especially in the tropical region. In Indonesia, maize is a major component of feed, accounting for about 51 per cent of feed ingredients because it has a high energy content and its nutritional content is appropriate for animal feed, especially for poultry and swine. Efforts to substitute other secondary crops for maize in Indonesia are likely to be unsuccessful. Fresh soybean is expensive and requires processing before it can be used for feed, except soybean meal, which is imported. Cassava, although abundant, is bulky and also needs intermediate processing. Dried cassava (*gaplek*) has a low protein content, and therefore needs additional sources of protein to be added in order to be adequate for feed. Wheat and barley are mostly used in temperate regions (Europe and Australia). These two crops are not used for animal feed by developing countries in the tropical region, including Indonesia, due to their scarcity. Sorghum is the only crop that can partially substitute maize, but its availability in Indonesia is very limited. Another problem of using sorghum is its content, which has a negative effect on poultry's growth (Tangenjaya *et al*., 2003). Table 1.1 shows the dominant uses of maize (among secondary crops) in feed ingredients for chicken and swine. The second most used is soybean meal. No fresh soybean or cassava are used as feed ingredients. Therefore, this study will be focused primarily on maize. Other secondary crops will be referred to where appropriate.

Table 1.1 The use of maize in feed ingredients in Indonesia, January 2001 (in per cent)

Feed ingredients	Broiler	Layer	Swine
1. Maize	54.00	47.14	49.34
2. Rice bran	10.00	25.00	30.00
3. Soybean meal	20.71	13.51	17.91
4. Lime stone powder	0.33	7.07	1.18
5. Meat powder	5.00	3.37	-
6. Feather powder	2.00	2.00	-
7. Bone powder	-	1.06	-
8. Palm oil	3.00	0.34	-
9. Salt	0.24	0.28	0.42
10. Methionin	0.24	0.11	-
11. Lysine	0.24	0.03	-
12. Rapeseed meal	3.00	-	-
13. DiCal. Phosphate	0.94	-	1.06

Source: Tangendjaja *et al*., 2003.

In Indonesia, maize is not only an important feed crop, it is also the second most important food crop after rice. Its importance in terms of a food crop is indicated by the percentage of area planted to maize (about 19 per cent) relative to the total area planted to food crops. Rice occupies about 61 per cent of the area planted to food crops (Kasryno, 2002 and Djulin *et al*., 2003).

In terms of utilization, most of the maize in Indonesia is used for food. The Food Balance Sheets show that in 1998 about 69 per cent of the maize was used for food, consisting of direct consumption and to be used in the food industry. In some provinces, such as East Java, East Nusa Tenggara, North Sulawesi, Southeast Sulawesi, and Irian Jaya, maize is consumed as a staple food as well as rice (Bastara, 1988; Malian and Djauhari, 1988; Subandi and Manwan, 1990). This condition has caused the maize production system to remain less intensive, using local and composite varieties, although in some provinces such as North Sumatera, Lampung, Central Java, East Java and South Sulawesi, hybrid maize is commonly grown. CIMMYT estimated that in 1997 the areas planted to hybrids, composites and local maize varieties were about 23 per cent, 71 per cent and 6 per cent respectively of the total area planted to maize in Indonesia (Maamun *et al*., 2001). Limited use of hybrid maize seeds in farming produces low average yields. This significantly affects national maize production. Consequently, Indonesia is unable to meet the growing domestic demand for maize in line with the rapid growth of the poultry industry. To meet domestic demand Indonesia has continuously imported maize at an average of about 1 million tons annually. There needs to be a breakthrough to obtain self-sufficiency in maize for both food and feed. This study aims to investigate the status and future prospects of maize development as a main feed crop in Indonesia.

1.2 Subjects of study

The subjects of this study are:

- Feed crop production and supply and their determinants;
- Feed crop consumption and demand and their determinants;
- Feed crop imports and exports and their determinants; and
- The potentials and constraints of feed crop development with emphasis on secondary crops, especially maize.

1.3 Objectives

The objectives of this study are:

- To analyze historical dynamics and future trends of supply and demand for feed and feed crops in Indonesia;
- To evaluate potentials, weaknesses, opportunities and constraints for expanding feed crops in Indonesia; and
- To formulate policy options to promote the sustainable development of feed crop farming in Indonesia.

1.4 Expected outputs

- Better understanding of the dynamics and future trends of the supply of and demand for feed and feed crops in Indonesia;
- Clearer understanding of the potentials, weaknesses, opportunities and constraints for expanding feed crops in Indonesia;
- Strategies and policy recommendations to promote feed crop farming in Indonesia; and
- Reference for setting up a regional cooperation scheme for trade and development of feed crops among Asian countries.

2. Research Methodology

2.1 Conceptual framework

As per capita income increases, the demand for animal origin food increases, while the demand for grains for food decreases. An increase in demand for animal products provides a market for the livestock industry, as well as for the feed industry. Based on information from Japfa Comfeed (the biggest feed company in East Java), about 94 per cent of manufactured feed is used for poultry. Swine uses about 5 per cent, and dairy cows 0.5 to 1 per cent (Swastika *et al*., 2000). In other words, manufactured feed is primarily used for poultry (broiler and layer).

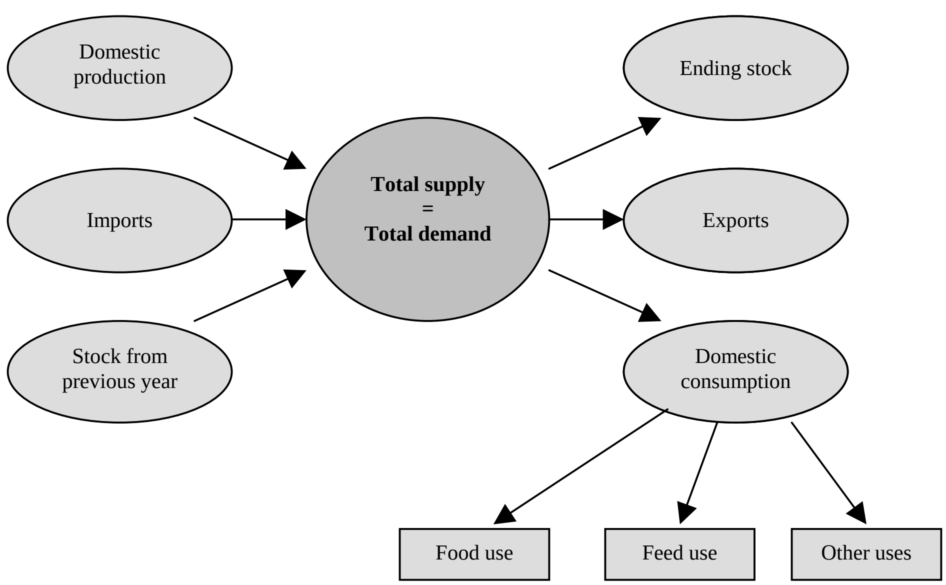
Rapid growth of the poultry industry in Indonesia (before the economic crisis) resulted in substantial growth in demand for feed. As a major component of feed (accounting for about 51 per cent), the demand for maize for feed was estimated to grow at a rate of 8-12 per cent/annum (Subandi, 1998 and Kasryno, 2003).

Domestic maize production cannot satisfy demand. To meet the increasing domestic demand Indonesia still imports about 1 million tons of maize annually. In other words, Indonesia is a net importer of maize.

2.2 Analytical framework

The analytical framework has been developed based on the basic economic theory of supply and demand. Given the theoretical relationship that supply and demand should be equal at equilibrium. The total supply of feed crops is basically the sum of domestic production, imports, and stock from the previous year. Total supply, which is equal to total demand, is used for consumption, some exports, and some to be stocked at the end of the year. Total domestic consumption is made up of food, feed and other uses, as depicted in Figure 2.1.

Figure 2.1 Supply of and demand for maize as a feed crop



2.3 Model formulation

Model formulation begins with the identification of the actual problem using an econometric approach. Using this approach the model is identified. Once the model has been identified, it is used to estimate the parameters that indicate the characteristics and relationships among economic variables. In this study, the supply-demand system of maize as a main feed crop can be formulated as follows:

2.3.1 Harvested area

The harvested area of maize in Indonesia is a function of the real price of maize, real prices of competitive crops (soybean and peanut), and the harvested area of the previous year. In mathematical form the equation can be expressed as:

$$A_t = a_0 + a_1 PM_{t-1} + a_2 PS_t + a_3 PP_t + a_4 D_t + u_1 \qquad (1)$$

The expected signs of the parameters are:

$a_1 > 0$; and $a_2, a_3 < 0$

Where:

A_t = harvested area of maize in year t ('000 ha)

PM_t = real price of maize in year t (Rp/kg)

PM_{t-1} = lagged variable of real price of maize (Rp/kg)

PS_t = real price of soybean in year t (Rp/kg)

PP_t = real price of peanut in year t (Rp/kg)

D_t = dummy variable, ($D_t = 1$ during & after crisis; $D_t = 0$ before crisis)

u_1 = error term

2.3.2 Yield response

Maize yield is a function of the real price of maize, the real price of fertilizer, real wage, technology, and maize yield of the previous year.

$$Y_t = b_0 + b_1 PM_{t-1} + b_2 PFer_{t-1} + b_3 W_t + b_4 T_1 + b_5 Y_{t-1} + b_6 D_t + u_2 \qquad (2)$$

The expected signs of the parameters are:

$b_1, b_4 > 0$; $b_2, b_3 < 0$; and $0 < b_5 < 1$

Where:

Y_1 = maize yield in year t (tons/ha)

$PFer_t$ = real price of fertilizer in year t (Rp/kg)

$PFer_{t-1}$ = lagged variable of real price of fertilizer (Rp/kg)

T_t = technology (represented by time trend)

W_t = real wage of labour in agricultural activities in year t (Rp/man-day)

Y_{t-1} = lagged maize yield

u_2 = error term

2.3.3 Maize production

Maize production is a product of maize area and its yield. Therefore, maize production is an identity equation.

$$Q_t = A_t * Y_t \qquad (3)$$

2.3.4 Maize imports

Indonesia is a net importer of maize. Therefore, imports are one component of maize supply (Labys, 1973). Maize imports to Indonesia are determined by the real import price of maize, its real domestic price, the exchange rate, GDP, and maize imports of the previous year. In mathematical form, the equation for maize imports can be expressed as follows:

$$M_t = c_0 + c_1 IP_t + c_2 PM_t + c_3 ER_t + c_4 GDP_t + c_5 M_{t-1} + c_6 D_t + u_4 \qquad (4)$$

Expected signs of the parameters are:

$c_1, c_3 < 0; c_2, c_4 > 0; 0 < c_5 < 1$

Where:

M_t = quantity of maize imports to Indonesia in year t ('000 tons)

IP_t = real price of imported maize (CIF) in year t (US$/kg)

PM_t = domestic price of maize in year t (Rp/kg)

ER_t = exchange rate of rupiah to US dollar in year t (Rp/US$)

GDP_t = Gross Domestic Product in year t (Rp billion)

M_{t-1} = lagged variable of maize imports

u_4 = error term

2.3.5 Supply of maize in Indonesia

The supply of maize in Indonesia is an identity equation, where the supply of maize is the summation of domestic production and net imports. Changes in stock are negligible. Therefore, the supply equation is:

$$Qs_t = Q_t + M_t - Ex_t \qquad (5)$$

Where:

Qs_t = quantity of maize supply in Indonesia in year t ('000 tons)

Ex_t = exports of maize from Indonesia, if any, in year t ('000 tons)

2.3.6 Maize demand for the feed industry

Maize demand for the feed industry is determined by the domestic real price of maize, the real price of feed, real price of soybean (to represent soybean meal), and maize demand for feed in the previous year. Therefore, the equation for maize demand for feed is:

$$DF_t = d_0 + d_1 PM_t + d_2 PF_t + d_3 PS_t + d_4 DF_{t-1} + d_5 D_t + u_6 \qquad (6)$$

The expected signs of the parameters are:

$d_1 < 0;\ d_2, d_3, > 0; 0 < d_4 < 1$

Where:

DF_t = demand for maize for the feed industry ('000 tons)

PF_t = real price of feed in year t (Rp/kg)

DF_{t-1} = lagged variable of maize demand for the feed industry

u_6 = error term

2.3.7 Demand for maize for direct food consumption

The demand for maize for direct human consumption is determined by the real price of maize, the real price of milled rice, per capita income, and changes in taste and preference. Therefore, the demand equation is:

$$DH_t = da_0 + da_1 PM_t + da_2 PBR_t + da_3 Inc_t + da_4 Taste_t + da_5 DH_{t-1} + da_6 D_t + u_7 \quad (7)$$

The expected signs of the parameters are:
$da_1, da_3, da_4 < 0; da_2, > 0; 0 < da_5 < 1$

Where:

DH_t = demand for maize for human food in year t ('000 tons)

PBR_t = real price of milled rice in year t (Rp/kg)

Inc_t = per capita income in year t (Rp/capita/year)

$Taste_t$ = changes in taste and preference over time (represented by time trend)

DH_{t-1} = lagged variable of DH_t

u_7 = error term

2.3.8 Demand for maize for the food industry

The demand for maize for the food industry includes: snacks, cooking oil, coffee mixes, etc. Therefore, the demand for maize for the food industry can be expressed as follows:

$$\begin{aligned} DFI_t = {} & db_0 + db_1 PMF_t + db_2 PMF_t + db_3 PWF_t + db_4 PSG_t + db_5 PCO_t + db_6 Inc_t + db_7 WI_t \\ & + db_8 Taste_1 + db_9 DFI_{t-1} + db_{10} D_t + u_8 \end{aligned} \quad (8)$$

The expected signs of the parameters are:
$db_2, db_4, db_7 < 0;\ db_1, db_3, db_5, db_6, db_8 > 0; 0 < db_9 < 1$

Where:

DFI_t = demand for maize for the food industry in year t ('000 tons)

PMF_t = real price of manufactured food in year t (Rp/kg)

PWF_t = real price of wheat flour in year t (Rp/kg)

PSG_t = real price of sugar in year t (Rp/kg)

PCO_t = real price of cooking oil in year t (Rp/kg)

DFI_{t-1} = lagged variable of DFI_t

u_8 = error term

2.3.9 Demand for maize for other uses

Demand for maize for other uses in Indonesia is the difference (residual) between total supply and total demand for feed, food and the food industry. By assuming that total supply equals total demand, the equation of the demand for maize for other uses is:

$$Dou_t = QS_t - DF_t - DH_t - DFI_t \quad (9)$$

Where:

Dou_t = demand for maize for other uses ('000 tons)

Total domestic demand for maize is: $Qd_t = DF_t + DH_t + DFI_t + Dou_t$

Where:

Qd_t = total domestic demand for maize

2.3.10 Maize trade

(a) World price of maize

Theoretically, the behaviour of the world price is determined by the supply of (exports) and demand for (imports) maize in the world market. Therefore, the world price equation is:

$$PW_t = f_1(XW_t, MW_t, PW_{t-1}) \quad (10)$$

Where:

PW_t = real world price of maize, CIF (US$/kg)

XW_t = maize exports in the world ('000 tons)

MW_t = maize imports in the world ('000 tons)

PW_{t-1} = lagged variable of PW_t

(b) World exports and imports

In terms of international trade, the biggest maize exporter is the USA, while the biggest importer is Japan. Indonesia is a net importer. Therefore, the trade equation is as follows:

$$XW_t = XUS_t + XRW_t \quad (11)$$

$$MW_t = MJ_t + M_t + MRW_t \quad (12)$$

Where:

XW_t = world exports of maize in year t ('000 tons)

XUS_t = maize exports from the USA in year t ('000 tons)

XRW_t = maize exports from the rest of the world ('000 tons)

MW_t = world imports of maize in year t ('000 tons)

MJ_t = maize imports to Japan ('000 tons)

MRW_t = maize imports to the rest of the world ('000 tons)

(c) Price of imported maize

The price of imported maize in Indonesia is determined by the world price and the exchange rate of the rupiah to the US dollar. Therefore, the price of imported maize is a function of these two variables.

$$IP_t = f_2\left(PW_t, ER_t, IP_{t-1}\right) \quad (13)$$

Where:

IP_t = price of imported maize in year t (US$/kg)

ER_t = exchange rate in year t (Rp/US$)

IP_{t-1} = lagged variable of IP_t

(d) Domestic price of maize

Domestic price is determined by total supply of and demand for maize (Henderson and Quandt, 1980), and its import price. Therefore, the domestic price of maize is defined as a function of total supply and demand, import price of maize, and price of maize in the previous year.

$$PM_t = f_3\left(Qs_t, Qd_t, IP_t, PM_{t-1}, D_t\right) \quad (14)$$

Where:

PM_{t-1} = lagged variable of PM_t

2.3.11 Imports of feed components

$$IFC_t = s_0 + s_1 PIFC_t + s_2 PF_1 + s_3 ER_t + s_4 FPR_t + s_5 IFC_{t-1} + u_{15} \quad (15)$$

The expected signs of the parameters are:

$s_1, s_3 < 0; s_2, s_4 > 0; 0 < s_5 < 1$

Where:

IFC_t = volume of imports of feed components in year t ('000 tons)

IFC_{t-1} = volume of imports of feed components in year t-1 ('000 tons)

$PIFC_t$ = price of imported feed components (US$/kg)

ER_t = exchange rate in year t (Rp/US$)

FPR_t = feed production ('000 tons)

u_{15} = error term

2.3.12 Feed production in Indonesia

Domestic feed production is determined by the price of feed, the domestic price of maize, the domestic price of imported feed components, the interest rate, and feed production in the previous year. The equation can be expressed as:

$$FPR_t = k_0 + k_1PF_t + k_2PM_t + k_3DF_1 + k_4DPIFC_t + k_5IR_t + k_6FPR_{t-1} + k_7D_t + u_{16} \quad (16)$$

Expected signs of the parameters are:
$k_1, k_3 > 0; k_2, k_4, k_5 < 0; 0 < k_6 < 1$

Where:

FPR_t = feed production in year t ('000 tons)

PF_t = price of feed in year t (Rp/kg)

$DPIFC_t$ = domestic price of imported feed components in year t (Rp/kg)

IR_t = interest rate in year t (per cent)

FPR_{t-1} = lagged variable of FPR_t ('000 tons)

u_{16} = error term

Since there are no feed imports or exports, domestic supply of feed is solely from domestic feed production.

2.3.13 Demand for feed

The demand for feed is determined by the price of feed, the price of livestock products (eggs or chicken meat), the chicken population, and the demand for feed in the previous year. The equation is:

$$FDm_t = m_0 + m_1PF_t + m_2PMeat_t + m_3PopC_t + m_4FDm_{t-1} + m_5D_t + u_{17} \quad (17)$$

The expected signs of the parameters are:
$m_1 < 0; m_2, m_3 > 0; 0 < m_4 < 1$

Where:

FDm_t = demand for feed in year t ('000 tons)

$PopC_t$ = chicken population in year t (no. of birds)

FDm_{t-1} = lagged variable of FDm_t ('000 tons)

u_{17} = error term

2.3.14 Projection model

Projections made in this study use the elasticities obtained from the above estimated parameters.

(i) Projections of maize production

The projections of maize production are obtained from the projections of harvested area and yield. Therefore, the equations are:

$$A_t = A_{t-1}\left(1 + \varepsilon_j\rho_j + \Sigma\varepsilon_{ji}\rho_j\right) \quad (18)$$

$$Y_t = Y_{t-1}\left(1 + \varphi_j\rho_j + \Sigma\kappa_k\rho_k\right) \quad (19)$$

$$Q_t = A_t * Y_t \tag{20}$$

Where:

A_t = harvested area of maize in year t ('000 ha)

A_{t-1} = harvested area of maize in year t-1 ('000 ha)

ε_j = elasticity of harvested area of maize with respect to its own price

ρ_j = growth rate of the real price of maize (per cent)

ε_{ji} = cross price elasticity of maize harvested area w.r.t. real price of commodity j

ρ_j = growth rate of real price of commodity j (per cent)

Y_t = maize yield in year t (tons/ha)

Y_{t-1} = maize yield in year t-1 (tons/ha)

φ_j = elasticity of maize yield with respect to its own price

κ_k = elasticity of maize yield with respect to the real price of input k

ρ_k = growth rate of the real price of input k (per cent)

Q_t = total maize production in year t ('000 tons)

(ii) Projections of feed production

The projections of feed production can be written:

$$FPR_t = FPR_{t-1}\left(1 + \eta_i\theta_1 + \Sigma\psi_j\gamma_j\right) \tag{21}$$

Where:

FPR_t = quantity of feed production in year t ('000 tons)

FPR_{t-1} = quantity of feed production in year t-1 ('000 tons)

η_i = elasticity of feed production w.r.t. its own price

θ_1 = growth rate of the real price of feed (per cent)

ψ_j = elasticity of feed production w.r.t. the real price of input j

γ_j = growth rate of the real price of input j (per cent)

(iii) Projections of maize demand

The projections of demand for maize can be calculated using the demand for maize for feed, for food, for the food industry, and other uses. The model is as follows:

$$DF_t = DF_{t-1}\left(1 + \alpha_p\rho_p + \Sigma\alpha_{p1}\rho_1\right) \tag{22}$$

$$DH_t = DH_{t-1}\left(1 + \delta_M\rho_j + \chi_I I_I\right) \tag{23}$$

$$DFI_t = DFI_{t-1}\left(1 + \vartheta_{IP}\rho_j + \Sigma\varpi_{jm}\rho_m\right) \quad (24)$$

$$Qd_t = DF_t + DH_t + DFI_t + Dou_t \quad (25)$$

Where

DF_t	= demand for maize as feed in year t ('000 tons)
DF_{t-1}	= demand for maize as feed in year t-1 ('000 tons)
α_p	= elasticity of demand for maize as feed w.r.t. the real price of feed
ρ_p	= growth rate of the real price of feed (per cent)
α_{p1}	= cross elasticity of maize demand for feed w.r.t real price of commodity l
ρ_1	= growth rate of the real price of commodity l (per cent)
DH_t	= demand for maize as human food in year t ('000 tons)
DH_{t-1}	= demand for maize as human food in year t-1 ('000 tons)
δ_M	= elasticity of demand for maize as human food w.r.t its own price
χ_I	= elasticity of demand for maize as human food w.r.t per capita income
I_I	= growth rate of per capita income (per cent)
DFI_t	= demand for maize for the food industry in year t ('000 tons)
DFI_{t-1}	= demand for maize for the food industry in year t-1 ('000 tons)
ϑ_{IP}	= elasticity of demand for maize for the food industry w.r.t the real price of maize
I_{Ijm}	= elasticity of demand for maize for the food industry w.r.t the real price of commodity m
ρ_m	= growth rate of the real price of commodity m (per cent)
Dou_t	= demand for maize for other uses in year t ('000 tons)
Qd_t	= total demand for maize in Indonesia in year t ('000 tons)

3. General and Socio-Economic Features

Before the economic crisis that began mid 1997, Indonesia benefited from average annual economic growth rates of between 5 and 7 per cent. The Indonesian economic crisis triggered by the monetary crisis in Asia lowered economic growth rates, inflated foreign debt and escalated inflation rates. Overtime, however, the country's economy recovered, albeit slowly.

3.1 General economy

During the early development stage of the country, the agricultural sector held a substantial role as shown by its highest absorption of labour employment compared to other sectors (Table 3.1). For example, in 1981 agriculture employed 31.6 million workers or 54.7 per cent of the labour force and second was the financial sector (14.8 per cent). Conversely, the industrial sector absorbed only 0.4 million workers or 0.7 per cent in the same year. During the period of 1981-1990 the growth rate of labour employment in the agricultural sector (2.69 per cent) was the lowest among the other sectors. Trade had the highest growth rate of 9.34 per cent followed by that of industry at 3.75 per cent. Despite absolute labour employment within the agricultural sector still being the largest, the declining growth rate indicates that the role of this sector had declined over time, while those of the others became more significant. During the next period (1991-1997) the agricultural sector experienced a negative growth rate, while the other sectors kept their positive growth with transportation as the leading sector (9.50 per cent) and with services second (8.81 per cent). During the period of 1997-2001, the construction, finance, mining and utilities sectors experienced negative growth rates of labour absorption.

The economic crisis that started in 1997 greatly affected both poor and rich people alike. Poor people suffered through reduced demand for labour and fewer transfers from wealthier families. Furthermore, the impacts worsened along with the rising prices of goods, especially those imported. Impacts of the crisis were more serious in urban than in rural areas, and the impacts in rural areas were secondary effects. In the same year, there was a severe drought season *(El Niño)* that hampered rural regions more intensely than urban areas. The impacts also varied across the country. Urban and rural areas on Java were more severely affected than outside Java. This shows stronger integration between rural and urban areas in Java. Generally, small pockets of rural areas outside Java were affected due to the increasing prices of agricultural products during the crisis. In general, the crisis also heightened poverty, but there was no correlation to the initial poverty level. Most urban areas were greatly affected by the crisis with rural areas in the same province also being severely hampered (Warr, 1999).

Table 3.1 Labour employment by economic sector, 1981-2001 (persons)

Sector	Year				Growth (%/yr)		
	1981	1991	1997	2001	1981-1991	1991-1997	1997-2001
1. Agriculture	31,593,314	41,205,791	35,848,631	39,743,908	2.69	-2.29	2.61
(%)	54.66	53.92	41.18	43.77			
2. Industry	390,661	564,599	896,611	12,086,122	3.75	8.01	91.61
(%)	0.68	0.74	1.03	13.31			
3. Construction	6,021,929	7,946,350	11,214,822	3,837,554	2.81	5.91	-23.52
(%)	10.42	10.40	12.88	4.23			
4. Trade	61,666	150,660	233,237	17,469,129	9.34	7.56	194.18
(%)	0.11	0.20	0.27	19.24			
5. Transportation	2,146,210	2,436,594	4,200,200	4,448,279	1.28	9.50	1.44
(%)	3.71	3.19	4.83	4.90			
6. Finance	8,553,919	11,430,655	17,221,184	1,127,823	2.94	7.07	-49.41
(%)	14.80	14.96	19.78	1.24			
7. Service	1,796,112	2,493,424	4,137,653	11,003,482	3.33	8.81	27.70
(%)	3.11	3.26	4.75	12.12			
8. Others	7,238,990	10,195,106	13,297,418	1,091,120	3.48	4.53	-46.48
(%)	12.52	13.34	15.28	1.20			
Total	57,802,888	76,423,266	87,049,841	90,807,516	2.83	2.19	1.06
(%)	100.00	100.00	100.00	100.00			

Source: CAS (1971-2001).

Impressive economic growth during the pre-crisis period was previously attributed to applying liberal economies through open foreign capital investment, industrialization and free trade. However, not all of the arguments were true. There was still strong cronyism, a bureaucratic and centralized government, and the economy was not as open as was publicized. Previously, the government emphasized agricultural development and human resource development. Nevertheless, development programmes and their results were not well distributed. In order to improve the worsening economic performance post-crisis, there needed to be balance between rural and urban areas, agricultural and industrial sectors, more concern for small farmers, optimizing domestic resource use rather than relying on imported goods, and employing labour optimally rather than intensive capital use (Uphoff, 1999).

3.2 Role of the agricultural sector

The agricultural sector still plays an important role in the economy of the country, indicated by its contribution to GDP. In nominal terms, the contribution of the agricultural sector to GDP increased from Rp 30,534 billion in 1971 to Rp 68,018 billion in 2002; more than double. However, during the same period GDP rose from Rp 79,363 billion to Rp 426,714 billion; more than five-fold (Table 3.2). It shows that the growth of the agricultural sector was on average less than that of the other sectors. The share of the agricultural sector in 1971 was the largest, namely 38.5 per cent, but it kept declining to just 15 per cent in 1997. During the next period, i.e. 1997-2000, the role of the agricultural sector grew but also declined. Contrary to agriculture, the industrial sector began with only a small share in 1971 (7.0 per cent) but the next two decades saw its share (19.9 per cent) surpass that of the agricultural sector. Since then, the industrial sector has always been the leading sector. That was until 2002, as shown in Table 3.3. This reveals that economic development in the country has been more industrialized.

Table 3.2 Gross Domestic Product based on 1993 constant price, 1971-2002 (Rp billions)

Sector	1971	1981	1991	1996	1997	1999	2000	2002
1. Agriculture	30,534	41,067	54,839	63,779	64,149	64,985	66,209	68,018
Food crops	*14,715*	*22,952*	*30,145*	*33,647*	*33,048*	*34,012*	*34,534*	*34,442*
Estate crops	*3,381*	*4,869*	*8,131*	*10,331*	*10,772*	*10,702*	*10,722*	*11,328*
Livestock	*2,566*	*3,524*	*5,442*	*7,132*	*7,422*	*6,837*	*7,061*	*7,537*
Forestry	*7,939*	*6,911*	*6,307*	*6,384*	*6,346*	*6,288*	*6,389*	*6,651*
Fisheries	*1,934*	*2,811*	*4,815*	*6,284*	*6,561*	*7,146*	*7,503*	*8,060*
2. Industry	5,524	20,371	56,508	96,378	103,025	90,298	93,868	100,834
3. Mining	11,448	22,847	29,885	37,569	38,182	36,866	38,896	39,768
4. Construction	6,375	31,309	22,936	38,806	40,644	30,796	34,398	38,093
5. Utilities	369	1,345	2,713	4,841	5,414	6,113	6,548	7,515
6. Trade, hotel and restaurant	11,095	36,817	47,390	69,372	73,161	60,094	63,498	69,303
7. Transport	2,689	8,354	16,632	24,445	26,040	26,772	29,072	33,649
8. Finance	1,852	5,453	11,565	19,903	20,597	26,245	27,449	29,936
9. Services	9,476	22,780	42,262	54,107	56,311	37,184	38,052	39,597
Total	79,363	190,344	284,731	409,199	427,521	379,352	397,990	426,714

Source: CAS (1973-2002), data computed.

Within the agricultural sector, the share of food crops has dominated since 1971 at 18.5 per cent to 2002 at 15.9 per cent as shown in Table 3.3. The share of the forestry sub-sector was the second largest in 1971 (10 per cent), but it dropped sharply during the following decade and subsequent periods. The livestock sub-sector's share was just 3.2 per cent in 1971, decreasing to 1.9 per cent over the next decade and then varying from then on. In 2000, the share of the fisheries sub-sector exceeded that of livestock and since then the livestock sub-sector has become least significant.

For the decade 1971-1981, the overall growth of GDP was 9.14 per cent per annum. The growth was mainly due to the construction, industrial, utilities, transport, and services sub-sectors with 17.25, 13.94, 13.79, 12.00, and 9.17 per cent growth respectively. On the other hand, growth of the agricultural sector for the same period was only 3.01 per cent. The shares of food crops, estate crops, livestock, and fisheries were greater than that of the agricultural sector but the forestry sub-sector grew at a negative rate (Table 3.4).

Table 3.3 Share of Gross Domestic Product based on 1993 constant price, 1971-2002 (per cent)

Sector	1971	1981	1991	1996	1997	2000	2002
1. Agriculture	38.47	21.58	19.26	15.59	15.00	16.64	15.94
Food crops	*18.54*	*12.06*	*10.59*	*8.22*	*7.73*	*8.68*	*8.07*
Estate crops	*4.26*	*2.56*	*2.86*	*2.52*	*2.52*	*2.69*	*2.65*
Livestock	*3.23*	*1.85*	*1.91*	*1.74*	*1.74*	*1.77*	*1.77*
Forestry	*10.00*	*3.63*	*2.22*	*1.56*	*1.48*	*1.61*	*1.56*
Fisheries	*2.44*	*1.48*	*1.69*	*1.54*	*1.53*	*1.89*	*1.89*
2. Industry	6.96	10.70	19.85	23.55	24.10	23.59	23.63
3. Mining	14.42	12.00	10.50	9.18	8.93	9.77	9.32
4. Construction	8.03	16.45	8.06	9.48	9.51	8.64	8.93
5. Utilities	0.47	0.71	0.95	1.18	1.27	1.65	1.76
6. Trade, hotel and restaurant	13.98	19.34	16.64	16.95	17.11	15.95	16.24
7. Transport	3.39	4.39	5.84	5.97	6.09	7.30	7.89
8. Finance	2.33	2.86	4.06	4.86	4.82	6.90	7.02
9. Services	11.94	11.97	14.84	13.22	13.17	9.56	9.28
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: CAS (1973-2002), data computed.

During the period of 1991-1997, or before the economic crisis crippled Southeast Asian countries including Indonesia, GDP grew much higher than previously, i.e., 7.01 per cent per year. The growth was mainly driven by non-agricultural sectors, except mining. However, during this period the agricultural sector grew at a relatively low rate of just 2.65 per cent per year, while that of the livestock sub-sector reached higher growth than the previous period, i.e., 4.44 per cent per year (Table 3.4).

GDP growth during the economic crisis lasting from 1997-2000 dropped to -2.36 per cent per year. Most non-agricultural sectors experienced negative growth rates. On the other hand, the agricultural sector kept growing positively but at a lower rate of 1.06 per cent per year.

Except for the estate crop and livestock sub-sectors with growth rates of -0.15 and -1.65 per cent per year respectively, all sub-sectors in agriculture experienced positive growth rates. During the post-crisis period (2000-2002), GDP recovered at a rate of 3.55 per cent per year. Except for the food crop sub-sector, all other sub-sectors of the agricultural sector held positive growth rates.

Table 3.4 Growth of Gross Domestic Product based on 1993 constant price (per cent/yr)

Sector	1971-1981	1981-1991	1991-1997	1997-2000	2000-2002
1. Agriculture	3.01	2.93	2.65	1.06	1.36
Food crops	4.55	2.76	1.54	1.48	-0.13
Estate crops	3.71	5.26	4.80	-0.15	2.79
Livestock	3.23	4.44	5.31	-1.65	3.31
Forestry	-1.38	-0.91	0.10	0.23	2.03
Fisheries	3.81	5.53	5.29	4.57	3.65
2. Industry	13.94	10.74	10.53	-3.05	3.64
3. Mining	7.15	2.72	4.17	0.62	1.11
4. Construction	17.25	-3.06	10.00	-5.41	5.23
5. Utilities	13.79	7.27	12.21	6.54	7.13
6. Trade, hotel and restaurant	12.74	2.56	7.51	-4.61	4.47
7. Transport	12.00	7.13	7.76	3.74	7.58
8. Finance	11.40	7.81	10.10	10.05	4.43
9. Services	9.17	6.38	4.90	-12.25	2.01
Total	9.14	4.11	7.01	-2.36	3.55

Source: CAS (1973-2002), data computed.

Agricultural development in Indonesia is pursued to achieve high economic growth and employment creation based on a structural transformation approach. Industrial strategy was developed using import substitution and followed by export promotion. Manufacturing industries were expected to become the centre of demand power. However, manufacturing industries were unable to absorb the growth in the labour force. Most migrants from rural to urban areas, therefore, work in informal sectors. Unlike the agricultural sector, the industrial sector requires skilled labour but most of the labour from rural areas is only semi-skilled. When the economic crisis hit the country in mid 1997, most workers in the industrial sector were laid off. Some of the laid-off workers remained unemployed, while others went back to rural areas and worked again in the agricultural sector. This situation worsened the agricultural sector’s problems because even before the crisis the sector already suffered from an over-abundant workforce. However, during the crisis the agricultural sector was relatively less affected than the industrial sector. Agricultural products’ prices were relatively constant in real terms (Tambunan and Isdijoso, 1999).

3.3 Role of trade

Until 1975 Indonesia was still a net exporter of maize but in subsequent years became a net importer (Table 3.5). Only in 1990 did Indonesia have net exports; totaling 137 thousand tons. The volume of maize exports compared to domestic production decreased from 10.1 per cent (285,800 tons) in 1970 to 0.97 per cent in 2001. In contrast, maize imports increased from nothing in 1970 to 1 million tons in 2001.

World maize exports are dominated by the main maize producing countries, i.e., the United States, China and Argentina. On the other hand, the main maize importing countries are Japan, Korea, Mexico, Indonesia, and the Philippines, among others. The increased imports of maize are mainly due to the expanding feed industries. Demand for feed as an input for the livestock industry, especially poultry, keeps increasing as demand for meat rises. This indicates that household income has increased during the last three decades. Compared to Thailand, China, Argentina and the United States, Indonesia has the lowest maize yield at just 2 tons/ha

(Kasryno, 2003; Swastika, 2002). Increasing domestic maize production could be carried out through either expansion of the planted area or yield improvements.

Adoption of high yielding varieties, both hybrids and composites, would expand domestic production. However, there are some constraints to adopting new technologies, such as: (1) almost 90 per cent of maize is grown on rainfed and dry land with low soil fertility and erratic rainfall that leads to drought conditions; (2) areas planted with maize are usually located in less developed or remote areas; (3) most farmers are smallholders with a low educational background and a lack of capital that makes them unable to apply inputs properly; (4) there is no incentive for quality grain improvement; (5) the high price of inputs, especially fertilizers and pesticides; (6) most maize producing areas are far from seed industries and feed producers; and (7) not enough promotion of the hybrid varieties bred by government research centres (Swastika, 2002). Higher productivity has been achieved in irrigated lowland areas but these areas compete fiercely with rice in the first dry season and with other secondary crops during the second dry season. Another competitor, for example in East Java province is sugarcane. Any effort to boost domestic production in order to decrease maize imports will sacrifice other food crop production.

Table 3.5 Imports and exports of maize in Indonesia, 1970-2001

Year	Production	Imports		Exports	
	('000 tons)	('000 tons)	(%) *	('000 tons)	(%) *
1970	2825.22	0	0.00	285.83	10.12
1975	2902.89	0	0.00	50.72	1.75
1980	3525.60	33.80	0.98	14.89	0.37
1985	4329.50	50.00	1.24	3.54	0.08
1990	6734.03	9.10	0.34	146.21	2.17
1997	8770.85	1098.40	12.52	19.01	0.22
2000	9677.00	1264.60	13.07	28.23	0.29
2001	9347.00	1035.80	11.08	91.00	0.97
Growth (%)					
1970-1975	0.54	-	-	-29.24	-
1975-1980	3.96	-	-	-21.74	-
1980-1985	4.19	8.15	-	-24.97	-
1985-1990	9.24	-28.88	-	110.47	-
1990-1997	3.85	98.33	-	-25.28	-
1997-2001	1.60	-1.46	-	47.92	-
Average growth	3.97	27.56	-	6.04	

Source: FAO (1970-2001).

Note: * = percentage relative to production.

4. Review of the Past and Current Situation

The economic crisis of 1997 also significantly affected the domestic livestock industry. It affected both the production and consumption sides of livestock products. Consequently, the performance of feed and feed crop production was also affected. The condition worsened as Avian flu spread throughout Southeast and East Asian countries. This chapter will outline the historical profile (the past and current situation) of livestock, feed and feed crops in Indonesia.

4.1 Livestock population

The population of swine in the country has fluctuated over time. For the period of 1970-1975, the swine population decreased by 3.10 per cent per year but then positively grew at about 3.11 per cent annually from 1975-1980 reaching a peak in 1980-1985. Since then however, the growth rate has declined and during the economic crisis became negative, namely -8.12 per cent per year. Over the period of 1970-2001 as a whole, the swine population grew at an average of 2.19 per cent per year (Table 4.1).

The main pig producing areas in the country are North Sumatera, Central Java, Bali, East Nusa Tenggara, West Kalimantan, North Sulawesi, South Sulawesi and Irian Jaya. Most domestic production is intended for export because domestic demand is far below the supply. Exportable pigs are raised on large farms, while those raised on small farms are intended for local markets. However, Indonesia also imports a small quantity of pork of specific quality to meet certain consumers' demand, such as hotels. In domestic markets, for example in North Sumatera, fish is a substitute of pork (Ilham *et al.*, 2001). Most swine exported are suckling pigs. Parent stocks of pig are still imported from the United States, Australia and New Zealand (Hutabarat *et al.*, 1992).

The dairy cattle population has always experienced positive growth but at times variable. During the period of 1970-1975, the population grew rapidly at 8.81 per cent per year. For the period of 1975-1980, the population of dairy cattle increased slowly (2.74 per cent/year) but then grew much faster at 11.26 per cent annually during 1980-1985. However, the growth rate slowed again for the subsequent periods and was lowest during 1990-1997 at just 1.86 per cent per annum.

Dairy farms in Indonesia are dominated by smallholders; with ownership of less than four heads (80 per cent), 4-7 heads (17 per cent), and more than seven heads (3 per cent). It was estimated that most national dairy milk production (64 per cent) was produced by smallholders, while the remaining 28 and 8 per cent were produced by middle and large farms respectively (Erwidodo and Sayaka, 1998). Fast dairy growth began with the establishment of the Indonesian Union Dairy Cooperative (GKSI) in 1979. Total dairy cattle owned by cooperative members in 1979 was less than 7 per cent compared to the national population. The latest data, however, shows that almost 80 per cent of the dairy cattle population in 2002 (358,000 heads) were owned by cooperative members (GKSI, 2003). The dairy industry in the country was given a boost by attractive policies implemented by the government. Credit is provided to import dairy cattle from abroad, mainly, Australia. The government also imports dairy cattle from New Zealand and the United States. The credit was channeled to the cooperative members through GKSI. Dairy farmers also have access to other input credit, especially feed, from the cooperatives. Secondly, the purchase ratio applied to all domestic milk processing industries is fair. To obtain a permit to import certain volumes of milk, milk processing industries have to buy minimal volumes of milk produced by domestic dairy farmers. Increasing domestic demand for milk encourages dairy cattle population. Furthermore, dairy farms, for example in East Java, are profitable with a financial profit rate of 48 per cent compared to production costs (Adnyana, 1998 and Swastika *et al*., 2000). However, the increasing population of dairy cattle needs more feed rather than forage. In the long-term this condition will lead the country to dependence on feed importation.

The layer chicken population has grown rapidly since 1970. For the period of 1970-1975 for example, the population expanded from 0.7 million to 3.9 million birds; an increase of 40.77 per cent per year. The layer population continued to grow rapidly reaching a peak in 1997 of 70.6 million birds but in 1998 it was almost half of that of the previous year, i.e., 38.9 million. Slowly the population increased again to 66.9 million in 2001. Similar to layer trends, the broiler population in 1985 was 13 million and this increased over time. In 1997 the population of broilers reached a peak of 641.4 million but due to the economic crisis the population decreased to 354 million in 1998. In other words, the broiler population grew at 21.5 per cent per year for the period of 1985-1990 and during the period of 1990-1997 the broiler population grew at 51.84 per cent per year. However, during the economic crisis (1997-2000) the broiler population dropped by 6.11 per cent per year. For more details, the populations of the various livestock during the period of 1970-2001 are presented in Table 4.1.

At the first stage of poultry development in the country, native chickens dominated the industry. However, in the early 1990's the government imported commercial breeds to produce eggs. Some people preferred native chicken products to those of layer and broiler for various reasons, such as more nutritious, less fatty and more tasty. The lower productivity of eggs and meats of native chickens encouraged producers to raise layers and broilers. A negative growth rate of layer chickens (-1.33 per cent/year) occurred during the economic crisis (1997-2001). Tight competition among chicken producers led to decreases in layer chicken price.

Table 4.1 Population of livestock in Indonesia, 1970-2001

Year	Swine (heads)	Dairy cattle (heads)	Beef cattle (heads)	Layer (birds)	Broiler (birds)
1970	3,169,000	59,000	6,137,000	706,000	n.d.a.
1975	2,707,000	90,000	6,242,000	3,903,000	n.d.a.
1980	3,155,000	103,000	6,440,000	22,940,000	n.d.a.
1985	5,700,375	175,638	9,318,000	31,874,064	13,017,600
1990	7,135,643	293,878	10,410,000	37,228,434	34,463,215
1995	7,720,156	341,334	11,534,000	59,393,587	593,368,316
1997	8,232,839	334,371	11,939,000	70,622,771	641,373,816
1998	7,797,558	321,992	11,634,000	38,861,311	354,003,503
2000	5,356,834	354,253	11,008,000	69,366,006	530,874,055
2001	5,866,837	368,490	11,138,000	66,927,833	n.d.a.
Growth (%/yr)					
1970-1975	-3.10	8.81	0.34	40.77	-
1975-1980	3.11	2.74	0.63	42.51	-
1980-1985	12.56	11.26	7.67	6.80	-
1985-1990	4.59	10.84	2.24	3.15	21.50
1990-1997	2.06	1.86	1.98	9.58	51.84
1997-2001*	-8.12	2.46	-1.72	-1.33	-6.11
Average growth	2.19	6.17	1.98	17.03	14.39

Source: CAS (1970-2002), computed.
Note: n.d.a. = no data available.

4.2 Production and consumption of livestock products

Domestic egg production increased significantly during the periods of 1970-1975 (13.9 per cent/year) and 1975-1980 (18.5 per cent/year). During the subsequent period however, (1980-1997) the growth rate of egg production declined to between 5.5 and 8.7 per cent per year. During the crisis period egg production growth dropped to less than one per cent per year (Table 4.2). Milk production achieved highest growth during 1980-1985, i.e., 19.6 per cent per year. This growth declined during the subsequent periods to 12.46 per cent and -0.46 per cent per year during 1990-1997 and 1997-2001, respectively.

Beef production grew at about 3 per cent per year on average from 1985 to 2001. Pork production experienced negative growth of -1.4 per cent during 1985-1990 but grew significantly at a rate of 7.5 per cent per year during 1990-1997. This growth soon became negative again (-3.8 per cent per year during 1997-2001) in line with the decline in swine population. Except for eggs and beef, during the crisis period of 1997-2001 all livestock products experienced negative growth. This reveals that during the crisis the livestock sub-sector was negatively affected.

Table 4.2 Production of livestock products in Indonesia, 1970-2001

Year	Eggs (tons)	Milk (tons)	Beef (tons)	Pork (tons)	Chiken meat (tons)
1970	58,600	29,270	n.d.a.	n.d.a.	n.d.a.
1975	112,200	51,110	n.d.a.	n.d.a.	n.d.a.
1980	262,600	78,380	n.d.a.	n.d.a.	n.d.a.
1985	369,900	191,930	227,400	132,700	114,460
1990	484,000	345,600	259,220	123,810	261,360
1995	736,060	433,442	311,970	177,820	551,745
1997	765,033	423,665	353,652	146,781	515,298
1998	529,827	375,382	342,598	134,794	285,010
2000	783,317	495,647	339,941	162,398	515,003
2001	793,796	505,023	338,636	174,422	516,286
Growth (%/yr)					
1970-1975	13.87	11.79	-	-	-
1975-1980	18.54	8.93	-	-	-
1980-1985	7.09	19.62	-	-	-
1985-1990	5.52	12.48	2.65	-1.38	17.96
1990-1997	8.75	4.63	3.77	7.51	16.12
1997-2001	0.78	-0.46	2.54	-3.76	-1.36
Average growth	9.34	9.51	2.45	2.26	7.83

Source: FAO (1970-2001).
Note: n.d.a = no data available.

Per capita consumption of eggs experienced a positive trend from 1970 to 2000 with the highest growth rate during the period of 1975-1980 (14.9 per cent/year) and the lowest during the crisis period of 1997-2000 (1.1 per cent/year). Per capita consumption of beef and chicken meat experienced negative growth rates during the crisis, namely -1.61 per cent and -3.94 per cent per year respectively, while pork consumption grew positively throughout. Milk consumption increased at a low rate (0.24 per cent/year) during the crisis (Table 4.3). Therefore, during the crisis, egg consumption had the highest positive growth, while beef and chicken meat consumption were both negative. This indicates that during an economic crisis people tend to consume relatively cheaper sources of protein, such as eggs.

Table 4.3 Per capita consumption of livestock products in Indonesia, 1970-2000

Year	Eggs (kg/cap/yr)	Beef (kg/cap/yr)	Chicken meat (kg/cap/yr)	Pork (kg/cap/yr)	Milk (kg/cap/yr)
1970	0.5	1.7	0.5	0.58	n.d.a
1975	0.7	1.9	0.7	0.33	4.1
1980	1.4	1.7	1.2	0.58	4.2
1985	1.8	1.7	1.9	0.56	4.3
1990	2.1	1.7	2.8	0.47	4.4
1995	3.0	1.9	4.4	0.63	4.4
1997	3.0	2.1	4.4	0.50	4.5
1998	2.0	1.9	3.0	0.46	4.5
2000	3.1	2.0	3.9	0.77	4.5
Growth (%/yr)					
1970-1975	6.96	2.25	6.96	-10.47	-
1975-1980	14.87	-2.20	11.38	11.85	0.35
1980-1985	5.15	0.00	9.63	-0.85	0.35
1985-1990	3.13	0.00	8.06	-3.59	0.35
1990-1997	5.23	3.06	6.67	1.08	0.25
1997-2000	1.10	-1.61	-3.94	9.72	0.24
Average growth	6.14	0.21	6,94	1.00	0.30

Source: FAO (1970-2000).
Note: n.d.a = no data available.

4.3 Crop balance sheets

Almost all soybean is consumed for food which amounts to more than 90 per cent of total consumption (Table 4.4). Some domestic soybean production (about 2 per cent) is utilized directly for seed and there is about 5 per cent loss and waste. No domestic soybean production is used for feed due to the high cost and the need for intermediate processing, as mentioned in Chapter I. Most soybean (domestically produced and imported) is processed into industrial products and soybean meal is used for feed. The types of soybean products consumed are tofu, *tempe* or fermented soybean, soybean sauce, and soybean drinks such as soybean milk and yoghurt). In terms of participation rates and per capita consumption, urban people consume more than those in rural areas (Sudaryanto, 1996).

Table 4.4 Balance sheet of soybean in Indonesia, 1970-2001 ('000 tons)

Year	Total supply	Consumption					
		Feed	Seed	Waste	Other	Food	Total
1970	493.93	0.00	28.00	25.00	0.00	440.93	493.93
%		0.00	5.67	5.06	0.00	89.27	100.00
1975	607.60	0.00	32.00	30.00	0.00	545.60	607.60
%		0.00	5.27	4.94	0.00	89.80	100.00
1980	753.64	0.00	32.00	38.00	0.00	683.64	753.64
%		0.00	4.25	5.04	0.00	90.71	100.00
1985	1,171.67	0.00	34.00	57.00	0.00	1,080.67	1,171.67
%		0.00	2.90	4.86	0.00	92.23	100.00
1990	2,028.41	0.00	55.00	103.00	0.00	1,570.41	2,028.41
%		0.00	2.71	5.08	0.00	77.42	100.00
1997	1,972.89	0.00	48.00	97.00	0.50	1,827.89	1,973.39
%		0.00	2.43	4.92	0.03	92.63	100.00
2001	1,960.00	0.00	30.00	90.00	2.00	1,840.00	1,962.00
%		0.00	1.53	4.59	0.10	93.78	100.00
Growth (%)							
1970-1975	4.60	n.d.a.	2.86	4.00	n.d.a.	4.75	4.60
1975-1980	4.81	n.d.a.	0.00	5.33	n.d.a.	5.06	4.81
1980-1985	11.09	n.d.a.	1.25	10.00	n.d.a.	11.62	11.09
1985-1990	14.62	n.d.a.	12.35	16.14	n.d.a.	9.06	14.62
1990-1997	-0.39	n.d.a.	-1.82	-0.83	n.d.a.	2.34	-0.39
1997-2001	-0.16	n.d.a.	-9.38	-1.80	n.d.a.	0.17	-0.14
1970-2001	9.57	n.d.a.	0.23	8.39	n.d.a.	10.24	9.59

Source: FAO (1970-2001).
Note: n.d.a = no data available.

Cassava consumption for food accounted for about 75 per cent on average for the period of 1970-2001. Meanwhile, consumption of this commodity for feed was only around 2 per cent over the same period (Table 4.5). During the crisis period, cassava consumption increased by about 5 per cent per year but this growth rate slowed as the crisis passed. Lampung and East Java provinces are among the biggest cassava producing areas in Indonesia. Cassava production in these two provinces is mainly intended for export in the forms of chips and tapioca. Areas planted with cassava are usually dry land with relatively low soil fertility. Although this commodity is easily grown on any type of land in different agro-ecosystems, most farmers prefer to plant other cash crops. This is due to the relatively low cassava price during harvest season. On the other hand, cassava is a perishable product except if it is processed into chips or tapioca. Processing cassava into chips or tapioca however, adds expense and time but with minimal added value. This condition does not encourage farmers to process their cassava.

Table 4.5 Balance sheet of cassava in Indonesia, 1970-2001 ('000 tons)

Year	Total supply	Consumption				
		Feed	Waste	Other	Food	Total
1970	9,124.74	191.00	953.00	497.44	7,483.30	9,124.74
%		2.09	10.44	5.45	82.01	100.00
1975	11,390.10	245.00	1,224.00	553.54	9,367.56	11,390.10
%		2.15	10.75	4.86	82.24	100.00
1980	12,213.79	250.00	1,645.00	508.34	9,810.45	12,213.79
%		2.05	13.47	4.16	80.32	100.00
1985	11,971.24	250.00	1,624.00	494.03	9,603.21	11,971.24
%		2.09	13.57	4.13	80.22	100.00
1990	10,684.21	317.00	2,058.00	155.13	8,154.08	10,684.21
%		2.97	19.26	1.45	76.32	100.00
1997	14,567.43	303.00	1,967.00	515.76	11,781.67	14,567.43
%		2.08	13.50	3.54	80.88	100.00
2001	16,593.00	324.00	2,100.00	2,286.00	11,883.00	16,593.00
%		1.95	12.66	13.78	71.61	100.00
Growth (%)						
1970-1975	4.97	5.65	5.69	2.26	5.04	4.97
1975-1980	1.45	0.41	6.88	-1.63	0.95	1.45
1980-1985	-0.40	0.00	-0.26	-0.56	-0.42	-0.40
1985-1990	-2.15	5.36	5.34	-13.72	-3.02	-2.15
1990-1997	5.19	-0.63	-0.63	33.21	6.36	5.19
1997-2001	3.48	1.73	1.69	85.81	0.22	3.48
1970-2001	2.64	2.25	3.88	11.60	1.90	2.64

Source: FAO (1970-2001).

As the staple food after rice, in 1970 around 68 per cent of total maize consumption was directly used for food with another 15 per cent used by the food industry. This trend changed and in 1997 the share of maize for direct food consumption was only 6.6 per cent, which continued through the crisis (Table 4.6). On the other hand, maize used by the food industry increased from 15 per cent in 1970 to about 53 per cent in 1997 and to 60 per cent during 2000/2001.

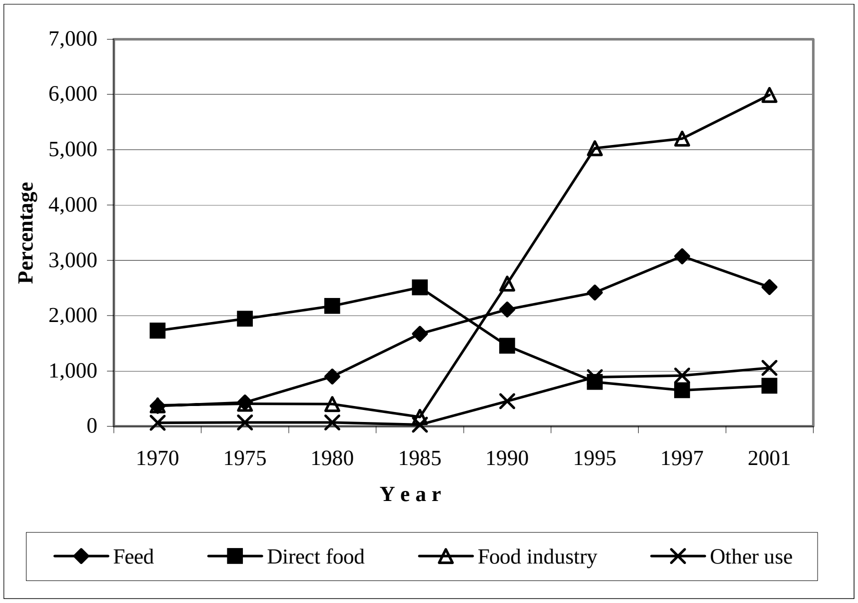
Table 4.6 Balance sheet of maize in Indonesia, 1970-2001 ('000 tons)

Year	Total supply*)	Maize demand				
		Feed industry	Direct consumption	Food industry	Other uses	Total*)
1970	2539.4	368	1729	376	66	2539.4
%		14.49	68.09	14.81	2.60	100
1975	2852.2	431	1943	406	72	2852.2
%		15.11	68.12	14.23	2.52	100
1980	3544.5	899	2175	400	71	3544.5
%		25.36	61.36	11.29	2.00	100
1985	4376.0	1670	2509	167	30	4376.0
%		38.16	57.34	3.82	0.69	100
1990	6596.9	2112	1454	2580	450.9	6596.9
%		31.99	22.03	39.08	6.89	100
1997	9850.2	3075	652	5205	918	9850.2
%		31.22	6.62	52.84	9.32	100
2000	10913.4	2285	716	6726	1187	10913.4
%		20.94	6.56	61.63	10.88	100
2001	10291.8	2518	730	5988	1057	10292.5
%		24.46	7.09	58.18	10.27	100
Growth						
1970-1975	2.35	3.21	2.37	1.54	1.54	2.35
1975-1980	4.45	15.84	2.28	-0.33	-0.33	4.44
1980-1985	4.32	13.18	2.90	-15.99	-15.99	4.30
1985-1990	9.15	4.81	-10.34	72.86	72.86	8.57
1990-1997	1.81	5.51	-10.82	10.54	10.54	5.88
1997-2001	3.41	-4.87	2.86	3.57	3.57	1.10
Average growth 1970-2001	4.12	6.59	-2.52	12.21	12.21	4.64

Source: FAO (1970-2001).
Note: *) = computed.

Conversely, the use of maize by the feed industry increased from about 0.37 million tons (14.5 per cent) in 1970 to about 2.1 million tons (32 per cent) and 2.5 million tons (24.5 per cent) in 1990 and 2001 respectively. This indicates that there has been a significant change in the use of maize, from direct food consumption to the food and feed industries. It also implies that maize is not considered as an inferior good anymore if it is processed into manufactured food and feed giving good market prospects for maize. The trends of maize usage are presented in Figure 4.1.

Figure 4.1 The use of maize in Indonesia, 1970 -2001



Source: Author's own calculation.

As a raw material for feed, maize has an advantage over other grains, especially for layers, due to its xanthophylls content which makes the yolk of the egg look brighter. Feed ingredients for chickens, ducks and pigs in Indonesia are dominated by maize. The other function of maize is a source of energy for broilers. The substitutes of maize for feed rations are wheat, rye and oat. These substitutes are only usually utilized in sub-tropical countries such as Australia and Europe (Tangenjaya *et al.*, 2002). Thus, the role of maize in Indonesia and other tropical countries will remain important.

4.4 Utilization of feed crops and feed ingredients

Principally, all feed components have to contain the nutrients required by livestock. The nutrients crucial for livestock's growth, health and reproduction are water, proteins, carbohydrates, fat, vitamins and minerals. The most common raw materials for feed are maize, soybean meal (SBM), corn gluten meal (CGM), rice bran, meat and bone meal (MBM), fish meal, wheat bran and coconut cake (Poultry Indonesia, 2003c).

There are several feed crops with the potential to be feed ingredients. Types of forage crops used for feed are (1) *Leuceaena sp* (lamtoro), which has the potential for feed in eastern parts of Indonesia; (2) *Calliandra calothyrsus* is good for sheep, rabbits and layers (yellow egg pigment) especially when it is fresh; and (3) *Gliricidia sepium* (gamal) is planted in rural areas for fence plantations and it is a source of protein (Tangendjaja, 1995). Rochiman *et al*. (1985) states that forages can be grass, legumes, bushes (succulent plants), agricultural waste and also sugarcane shoots: fresh, dried and silage. In Kediri, East Java, fresh sugarcane shoots are fed to beef cattle at 5-25 kg/head. The side effects of consuming these forages are a lack of appetite, higher urinating frequency and diarrhea. These forages are not used in the concentrates or manufactured feeds.

Maize is the feed component most frequently used in concentrated feeds. The water content of maize should be lowered to below 16 per cent to avoid damage, loss of nutrients, and fungal growth before it can be processed into feed. Yellow corn is preferred to white corn due to the higher content of vitamin A. Another advantage of yellow corn is its xanthophylls content, which is a coloring agent needed for yolk development. Soybean meal (SBM) is a by-product of soybean processed into oil. SBM retains protein, fat and crude fiber. Corn Gluten Meal (CGM) is a dried by-product of corn grain in which its starch, germ and outer membrane are extracted. During storage, the water content of CGM has to be maintained below 12 per cent. Rice bran is adequately available, especially during rice harvest seasons. Meat bone meal (MBM) has to contain at least 4.4 per cent indigestible protein and not more than 11 per cent crude protein. Fish meal contains high crude protein (55-72 per cent). Sometimes it is substituted with MBM due to its expensive price. Wheat bran is frequently applied in feed rations because of its crude protein, crude fat and crude fiber. Coconut cake also contains crude protein, crude fat and crude fiber.

4.5 Growth in consumption and production of feed and feed crops

The Feed Producers' Association (GPMT) predicted that feed production in the country would be stagnant during 2004, equal to demand at 6.8 million tons. The main reasons are worries about the political situation and disease outbreaks. Most probably the domestic political setting in 2004 will be worse due to a general election. The 2004 general election may discourage people from having parties or from eating in restaurants. Demand for chicken for catering and restaurants is predicted to decline. Furthermore, livestock disease issues have dampened meat and egg consumption. On the other hand, international institutions such as the United States Department of Agriculture (USDA) and Food-market-exchange are optimistic that Indonesian poultry production will grow by 8 per cent in 2004 from 6.8 to 7.3 million tons. According to this forecast chicken meat consumption is due to increase from 3.4 to 3.7 kg per capita per year (Pikiran Rakyat, 2003).

4.6 Agro-industrial and feedstuff processing industries

There are five feed mills classified as the big producers, namely Charoen Pokphand, Japfa Comfeed, Sierad Produce, Cheil Jedang and Wonokoyo. As shown in Table 4.7, the feed mills' sites are found in several provinces, i.e., North Sumatra with feed production of 624,000 mt, Lampung (360,000 mt), Banten (2,088,000 mt), Jakarta (564,000 mt), West Java (756,000 mt), Central Java (450,000 mt), East Java (2,000,000 mt), and South Sulawesi (18,000 mt). The five main producers supply more than 65 per cent of national production. Overall domestic feed production in 2003 was 6.86 million mt which is still below the production capacity of 11 million mt.

Nearly 70 per cent of raw feed materials are imported due to the lack of domestic supply, such as maize, soybean meal (SBM) and fish meal. Maize and SBM have no substitutes with other components containing the same nutrient make-up. If fish meal prices soar, feed producers reduce its content in poultry feed. Furthermore, some chicken feeds do not use it at all. Producers can use local fish meal as long as it is affordable. Some feed ingredients, such as SBM, CGM and MBM are not available throughout the year. Despite a relatively fixed supply, currently, world demand for SBM is increasing due to higher demand from China (Poultry Indonesia, 2003a).

Feed production in 2003 (6.8 million tons) was 18 per cent higher than in 2002. Imported feed ingredients, nevertheless, are expected to decline. The main objective of reducing imported feed ingredients is to expand domestic absorption. In 2002, imported corn was 57 per cent of the total requirement for feed and in 2003 it was expected to be 40 per cent. Imports of fish meal are expected to drop from 16 to 10 per cent, meat and bone meal from 79 to 75 per cent, poultry meat meal from 12 per cent to 10 per cent, and premix additives from 97 to 60 per cent. Aside from importing feed ingredients, Indonesia also exports beef cow feeds to Australia. For example, from August to November 2002 the volume of feed exported to Australia, i.e., Brisbane and Darwin, was 142,875 tons (Kompas, 2003). In 1998 several feed mills in Medan exported broiler feed to Malaysia. Some breeding companies also exported day old chicks or hatching eggs to Brunei and the Philippines.

Table 4.7 Feed mills and feed production in Indonesia by province, 2003 (mt)

Province	District	Province	District
A. North Sumatra		**E. West Java**	
1. Charoen Pokphand	Medan	1. Cargill	Bogor
2. Berlian Unggas Sakti	Medan	2. Gold Coin	Bekasi
3. Indojaya Agrinusa	Tanjung Morawa	3. Japfa Comfeed	Cirebon
4. Mabar	Medan	4. Metro Inti	Bekasi
5. Others		5. Sinta Prima	Bogor
Production	624,000	6. Universal Agribisnisindo	Bekasi
		7. Welgro	Bogor
		8. Others	
		Production	756,000
B. Lampung		**F. Central Java**	
1. Japfa Comfeed	Bandar Lampung	1. C.P. Prima	Semarang
2. Vista Grains	Bandar Lampung	2. Multiphala	Sragen
3. Sierad Grains	Tanjung Bintang	3. Rehobat	Semarang
4. Sentra Profeed	Bandar Lampung	4. Others	
5. Others		Production	450,000
Production	360,000		
C. Banten		**G. East Java**	
1. Bintang Terang	Serang	1. Bintang Terang	Surabaya
2. Cargill	Serang	2. Cargill	Pasuruan
3. Cheil Jedang	Serang	3. Charoen Pokphand	Sidoarjo
4. Charoen Pokphand	Balaraja	4. Cheil Samsung	Pasuruan
5. Cibadak Indah	Serang	5. Gold Coin	Surabaya
6. Japfa Comfeed	Tangerang	6. Japfa Comfeed	Sidoarjo
7. Kertamulya Saripakan	Serang	7. Panca Patriot Prima	Sidoarjo
8. Ayam Manggis	Balaraja	8. Sierad Grains	Sidoarjo
9. Sierad Produce	Serang	9. Wirifa Sakti	Surabaya
10. Wonokoyo	Serang	10. Wonokoyo	Surabaya
Production	2,088,000	11. Malindo	Sidoarjo
		12. Others	
		Production	2,000,000
D. Jakarta		**H. South Sulawesi**	
1. Charoen Pokphand	Ancol	1. Cargill	Makassar
2. Citra Ina	East Jakarta	2. Japfa Comfeed	Makassar
3. Malindo	East Jakarta	3. Others	
4. Hogindo	East Jakarta	Production	18,000
Production	564,000		

Source: Poultry Indonesia, 2004.

4.7 Agricultural policies

The main objectives of government policies in the food crop sub-sector are to increase domestic food production and to improve farmers' income. Measures taken are the provision of subsidized inputs, credit and a floor price. The strategic agricultural products targeted by the policies are rice, maize, soybean and sugarcane. Currently, the floor price policy is only maintained for rice and sugar.

4.7.1 Production policies

Intensification programmes were carried out to boost corn and soybean production. The last intensification programme to expand maize and soybean production was implemented in 1998, namely Self-Reliance Movement on Rice, Maize and Soybean (GEMA PALAGUNG). Currently the growth in maize production is based predominantly on the adoption of hybrid corn seed varieties. On the other hand, soybean production has declined due to relatively low yields and declining planted area.

4.7.2 Price policies

Due to the lack of budget, the government does not currently provide price subsidies for maize or soybean. The significant amounts of maize and soybean imports hamper domestic maize and soybean prices. Despite the cheap price of maize in the domestic market, most feed mills still rely on maize imports due to their better quality, especially the low water content, no aflatoxin and a continuous supply. On the other hand, the soybean meal required by feed mills is imported because domestic production of this commodity cannot satisfy domestic demand.

4.8 General marketing and trade policies

4.8.1 Monetary and exchange rate policies

Until 1996 the government applied a managed floating rate policy in which the rupiah depreciated less than 4 per cent per year. In 1997, however, the central bank shifted the policy to a free-floating rate which triggered a soaring exchange rate against the dollar from Rp 2,383 to Rp 4,650 per dollar. The rupiah plunged to Rp 8,025 per dollar in 1998 with the worst rate in 2000 at Rp 10,400 per dollar (Table 4.8). High exchange rates caused feed prices to rise and consequently, the livestock products too.

Domestic interest rates were higher during the economic crisis; at 23.7 per cent in 1997 and 32.6 per cent in 1999. In 2000 the exchange rate returned to a level lower than before the crisis due to low bank credit. Producers were still reluctant to apply for credit from the bank for working capital because the investment environment during the crisis period was not favourable. Currently, the government does not provide any subsidies on interest rates for the livestock industry. The government applies the commercial interest rate of 18-20 per cent per year.

Table 4.8 Exchange rates and interest rates in Indonesia, 1970-2002

Year	Exchange rate (Rp/$)	Interest rate * (%/year)
1970	306	18.9
1975	421	14.1
1980	633	15.3
1985	1,110	22.2
1990	1,844	20.7
1991	1,950	25.2
1992	2,030	24.1
1993	2,087	20.5
1994	2,200	18,5
1995	2,308	20,1
1996	2,383	20,5
1997	4,650	23,7
1998	8,025	36,4
1999	7,100	32,6
2000	7,595	17,8
2001	10,400	19,2
2002	8,940	18,2

Source: Bank Indonesia, 2003.
Note: *) Interest rates for working capital.

4.8.2 State trading enterprise

All of the feed mills in the country belong to private companies. The feed mills are either domestic investment or joint ventures. The only state trading company involved in the feed industry is BULOG. The role of BULOG is significant especially for soybean meal imports. BULOG was granted the monopoly right by the government on imports of this commodity.

4.8.3 Policy reforms initiative

The existing high interest rate translates to high variable costs for feed production and leads to high retail prices of feeds. Because the government does not intervene anymore in the feed industry through input subsidies, it is more conducive to feed producers if the existing interest rate is lowered. However, the current interest rate reflects the existing macroeconomic condition. Thus, reducing the current inflation rate to boost business activities including the feed industry is the crucial measure that needs to be taken by the government.

Many large companies owning breeding farms and feed mills have become integrators through raising broilers themselves or establishing contract growing with farmers. These companies have the ability to produce more added value through processing the primary product, such as cut up or ready-to-eat broilers. Smallholders who do not operate their farms efficiently will have to close their businesses unless they establish cooperatives. This would increase their economies of scales and thus their competitiveness.

The poultry industry in the country has to shift its orientation from import substitution to export promotion. The low exchange rate is the main component of the comparative advantage. Furthermore, low costs of labour will enable Indonesia’s poultry industry to compete abroad at least in the ASEAN region. Exporting poultry products to Japan is another opportunity since domestic production costs are relatively low. Furthermore, due the recent avian flu outbreak the government and the poultry producers should apply bio-security.

5. Demand for Feed and Feed Crops

5.1 Consumption structure and characteristics

In general, maize consumption in Indonesia can be grouped into four categories: (1) direct human consumption; (2) raw materials for the feed industry; (3) raw materials for the food industry; and (4) other uses (seed, loss, etc.). The trend of demand for maize in Indonesia during 1990-2001 was presented in Chapter 3. This chapter elaborates on the degree of the relationship between maize demand for various uses and their respective determinants, imports of feed components as well as demand for feed using econometric models.

The data used in the models is time series data covering 1980-2001, except for the imports of feed components' model which uses a 1985-1994 time period, due to limited availability of data. The data was taken from various sources, such as the Directorate of Livestock Production, Central Agency for Statistics (CAS), FAO and other relevant sources. The analyses use linear models with the syslin procedure of SAS software. The results of the analyses are presented in the following sections.

5.1.1 Maize demand for the feed industry

Table 5.1 shows factors that affect maize demand from the feed industry in Indonesia. The demand model used in this estimate explained well the behaviour of maize demand as a raw material for the feed industry, as exhibited by the coefficient of determination R^2 = 0.82. The signs of the parameter estimates also showed correct polarity with respect to the explanatory variables. In more detail, the variables that significantly determine the demand behaviour of maize for the feed industry are: (1) domestic price of maize; (2) domestic price of soybean; (3) lagged demand from the feed industry; and (4) dummy variable of economic crisis.

It was expected that soybean (in the form of soybean meal) is a complementary commodity to maize in its utilization as a raw material for the feed industry. Maize demand is highly responsive to the domestic price of soybean in the long run with a price elasticity of -1.64. Maize demand is also responsive to its own domestic price in the long run with an elasticity of -1.48. In addition, the demand for maize is also significantly determined by its demand the previous year. It seems that the economic crisis pushed the demand for maize from the feed industry down. When the economy of Indonesia is in crisis, demand for maize for the feed industry decreases. During the economic crisis many poultry farms folded, resulting in a decrease in demand for feed. Therefore, the price of feed is the only variable that does not significantly determine the behaviour of maize demand as shown in Table 5.1.

Table 5.1 Maize demand behaviour for the feed industry in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	3,821.4592	0.0001		
Price of feed (Rp/kg)	PF_t	0.0556	0.7953	0.0003	0.0017
Domestic price of maize (Rp/kg)	PM_t	-812.6942	0.0737	-0.2157	-1.4764
Domestic price of soybean (Rp/kg)	PS_t	-391.4055	0.0013	-0.2395	-1.6389
Lagged maize demand for feed ('000 tons)	DF_{t-1}	0.8539	0.0001		
Dummy (0 = before; 1 = during and after crisis)	D_t	-791.2193	0.0414		
Pr > F < 0.0001; Adjusted R^2 = 0.8208; DW = 1.778					

Source: Author's own calculation.

The probability of the F-statistic is 0.0001, indicating that simultaneously the affects of all explanatory variables on the dependent variable are highly significant. The adjusted R^2 is 0.82, indicating that about 82 per cent of the variation in maize demand can be explained by the variations of all explanatory variables used in this model. The Durbin-Watson value of 1.78 is close to two, indicating that there is no serious auto-correlation among the variables.

5.1.2 Maize demand for direct food consumption

The demand behaviour of maize for direct food consumption was explained quite well by explanatory variables included in the model with an adjusted $R^2 = 0.90$. In contrast with the demand behaviour of maize for the feed industry, lagged demand is the only variable that significantly determines the behaviour of maize demand for direct food consumption. The other variables have no significant affect.

Per capita income, although not significant, has a negative affect on maize demand for direct food. This indicates that maize as food for direct consumption may be inferior compared with rice for example, but as a raw material for the food industry it is widely accepted. This phenomena is also shown in maize demand behaviour for direct food that is elastic with respect to per capita income both in the short run and long run with income elasticities of -1.05 and -3.21 respectively. This means that as income per capita increases demand for maize for direct food consumption rapidly declines.

In general, although each individual independent variable has no significant affect, simultaneously they significantly determine maize demand for direct food consumption, shown by the probability of the F-statistic, which is 0.0001 (Table 5.2). Unfortunately, the Durbin-Watson coefficient of 1.07 indicates the presence of auto-correlation. This is unavoidable and was the best model among the alternatives that were estimated. The data used to estimate maize demand behaviour for direct food consumption is the most inconsistent data since a very limited number of people directly consume this commodity. According to regional mapping for direct maize consumption, only East Nusa Tenggara and a small area in West Nusa Tenggara and East Java directly consume maize in their diet.

Table 5.2 Maize demand behaviour for direct food consumption in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	1695.6674	0.3399		
Domestic price of maize (Rp/kg)	PM_t	-184.0750	0.7500	-0.0665	-0.2041
Price of milled rice (Rp/kg)	PBR_t	154.7505	0.6540	0.0903	0.2772
Per capita income (Rp ’000/year)	Inc_t	-0.7211	0.7840	-1.0473	-3.2141
Taste and preference	$Taste_t$	-56.1313	0.2431	-0.0009	0.0000
Lagged maize demand for food (’000 tons)	DH_{t-1}	0.6741	0.0031		
Dummy (0=before; 1=during and after crisis)	D_t	244.0609	0.4155		
Pr > F < 0.0001; Adjusted R^2 = 0.9002; DW = 1.073					

Source: Author’s own calculation.

5.1.3 Maize demand for the food industry

Maize demand behaviour for the food industry in Indonesia is presented at Table 5.3. The demand structure of maize is also determined by its utilization as a raw material for the food industry. Maize demand from the food industry remains the strongest accounting for 60 per cent of total domestic demand. The econometric model used in this study almost perfectly explains the demand behaviour of maize for the food industry. This is shown by the adjusted R^2, which is equal to 0.98, indicating that about 98 per cent of variation of the dependent variable can be explained by the variations of all explanatory variables used in the model. All signs of parameter estimates were as expected. As in the demand model for direct consumption, the Durbin-Watson value of 1.72 indicates no serious auto-correlation problem.

Among the explanatory variables included in the model, maize demand for the food industry is significantly influenced by: (1) the domestic price of maize; (2) the price of wheat flour; (3) the price of cooking oil; (4) per capita income; and (5) consumers' tastes and preferences. In the short run, except with respect to per capita income, demand behaviour is less responsive to other explanatory variables. However, in the long run, demand behaviour is responsive to fluctuations in variables such as: (1) the price of manufactured food; (2) the domestic price of maize; (3) the price of cooking oil; and (4) per capita income, with demand elasticities of 2.12, -2.41, -1.72, and 5.72 respectively.

Maize is no longer an inferior good as it is processed by the food industry. This is shown by its income elasticity: as income increases, demand for processed maize food increases rapidly. For example, if per capita income increased by 10 per cent, demand for processed maize food would increase by 15.63 per cent, or 57.33 per cent in the long run (Table 5.3).

Table 5.3 Maize demand behaviour for the food industry in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	-14284.0000	0.1691		
Price of manufactured food (Rp/kg)	PMF_t	1394.0503	0.2113	0.5772	2.1166
Domestic price of maize (Rp/kg)	PM_t	-3962.0248	0.0593	-0.6573	-2.4103
Price of wheat flour (Rp/kg)	PWF_t	4.5417	0.1083	0.0013	0.0046
Price of sugar (Rp/kg)	PSG_t	-1.3718	0.5565	-0.0005	-0.0020
Price of cooking oil (Rp/kg)	PCO_t	-1026.4945	0.0711	-0.4690	-1.7199
Per capita income (Rp '000/year)	Inc_t	13.4419	0.2086	1.5634	5.7329
Wage in industrial sector (Rp/kg)	WI_t	-46.0257	0.8602	-0.0721	-0.2643
Taste and preference	$Taste_t$	716.9015	0.1400	0.0049	0.0190
Lagged maize demand for food industry ('000 tons)	DFI_{t-1}	0.7273	0.5551		
Dummy (0 = before; 1 = during and after crisis)	D_t	-4655.4231	0.2123		
Pr > F < 0.0001; Adjusted R^2 = 0.9764; DW = 1.716					

Source: Author's own calculation.

5.1.4 Demand for feed

The model almost perfectly explains the behaviour of demand for feed with R^2 = 0.98. Table 5.4 shows that the effect of all explanatory variables are simultaneously significant. This is shown by the probability of the F-statistic which is 0.0001. On the other hand, the Durbin-Watson value is 1.72, so no serious problem of auto-correlation. Table 5.4 also shows that the population of chickens (layer and broiler) significantly influences demand for feed. However, even though demand for feed was not statistically determined by the price of chicken meat, it is highly responsive to meat price both in the short run and the long run. This is shown by its price demand elasticity of 4.32 and 4.86 respectively. In other worlds if the price of chicken meat increases by 10 per cent, demand for feed increases by 43.2 per cent in the short run and 48.6 per cent in the long run.

Table 5.4 Demand behaviour for feed in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	205.7788	0.6617		
Price of feed (Rp/kg)	PF_t	-0.0778	0.5463	-0.0405	-0.0456
Price of chicken meat (Rp/kg)	$Pmeat_t$	1.8385	0.9435	4.3200	4.8654
Population of chicken ('000 birds)	$PopC_t$	0.0042	0.0001	0.9311	0.9360
Lagged demand for feed ('000 tons)	FDm_{t-1}	0.1121	0.4449		
Dummy (0 = before; 1 = during and after crisis)	D_t	-114.7252	0.5610		
Pr > F < 0.0001; Adjusted R^2 = 0.9750; DW = 2.242					

Source: Author's own calculation.

5.1.5 Imports of feed ingredients

Some feed ingredients such as soybean meal (SBM), fish meal, meat bone meal (MBM), wheat bran and corn gluten meal (CGM) are imported. Among these feed ingredients, soybean meal is the most popular used in feed rations. Tangenjaya *et al*. (2002b) reported that soybean meal made up almost 21 per cent of broiler's feed ingredients.

FAO data shows that during the period of 1985-1994, soybean meal imports fluctuated dramatically but on average were 205.45 thousand tons, increasing from about 175 thousand tons in 1985 to about 499 thousand tons in 1994; a growth rate of 12.32 per cent per annum. Similarly to soybean meal, imports of all feed ingredients fluctuated but on average were 362.90 thousand tons (Table 5.5). There was no reliable data available before or after this period. FAO statistics show that the imports of feed ingredients during 1970-1984 and 1995-2001 were zero, which is difficult to believe or interpret.

Table 5.5 Imports of feed ingredients to Indonesia, 1985-1994

Year	Imports of feed ingredients ('000 tons)	
	Soybean meal	All feed ingredients
1985	175.22	389.00
1986	306.72	922.00
1987	257.00	257.00
1988	72.32	175.00
1989	114.38	230.00
1990	5.25	161.00
1991	93.35	137.00
1992	170.63	320.00
1993	361.06	433.00
1994	498.59	670.00
Average	205.45	362.90
Growth (%)	12.32	6.23

Source: FAO, 2002.

By using an econometric model for the period 1985-1994, imports of soybean meal were simultaneously determined by the price of soybean, the price of feed, the exchange rate, feed production and a lagged variable of soybean meal imports. The value of the F-statistic is equal to 0.0834. No single variable is significant at a confidence level of 90 per cent, or at a probability of t-statistic $\leq$ 0.1. However, all coefficients have signs in line with the a priori expectations.

All elasticities show low responses to imports of soybean meal with respect to the explanatory variables. As the domestic price of soybean increases by 10 per cent, imports of soybean meal increase by only 0.007 per cent in the short run and 0.01 per cent in the long run. In contrast, as the exchange rate increases by 10 per cent, imports of soybean meal decrease by 0.29 per cent in the short run and 0.54 per cent in the long run.

The adjusted R^2, which is equal to 0.76 indicates that 76 per cent of the variation in soybean meal imports can be explained by the variation of explanatory variables simultaneously. The Durbin-Watson coefficient of 2.28 indicates the absence of auto-correlation. The estimated parameters for the soybean meal imports' model are presented in Table 5.6.

Table 5.6 Import model of soybean meal in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	1.4826	6.0850	-	-
Domestic price of soybean	PS_t	0.1489	0.1614	0.0007	0.0012
Domestic price of feed	PF_t	0.6146	2.5022	0.0017	0.0031
Exchange rate of Rp to US$	ER_t	-3.4344	2.4615	-0.0294	-0.0536
Domestic feed production	FPR_t	1.4730	1.3771	0.0126	0.0230
Lagged soybean meal imports	Ism_{t-1}	0.4514	0.3150	-	-
Pr > F < 0.0834; Adjusted R^2 = 0.7602; DW = 2.28					

Source: Author's own calculation.

It is likely that the econometric model for all imported feed ingredients gave better results compared to soybean meal alone. Imports of feed ingredients are simultaneously determined by the price of imported feed ingredients, the domestic price of feed, the exchange rate, feed production, and lagged imports of feed ingredients. It is highly significant with an F-statistic of 0.0008. All signs of parameter estimates are as expected and highly significant with a probability of t-statistic < 0.05.

Imports of feed ingredients are likely to be inelastic with respect to the price of imported feed ingredients. If the price of imported feed ingredients increases by 10 per cent, imports of feed ingredients will decrease by only 0.03 per cent in the short run and about 0.04 per cent in the long run. In contrast, imports of feed ingredients are responsive with respect to the domestic price of feed, the exchange rate, and domestic feed production, as shown by their respective elasticities of greater than one (Table 5.7). If the exchange rate increases by 1 per cent, imports of feed ingredients decrease by about 7.95 per cent in the short run and 9.85 per cent in the long run.

Similarly, the adjusted R^2 of 0.9901 indicates that about 99 per cent of variation in feed ingredient's imports can be explained by the variation of explanatory variables used in the model. The Durbin-Watson value of 2.242 indicates that there is no auto-correlation. The results of the model are presented in Table 5.7.

Table 5.7 Import model of feed ingredients to Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	42.9948	0.0002	-	-
Price of imported feed component	$PIFC_t$	-1.8130	0.0171	-0.0029	-0.0036
Domestic price of feed	PF_t	3.0978	0.0251	4.8431	6.0006
Exchange rate of Rp to US$	ER_t	-1.6426	0.0006	-7.9467	-9.8460
Domestic feed production	FPR_t	0.4294	0.0035	2.0766	2.5729
Lagged imported feed component	IFC_{t-1}	0.1929	0.0283	-	-
Pr > F < 0.0008; Adjusted R^2 = 0.9901; DW = 2.242					

Source: Author's own calculation.

5.2 Consumer price behaviour

Consumer price behaviour is grouped into 'domestic price of maize', 'price of feed component', and 'price of feed'. Consumer price behaviour is analyzed simultaneously in relation to the demand for maize as well as demand for feed. Table 5.8, Table 5.9, and Table 5.10 respectively show the behaviour of maize prices, prices of feed ingredients, and prices of feed.

5.2.1 Maize price behaviour

Five main variables are analyzed as explanatory variables of price behaviour. Domestic price of maize is significantly affected by the total domestic demand for maize. However, domestic price was not highly responsive to demand fluctuations both in the short as well as the long run. Even though the imported price of maize does not significantly influence the behaviour of the domestic price it is highly responsive in the long run with an elasticity of 1.33 (Table 5.8).

The economic crisis did not significantly influence the domestic price of maize. This indicates that even during an economic crisis, the behaviour of domestic maize price remains determined by domestic demand. The lagged variable of domestic price slightly influences the behaviour of maize price.

Unfortunately, the econometric model developed in this study did not appropriately explain the behaviour of the domestic price of maize. This is indicated by the coefficient of determination (R^2) being very low at just 0.33. The signs of the parameter estimates were as expected. However, these results could still lead to a reliable conclusion since this was the most suitable model to explain the behaviour of the domestic price of maize. The Durbin-Watson value of 2.04 indicates the absence of auto-correlation.

Table 5.8 Behaviour of domestic prices of maize in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	1.7613	0.0060		
Domestic supply of maize ('000 tons)	Qs_t	-0.0297	0.3852	-0.4045	-0.5732
Domestic demand for maize ('000 tons)	Qd_t	0.0007	0.1005	0.3567	0.3579
Imported price of maize (US$/kg)	IP_t	0.0305	0.4124	0.9439	1.3377
Lagged domestic price of maize (Rp/kg)	PM_{t-1}	0.2944	0.2253		
Dummy (0 = before; 1 = during and after crisis)	D_t	0.1459	0.4321		
Pr > F < 0.4470; Adjusted R^2 = 0.3327; DW = 2.039					

Source: Author's own calculation.

5.2.2 Price behaviour of feed ingredients

Table 5.9 shows the behaviour of the domestic price of feed ingredients other than maize, especially soybean meal. As exhibited by the value of R^2, the econometric model used to analyze the behaviour of the domestic price of feed ingredients was statistically appropriate (R^2 = 0.93). The signs of parameter estimates were as expected. The price behaviour of feed ingredients was positively and significantly determined by the price of imported feed components and the lagged variable.

Unfortunately, the Durbin-Watson coefficient was very low (0.649) indicating the presence of auto correlation. Therefore, the choice of this model for future study must be more carefully evaluated. The behaviour of the domestic price of feed ingredients is highly responsive to the exchange rate of the rupiah to the US dollar even though it is statistically insignificant. This is shown by short as well as long run price elasticities at 1.04 and 1.32 respectively. In addition, the price of feed ingredients is responsive to world prices of imported ingredients especially in the long run.

Table 5.9 The behaviour of the domestic price of imported feed ingredients in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	-0.000015	0.9750		
World price of imported feed ingredients (US$/kg)	$PICF_t$	0.8837	0.0001	0.8431	1.0721
Exchange rate (Rp/US$)	ER_t	0.6923	0.8358	1.0354	1.3166
Lagged imported feed components (tons)	$DPICF_{t-1}$	0.2136	0.0945		
Pr > F < 0.0001; Adjusted R^2 = 0.9333; DW = 0.649					

Source: Author's own calculation.

5.2.3 Feed price behaviour

The price of feed is significantly influenced by its lagged variable and the economic crisis. In other words, the price of feed in the current year is significantly influenced by its price in the previous year. The model explains 86.4 per cent of the feed price behaviour (R^2 = 0.864). This phenomenon indicates that due to the economic crisis, some small-scale poultry businesses folded due to the rapid rise in feed prices. This is because the feed industry in Indonesia is heavily dependant on imported ingredients. If the exchange rate increases, the price of imported feed ingredients moves in the same direction. However, this has not happened since 2001, when the poultry industry in Indonesia recovered.

The value of the F-statistic equals 0.0001, indicating the highly significant affect of explanatory variables simultaneously on the behaviour of the feed price. The Durbin-Watson value 2.33 indicates the absence of auto-correlation.

The parameter estimates showed that in the short run as well as in the long run, domestic feed price behaviour is highly responsive to changes in domestic supply with elasticities of -1.46 and -1.77 respectively. Meanwhile, feed price was not significantly influenced by its supply and shows low response in both scenarios (Table 5.10).

Table 5.10 Behaviour of feed prices in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	1085.3705	0.0110		
Demand for feed ('000 tons)	FDm_t	0.1442	0.5293	0.7324	0.9934
Supply of feed ('000 tons)	FSp_t	-0.2269	0.4884	-1.4615	-1.7705
Lagged feed price (Rp/kg)	PF_{t-1}	0.1802	0.0590		
Dummy (0 = before; 1 = during and after crisis)	D_t	1095.207	0.0044		
Pr > F < 0.0001; Adjusted R^2 = 0.8640; DW = 2.333					

Source: Author's own calculation.

6. Supply of Feed and Feed Crops

Feed is the range of food or feeding stuffs available to an animal. Amongst these are forages, concentrates and succulent feeds. Feed can also be classified as conventional and non-conventional feedstuffs. Conventional feedstuffs are feedstuffs that have been traditionally used for decades or even centuries. Examples are maize, sorghum, rice, wheat, barley, cassava, fish meal and copra meal. Non-conventional feedstuffs are defined as by products derived from industry due to processing of the main products and those feeds which have not been traditionally used in animal feeding and not normally used in commercially produced rations for livestock (Hutabarat, 2003).

In this study, the discussion focuses on conventional manufactured feeds or concentrates that use secondary crops as raw materials. As mentioned earlier, among secondary crops maize is the most popular ingredient of manufactured feed in the world. In Indonesia, it makes up about 51 per cent of feed ingredients. No other crop in Indonesia can be used as an appropriate substitute for maize. Therefore, the production of manufactured feeds in Indonesia is highly dependant upon the supply of maize. Another feed ingredient is soybean meal which is imported.

6.1 Production structure

6.1.1 Maize production and supply

Domestic production of maize contributes more than 90 per cent to domestic maize supply. Less than 10 per cent of maize supply comes from imports indicating that maize supply is highly dependent on domestic production. The harvested area of maize fluctuated during the period of 1970-2001; declining during 1970-1985, increasing during 1985-1997, and then declining again during and after the economic crisis (1997-2001). These fluctuations were mainly due to unstable prices as well as changes in climate. For example, in 1997, when El-Nino hit most Southeast Asian Countries, the harvested area of maize in Indonesia declined from 3.74 million ha in 1996 to 3.35 million ha in 1997. In general, during the 1970-2001 period, the harvested area of maize grew at an average rate of 0.39 per cent per year (Table 6.1). Most maize (57 per cent) is planted on Java, which contributed about 61 per cent of national maize production (Swastika, 2002).

For more than three decades (1970-2001), maize production has shown significant growth (3.97 per cent per annum) despite the harvested area growing at only a very low rate. The high production growth of maize is attributed to the significant improvement in yield (3.57 per cent/year), indicating good technological progress, especially the increasing use of hybrids. The rapid growth in production, however, has failed to satisfy domestic demand, causing a rapid increase in net imports. As shown in Table 6.1, net maize imports increased from 18.9 thousand tons in 1980 to about 944.8 thousand tons in 2001; an average rate of 20.47 per cent per year. The import peak occurred in 2000, when net imports reached 1.24 million tons.

Table 6.1 Harvested area, production and supply of maize in Indonesia, 1970-2001

Year	Harvested area ('000 ha)	Production ('000 t)	Yield (t/ha)	Net imports ('000 t)	Supply ('000 t)
1970	2,938.6	2,825.2	0.96	-285.83	2,539.39
1975	2,444.8	2,902.9	1.19	-50.72	2,852.20
1980	2,481.8	3,525.6	1.42	18.91	3,544.51
1985	24,39.97	4,329.5	1.77	46.46	4,375.96
1990	31,58.09	67,34.03	2.13	-137.11	6,596.92
1997	33,55.22	87,70.85	2.61	1,079.39	9,850.24
2000	3,493.5	9,676.9	2.77	1,236.37	10,913.37
2001	3,279.7	9,347.2	2.85	944.8	10,291.80
Growth					2.35
1970-1975	-3.61	0.54	4.31	-	4.44
1975-1980	0.3	3.96	3.65	-	4.3
1980-1985	-0.34	4.19	4.55	-	8.56
1985-1990	5.3	9.24	3.74	-	5.89
1990-1997	0.87	3.85	2.95	-	1.1
1997-2001	-0.57	1.6	2.18	-	4.64
Average growth	0.39	3.97	3.57	20.47 [a]	4.64

Source: CAS, 1970-2001.
[a] = during 1980-2001.

Supply steadily increased from about 2.54 million tons in 1970 to about 10.29 million tons in 2001; an average rate of 4.64 per cent per annum. This growth was much lower than that of the livestock population, especially layer and broiler chickens. This implies that in future, demand for feed and consequently demand for maize as feed will grow very fast in line with the growth of the poultry population. If there is no significant growth in domestic maize production, maize imports will steadily increase.

6.1.2 Feed production and supply

Since there has been no international trade of manufactured feed, the supply of feed has come solely from domestic production and stock. The boom in the poultry industry (layer and broiler) occurred in the mid 1980s followed by feed production and its supply. In 1970, feed production totaled only 14 thousand tons, while in 1985 it was 1.06 million tons (Table 6.2) steadily increasing to about 4.5 million tons in 2001.

It seems that there was a very small quantity of feed stocked (less than 5 per cent) relative to production, although the growth of stock was relatively high (25.95 per cent/year). Therefore, the supply of feed was almost similar to domestic production itself. In terms of feed demand, the feed market before the economic crisis was almost balanced. However, since 1997 (during and after the crisis) the demand for feed has declined and as such, the feed market over supplied. The decline in demand for feed may be attributed to the closure of many poultry farms during the economic crisis. After 1998, the poultry population sharply increased, indicating the recovery of the poultry industry (Table 4.1). Considering the progress of the poultry industry since 1998, however, the future demand for feed could grow faster than domestic feed production. Therefore, the feed industry should be consistently developed to anticipate the increasing demand for feed in line with the development of the poultry industry. One alternative to increase feed production is by optimally utilizing the capacity of the factories, which are currently under-utilized.

Table 6.2 Supply of and demand for feed in Indonesia, 1970-2001

Year	Production ('000 t)	Stock ('000 t)	Supply ('000 t)	Demand ('000 t)
1970	14	0.1	14.1	13
1975	88	0.3	88.3	84
1980	447	0.8	447.8	425
1985	1,061	4.4	1,065.4	1,007
1990	1,598	7.3	1,605.3	1,546
1995	3,350	49.9	3,399.9	3,145
1997	4,445	84.8	4,529.8	3,017
1998	2,086	142.8	2,228.8	1,665
2000	4,497	74.8	4,571.8	2,497
2001	4,496	200.0	4,696.0	2,466
Growth				
1970-1975	44.43	24.57	44.33	45.23
1975-1980	38.41	21.67	38.36	38.30
1980-1985	18.87	40.63	18.93	18.83
1985-1990	8.54	10.66	8.54	8.95
1990-1997	15.74	31.60	15.97	10.02
1997-2001	0.29	23.92	0.90	-4.92
Average growth				
1970-2001	21.3728	25.95	21.49	19.58

Source: Livestock Statistics, 1970-2001.

6.2 Producer price behaviour

Producer price behaviour is reflected by the response of maize farmers to market forces and government policies. Theoretically, as the price of maize increases, farmers tend to respond by increasing their area planted with maize. In contrast, if the prices of competitive crops rise, farmers reduce the area planted with maize and grow more competitive crops. In this study, producer price behaviour is reflected in maize area and yield responses.

Similarly to the demand models, the econometric models for the supply system also use 1980-2001 series data. The linear model using the syslin procedure of SAS software was used in this analysis. The results of analysis are presented in the following section.

6.2.1 Area response

The results of the analysis showed that the area planted with maize (represented by harvested area of maize) was significantly determined by its own lagged price, soybean price, peanut price, and a dummy variable for the economic crisis. An increase in the maize price one year would result in an increase in the area planted the following year. This implies that maize farmers are unable to respond to price increases within the same year, which could be true because of the preparation time required for planting maize so that farmers have ordinarily already planted maize when the price increases. In other words, farmers decide to grow maize based on their experience with price in the previous year. The short run elasticity of maize area with respect to maize price was 0.74 which means that a 10 per cent increase in maize price one year would result in an increase in the area planted with maize by 7.4 per cent the following year.

The positive parameter estimate of soybean price indicates that soybean is not a maize-competitive crop, which is true because maize and soybean are planted in different seasons. On irrigated lowland, farmers usually grow maize during the second dry season, while soybean is usually not grown in this agro-ecosystem. This is due to the different characteristics of maize and soybean. Soybean needs relatively less water/rainfall (250-400 mm) compared to maize (300-600 mm) or peanuts (250-600 mm) per 3 months (Muhadjir, 1988; Sutoro *et al*., 1988; Saleh *et al*., 2000 and Kasno *et al*., 2000). In some cases, farmers grow maize between soybean's rows as an intercrop, to avoid the risk of failure in harvesting soybean. Therefore, an increase in soybean planting area will be followed by an increase in maize area. In this case, the area planted with soybean has a positive affect on the area planted with maize. The short run elasticity of maize area with respect to soybean price was 0.66, meaning that an increase in the price of soybean by 10 per cent would result in an increase in area planted with maize by 6.6 per cent.

The price of peanuts has a negative affect on maize area, indicating that peanuts are a maize-competitive crop. This is logical as maize and peanuts need very similar environments to grow and therefore, they are usually grown in the same season and agro-ecosystem. The elasticity of maize area with respect to peanut price was -0.61 meaning that a 10 per cent increase in the price of peanuts would result in a decline in area planted with maize by 6.1 per cent.

The effect of the dummy (economic crisis) variable on the area planted with maize was positive meaning that during the economic crisis there was an increase in the area planted with maize. The severe devaluation of the rupiah to the US dollar caused the price of imported maize to become prohibitively expensive. Therefore, most feed industries sought domestic maize making the price of maize grain very attractive, encouraging farmers to grow more maize. The results of the analysis on area response are presented in Table 6.3.

Table 6.3 The analysis of maize area response in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	427.4321	0.7081		
Lagged maize price (Rp/kg)	PM_{t-1}	1205.5610	0.0463	0.7393	-
Soybean price (Rp/kg)	PS_t	423.2828	0.0248	0.6573	-
Peanut price (Rp/kg)	PP_t	-190.8920	0.0106	-0.6071	-
Dummy (0 = before; 1 = during and after crisis)	D_t	1049.4300	0.0026		
Pr > F < 0.0175; Adjusted R^2 = 0.5076; DW = 2.5427					

Source: Author's own calculation.

As shown in Table 6.3, the signs of parameter estimates are as expected. All explanatory variables, both simultaneously and individually show a highly significant effect on the area planted with maize. This is shown by the probabilities of the F-statistic and t-statistic, which are less than 0.05. Unfortunately, the coefficient of determination (R^2) is only 0.51, indicating that only 51 per cent of variation in maize area can be explained by the variation of all explanatory variables used in the model. The Durbin-Watson value of 2.54 indicates the absence of auto-correlation.

6.2.2 Yield response

Another form of producer price behaviour is yield response. Based on the estimated results, maize yield is simultaneously determined by the lagged maize price, fertilizer price, wage rates, progress of technology, and the dummy variable (economic crisis), with a determination coefficient of 0.99. This means that about 99 per cent of variation of the endogenous (dependent) variables could be explained by the variation of the exogenous (independent) variables used in the model. All signs of parameter estimates are as expected.

The positive parameter estimate of maize price indicates that there is an incentive for farmers to increase yield through more technology application as the price of maize increases. Similarly to area response, maize farmers decide to increase yield through improvements in technology based on their experience of price in the previous year. The short run elasticity of yield with respect to its own price is 0.14, meaning that a 10 per cent increase in maize price one year would result in an increase in yield by 1.4 per cent the following year (Table 6.4).

Table 6.4 The analysis of maize yield response in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	0.4584	0.1540		
Lagged maize price (Rp/kg)	PM_{t-1}	0.1604	0.1122	0.1449	0.1916
Lagged fertilizer price (Rp/kg)	$PFert_{t-1}$	-0.1157	0.3700	-0.0614	-0.0812
Wage rates (Rp/0.5 man day)	W_t	-0.0130	0.6594	-0.0433	-0.0573
Time as proxy of technology	T	0.0498	0.0233	–	–
Lagged maize yield	Y_{t-1}	0.2437	0.3993	–	–
Dummy (0 = before; 1 = during and after crisis)	D_t	0.0401	0.7585	–	–
Pr > F < 0.0001; Adjusted R^2 = 0.9886; DW = 1.7993					

Source: Author's own calculation.

Similar to the producer's response to own price, farmers also decide to increase yield through the adoption of improved technology based on their experience with fertilizer price in the previous year. This is true for farmers who usually buy fertilizer before and during the planting season to ensure that they can apply fertilizers to their crop. The short run elasticity of maize yield with respect to fertilizer price is -0.06, meaning that a 10 per cent increase in fertilizer price in a given year would result in a decrease in maize yield by 0.6 per cent the following year. The low value elasticity indicates that farmers are generally reluctant to reduce the amount of fertilizer application, even if the fertilizer price rises. Farmers worry if their maize yield declines.

The effect of the labour wage on maize yield is negative. As wage rates increase, farmers tend to reduce labour, especially hired labour. The short run elasticity of maize yield with respect to the labour wage is 0.04 meaning that a 10 per cent increase in the labour wage would result in a decrease in the use of labour by 0.4 per cent. The low elasticity value indicates that farmers are not able to significantly reduce the use of labour, which is because farmers have a standard practice for crop management. If wages increase, farmers tend to reduce the use of hired labour but they use more family labour. Thus, an increase in labour wages only reduces the use of labour by a relatively small proportion.

The parameter estimate of technological progress (represented by time trends) is positive and highly significant indicating that there is technological improvements over time. The Durbin-Watson coefficient of 1.80 indicates that statistically there is no serious problem of auto-correlation.

6.2.3 Feed production behaviour

The producer price behaviour of the feed industry is reflected by the response of feed production with respect to market forces. The results of the analysis show that feed production is simultaneously determined by the price of feed, the domestic price of maize, domestic price of imported feed ingredients, the demand for maize as feed, the interest rate, and a dummy variable for the economic crisis, with an F-statistic of 0.0001. The coefficient of determination is 0.95, meaning that about 95 per cent of the variation in feed production can be explained by the variation of the independent variables used in the model. In addition, the signs of all parameter estimates are in line with a priori expectations. The Durbin-Watson value of 2.21 indicates that there is no auto-correlation. The detailed results of the analysis are presented in Table 6.5.

Table 6.5 The analysis of feed production in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	1128.1662	0.4243		
Price of feed (Rp/kg)	PF_t	0.4994	0.1455	0.2093	0.2546
Domestic price of maize (Rp/kg)	PM_t	-728.81	0.1237	-1.8058	-2.1965
Demand for maize as feed ('000 tons)	DF_t	1.3407	0.0001	1.2513	1.5220
Domestic price of imported feed ingredients (US$/kg)	$DPICF_t$	-0.0337	0.3297	-1.1054	-1.3445
Interest rate (%/year)	IR_t	-93.9463	0.0253	-0.2409	-0.2930
Lagged feed production ('000 tons)	FPR_{t-1}	0.1779	0.2882		
Dummy (before and after crisis)	D_t	-203.20	0.6919		
Pr > F < 0.0001; Adjusted R^2 = 0.9503; DW = 2..214					

Source: Author's own calculation.

The price of feed has a positive affect on feed production. The short run and long run elasticities of feed production with respect to feed price are 0.21 and 0.25 respectively. These numbers show that a 10 per cent increase in the feed price would encourage feed producers to increase feed production by 2.1 per cent and 2.5 per cent, in the short and long run respectively.

The domestic price of maize, domestic price of feed ingredients, and the interest rate have negative impacts on feed production. The short and long run elasticities of maize production with respect to domestic price of maize are -1.81 and -2.20 respectively, which means that a 10 per cent increase in the domestic price of maize would result in a decrease in feed production by 18.1 per cent and 22.0 per cent in the short and long run respectively. These magnitudes of elasticities indicate that feed production is elastic with respect to the domestic price of maize, which implies that the domestic maize price can be used as a strategic policy to encourage feed producers to produce feed.

The short and long run elasticities of feed production with respect to the domestic price of imported feed ingredients are -1.11 and -1.34 respectively. Again, these numbers show that feed production is elastic with respect to the domestic price of imported feed ingredients. A 10 per cent increase in the domestic price of imported feed ingredients results in a decrease in feed production of more than 10 per cent, both in the short and long run.

The interest rate is another factor that can discourage producers from producing more feed, as indicated by the negative parameter estimate and elasticities. The short run and long run elasticities are -0.24 and -0.29 respectively. An increase in the interest rate by 10 per cent would result in a decrease in feed production by 2.4 per cent and 2.9 per cent in the short and long run respectively.

The dummy variable for the economic crisis had a negative impact on feed production. The economic crisis caused an increase in the prices of maize and other imported feed ingredients, and was followed by the closure of some poultry farms. Therefore, feed production also declined, following its demand.

6.2.4 Product price behaviour

The products of feed crops discussed in this study are the manufactured feeds or concentrates (called feed). The price of feed is determined by its market forces, namely the supply of and demand for feed. Consistent with economic theory, as the supply of feed increases, its price declines. In contrast, as demand for feed increases, its price increases. The positive parameter estimate of the dummy variable showed that during the economic crisis the price of feed increased. This is true because the Indonesian rupiah sharply devalued against the US dollar. Hence, prices of imported maize and all other feed ingredients became more expensive, and therefore the feed price became more expensive.

The short run and long run elasticities of feed price with respect to feed supply are -1.46 and -1.77 respectively. A 10 per cent increase in the supply of feed would result in a decline in the feed price by 14.6 per cent in the short run and 17.7 per cent in the long run. These numbers also show that feed price is elastic with respect to its supply. On the other hand, a 10 per cent increase in feed demand would result in an increase in feed price by 7.3 per cent in the short run and 9.9 per cent in the long run. The coefficient of determination is 0.86, meaning that about 86 per cent of the variation in the feed price can be explained by the variation of the explanatory variables used in the model. The Durbin-Watson test of 2.33 shows the absence of auto-correlation. The results of the analysis on feed price are presented in Table 6.6.

Table 6.6 The behaviour of feed price in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	1085.3705	0.0110		
Supply of feed ('000 tons)	FSp_t	-0.2269	0.4884	-1.4615	-1.7705
Demand for feed ('000 tons)	FDm_t	0.1442	0.5293	0.7324	0.9934
Lagged feed price (Rp/kg)	PF_{t-1}	0.1802	0.0590		
Dummy (0 = before; 1 = during and after crisis)	D_t	1095.2074	0.0044		
Pr > F < 0.0001; Adjusted R-Square = 0.8640; DW = 2.333					

Source: Author's own calculation.

6.3 Development of farming technologies

Many efforts have been made to increase maize production in Indonesia through improvements in technology. The most popular component of technology that has been quickly and widely adopted by farmers in Indonesia is the use of high yielding varieties (HYVs). The activities of research and development carried out by Indonesian public research institutes and multinational companies have resulted in many HYVs, both composites (Open Pollinated Varieties = OPVs) and hybrids. By 2001, at least 37 OPVs and 47 hybrids had been released in Indonesia (Nugraha *et al.*, 2002). Indonesian research institutes bred all the OPVs, while multinational companies bred most of the hybrids. About 10 hybrids, namely Semar-1 to Semar-10 were bred by Indonesian research institutes. Since the 1990s, some of the released HYVs have not only shown high yields, they are also resistant to downy-mildew. This additional superiority has significantly contributed to the increase in maize yield in Indonesia.

Apart from varietal research, research on cultural practices has also been conducted. The results of this research have been disseminated through the agricultural extension programme. To speed up the transfer of technology, The Indonesian Agency for Agricultural Research and Development (IAARD) formed The Assessment Institutes of Agricultural Technology (AIAT) in each province beginning in 1995. The mandates of these AIATs are to carry out downstream or applied research and assessment, i.e. location specific assessments of mature technologies from national research institutes. The AIATs undertake research and assessment in collaboration with regional agricultural offices as stakeholders, and at the same time cooperatively work with farmers as end users of the technology. By using this approach, the transfer of improved technology from research centres to farmers will be much faster, and finally yield and then production can be increased.

6.4 Supply and demand projections to 2015

For projection purposes, this study uses short run and long run elasticities as well as the last 10 years growth of the explanatory variables. The assumptions made are (i) fifteen years is considered as a long run, and one year as a short run; (ii) the elasticity is changing over time (from short run to long run); and (iii) the future growth of explanatory variables approximately follows the last ten years growth.

Therefore, the projections as shown in equations (18) to (21) of Chapter 2 use dynamic elasticities and the previous ten years' growth of explanatory variables. Similarly, parameter estimates of the demand behaviour model as well as its respective price elasticities are calculated to compute maize and feed demand projections until 2015, using equations (22) to (25). Using these approaches, the projections of maize and feed supply as well as maize and feed demand are presented in Table 6.7.

In the future, domestic maize production is projected to increase from about 9.54 million tons in 2002 to about 12.92 million tons in 2015, or grow at a rate of 2.36 per cent per year. However, the projected domestic demand for maize is much higher (5.39 per cent/year), so a maize deficit is projected to continuously widen. There needs to be some breakthroughs to improve the technology of maize farming or extend the area planted with maize in order to speed up maize production.

On the feed side, production is projected to increase from about 4.55 million tons in 2002 to about 5.35 million tons in 2015; a growth rate of 1.25 per cent per annum. Projected production (supply) is higher than projected demand. However, since the growth of projected demand is much higher (5.40 per cent/year), a surplus is projected to occur until 2008 after which a deficit situation is predicted (Table 6.7).

Table 6.7 Projected production, demand and balance of maize and feed in Indonesia, 2002-2015 ('000 tons)

Year	Projected production		Projected demand		Balance	
	Maize	Feed	Maize	Feed	Maize	Feed
2002	9,540.69	4,549.16	9,736.75	3,524.80	-196.06	1,024.36
2003	9,744.46	4,606.03	10,011.12	3,699.76	-266.66	906.27
2004	9,958.89	4,663.60	10,349.05	3,888.26	-390.16	775.34
2005	10,184.49	4,721.90	10,765.22	4,091.38	-580.73	630.52
2006	10,421.80	4,780.92	11,277.72	4,310.25	-855.92	470.67
2007	10,671.41	4,840.68	11,908.83	4,546.11	-1,237.42	294.57
2008	10,933.91	4,901.19	12,685.96	4,800.29	-1,752.05	100.90
2009	11,209.97	4,962.46	13,642.90	5,074.23	-2,432.93	-111.77
2010	11,500.27	5,024.49	14,821.25	5,369.48	-3,320.98	-344.99
2011	11,771.68	5,087.30	15,620.12	5,659.43	-3,848.44	-572.13
2012	12,049.49	5,150.89	16,462.04	5,965.04	-4,412.55	-814.15
2013	12,333.86	5,215.27	17,349.34	6,287.15	-5,015.48	-1,071.88
2014	12,624.93	5,280.46	18,284.47	6,626.66	-5,659.54	-1,346.20
2015	12,922.88	5,346.47	19,270.01	6,984.50	-6,347.13	-1,638.03
Growth (%/yr)	**2.36**	**1.25**	**5.39**	**5.40**	**30.67**	**-34.09**

Source: Author's own calculation.

The demand for maize is projected to reach about 14.82 million tons in 2010 and then increase rapidly to 19.27 million tons in 2015. On average, the demand for maize will increase at about 5.39 per cent annually during 2002-2015. This tremendous increase in maize demand is mainly triggered by rapid increases in feed production for poultry industry development. The food industry will also play a significant role in pushing the demand for maize.

Meanwhile, under normal conditions, the demand for feed is projected to move in the same direction as maize demand. For example, demand for feed is projected to reach volumes of about 5.37 million tons in 2010, and by 2015 be close to 7.00 million tons. On average, feed demand is projected to grow at about 5.40 per cent annually.

7. Trading of Feedstuff and Feed Crops

Nationally, maize domestic production may not have comparative advantage compared with the world market, since the production structure among areas in Indonesia widely varies. Farm households' capital position, the agro-ecosystems and seasonal variability are among factors that determine the low comparative advantage of domestic maize production. However, for specific locations, especially in the main producing areas, domestic maize production shows significant comparative advantage. Feed industries are predominantly located in North Sumatra, Lampung, West Java, East Java and South Sulawesi and inter-island trading is intensified by the support of appropriate sea, as well as land transportation.

7.1 Domestic and international trading

Demand for maize from the world and domestic markets steadily increases every year. This is caused by the multipurpose characteristic of maize, such as for direct consumption, and as a raw material for feed and food processing industries. Other agricultural products cannot substitute maize as a raw material for the feed industry. This has caused the demand for maize to progressively increase, especially in developing nations, which is derived from the increasing demand for livestock products like eggs, poultry and milk.

7.1.1 Domestic trading

Results of a study conducted by Kariyasa and Adnyana (1998), Nurkhalik (1999), Sadikin (2002) and Simatupang (2003) indicate that in the main producing areas of Indonesia, producing maize has comparative advantage. In other words, if maize production is managed properly, especially in suitable areas, there is an opportunity to reduce foreign exchange expenditure for imported maize to meet domestic demand.

In the market of feedstuff, a phenomenon that is happening is the accelerating increase of the price of feed, which is far exceeding the increasing trend of the price of maize and soybean. This can also be seen from the price ratio between maize and feed that is from 0.78 in 1980 to 0.22 in 1996 (Purba, 1999). On the other hand, the continuity of supply is another factor affecting the feed market since most of the feed industries are highly dependent on imported raw materials, especially soybean meal and maize. Since 1994, the share of imported maize has been more than 30 per cent, even in 2000 the use of imported maize and domestic maize was almost the same; 47.04 per cent and 52.96 per cent respectively.

Indonesia imported about 660 thousand tons per annum on average increasing at 11.28 per cent per year during the period of 1990-2001. During the same period, Indonesia also exported 116 thousand tons per year but the trend declined at 4.20 per cent annually. Indonesia is still a net importing country for maize, although the volume is relatively small at only 19.60 per cent of the total requirement during 1970-2001. The trend of imported maize during this period was increasing with growth at about 11.81 per cent per year.

The main use of maize imports is to fulfil the need for raw materials for the feed industry. Meanwhile, the use of imported maize for the food industry is still limited. Table 7.1 presents the composition usage of maize imports and domestic production during 1970-2001.

During 1970-2001, the share of imported maize significantly increased by 11.81 per cent per year. On the contrary, the use of domestic maize declined by 3.77 per cent per year. This condition indicates the high dependency on imported maize may not be beneficial to the feed industry or livestock raising in Indonesia. Moreover, within the last ten years the volume of maize traded on the world market has been very small (Kasryno, 2002).

Table 7.1 Percentage of imported and domestic maize usage for the feed industry in Indonesia, 1970-2001

Year	Share (%)	
	Imports	Domestic
1970	0.00	100.0
1975	0.00	100.0
1980	3.20	96.80
1985	2.54	97.46
1990	3.63	96.37
1991	12.64	87.36
1993	18.29	81.71
1994	40.29	59.71
1995	34.04	65.96
1996	15.82	84.18
1997	30.36	69.64
1998	20.59	79.41
1999	30.60	69.40
2000	47.04	52.96
2001	34.97	65.03
Average	*19.60*	*80.40*
Growth (%/yr)	*11.81*	*-3.77*

Source: Kariyasa, 2003.

The tremendous increase in the livestock population during the boom of the poultry industry in Indonesia had a significant affect on maize demand from the feed industry. The increasing demand for meat due to the higher income and better welfare of the Indonesian people has triggered livestock industry development, which has created a derived demand for feed and maize. In addition, about 56 per cent of feed ingredients for carbohydrates is provided by maize. Meanwhile, on the maize production side, soybean is one of the competing crops that could significantly influence maize demand.

The research results of Nurkhalik (1999) concerning the analysis of agribusiness development strategy for maize showed that the price of maize, fertilizer and rice significantly influences maize supply in Indonesia. This research also differentiates maize demand for food and feed. The price of maize, soybean, rice, and per capita income has a significant effect on maize demand for food. Meanwhile, maize demand for feed is influenced by the price of maize, soybean price and feed price. In addition, maize and soybean are in fact complementary since maize and soybean meal are the main raw materials of the feed industry. Similar findings reported by Tangendjaja *et al*. (2002) state that maize and soybean meal are highly complementary in the feed industry. They also concluded that maize cannot be replaced by another product or commodity that gives the same quality of feed.

Research results from Rusastra *et al*. (1990) regarding feed production comparative advantage in West Java and Lampung showed that feed price fluctuation is very much influenced by raw material price distortion. Feed components make up between 70-80 per cent of production costs. Therefore, improvements in poultry and other livestock industries will significantly be determined by the performance of feed crop production. Similar findings are also obtained from study results of Hutabarat *et al*. (1993) where four provinces, namely DKI Jakarta, West Java, East Java and South Sulawesi, where maize is the main raw material, share 40-60 per cent of the feed factories. The dominant share of maize in feed is due to the low price of maize, bulk availability, high calorie content and the suitability to livestock tastes. Therefore, any effort to replace maize with other sources has not yet been successful. This finding is also strengthened by a study by Tangendjaja *et al*. (2002) that indicates the role of maize in the production of livestock feed is vitally important and cannot be replaced perfectly by any other raw material.

Yusdja and Pasandaran (1996) also support the above research findings, and they concluded that maize is the main raw material of the feed industry. Maize in feed ranges from

56-62 per cent of the total raw materials. Meanwhile feed costs are equal to 87.8 per cent of the total poultry production costs.

Furthermore, research conducted by Alim in 1996 that focused on the efficiency of feed factories in Bogor and Bekasi concluded that the price of yellow maize primarily determines factory profit and efficiency. This is due to the share of this type of maize being very high. Sensitivity analysis also showed that even a 100 per cent increase in feed price would not significantly affect the composition of feed ingredients. This again strengthens the vital role of maize in the feed industry.

Market linkages between the feed market and poultry market are very close as shown by research results conducted by Purba (1999). The production of feed is influenced by price differences between feed and maize, the interest rate, and the poultry population. However, in both the short as well as the long run, feed production was less responsive to changes in these variables. However, the price ratio between feed and poultry products, and the poultry population were among the factors that significantly influenced the demand for feed.

7.1.2 International trading

In the world market, the trade volume of maize dramatically increased during the period of 1960-1980, with the highest volume reached in 1980: 82 million tons or about 20 per cent of world production (Kasryno, 2002). However, since, maize trade volume has continuously declined despite production increases. In 2000 and 2001, the volume of exported maize was 82 million and 79 million tons or 13.86 per cent and 12.85 per cent of world production respectively. After 1980, the dependence of developing countries on imported maize progressively grew due to the rapid expansion of the poultry industry. This situation indicates that in future maize will not be as easily obtained on the world market. Again, this situation may not benefit feed factories or domestic poultry businesses. Meanwhile, domestic chicken meat production cannot meet the increasing demand. Even though during 1990-2001 the increase in domestic chicken meat production was higher than consumption at 2.76 per cent and 2.46 per cent respectively. However, Indonesia remains a net-importing country (CAS, 2001 and 2002).

World production of chicken meat during 1990- 2001 experienced growth of about 4.93 per cent on average per year (FAO, 2002). The trade volume of chicken meat during the same period was about 9.50 per cent of total world production with increases of 10.71 per cent per year. Meanwhile, the trend of world chicken meat imports is only about 9.70 per cent per year. Indonesia only imports a small volume (0.06 per cent) of the total world supply.

The economic crisis weakened the Indonesian rupiah against the American dollar and this condition caused the costs of maize production, feed, and chicken meat to progressively increase. This is due, in turn, to these businesses depending upon imported raw materials. Meanwhile, in terms of chicken meat and maize production, the performance of the domestic feed industry is strongly influenced by various government policies like a credit interest rate, fertilizer price and limited tariffs. It is important to know the affect of all changes on these three markets.

On the other hand, changes in the international strategic environment, for example WTO rules and regulations, have reduced agricultural subsidies as well as trade protection and will also encourage the domestic market to progressively integrate with the world market. The level of import tariffs for chicken meat is now equal to 5 per cent (Ditjen Keuangan, 2001), meanwhile no import tariff is imposed on maize. However, it has been proposed that an import tariff equal to 25-20 per cent together with an import tariff for rice, wheat and sugar will be introduced in the near future (Sinar Tani, 2002).

In the world market, the main maize producer is the United States of America. During 1990-2001, the USA produced about 40.22 per cent of total world production, increasing at 4.38 per cent per year (Table 7.2). The second largest maize producer is China with about 19.79 per cent of world production increasing at 2.30 per cent per year over the same period. Other maize producing countries are Brazil and Mexico with about 5.61 per cent and 3.17 per cent respectively. Meanwhile, Indonesian maize production is very small compared to the above-mentioned countries at only about 1.48 per cent.

Table 7.2 Maize production in main producer countries, 1990-2001 ('000 tons)

Year	Country						World
	USA	China	EEC	Brazil	Mexico	Indonesia	
1990	201,532	97,214	24,216	21,348	15,664	6,734	483,329
1991	189,866	99,148	28,911	23,624	16,530	6,256	494,359
1992	240,719	95,773	31,184	30,506	17,245	7,995	533,526
1993	160,985	103,110	31,704	30,056	18,631	6,460	476,681
1994	255,293	99,674	29,590	32488	19,141	6,869	569,212
1995	187,969	112,362	30,368	36,267	17,005	8,246	517,068
1996	234,527	127,865	35,576	32,185	16,000	9,307	589,174
1997	233,867	104,648	39,386	32,948	18,922	8,771	584,920
1998	247,882	133,198	36,436	29,602	16,934	10,169	615,460
1999	239,549	128,287	37,522	32,038	17,788	9,204	606,946
2000	251,854	106,180	38,774	31,879	19,000	9,677	592,501
2001	241,485	114,254	40,820	41,439	19,000	9,165	614,234
Average	223,794	110,143	33,707	31,198	17,655	8,238	556,451
Share (%)	40.22	19.79	6.06	5.61	3.17	1.48	100.00
Growth (%/yr)	4.38	2.30	5.17	6.97	2.11	3.75	2.56

Source: FAO, 2002 (computed).

Except for the United States, it is likely that the main maize producing countries in the world are not automatically maize exporters (Tables 7.3). This is caused by high maize consumption in these countries, so that the main target of producing maize is to satisfy domestic demand. During 1990-2001, the share of the United States in the international trade of maize was the highest in the world at about 63.42 per cent. As such, the trade volume of maize is very much determined by the trade policy of America. Argentina and China are two other countries that have also become maize exporters with a share of about 9.90 per cent and 8.59 per cent respectively.

Furthermore, during the period of 1990-2001, the volume of maize traded in the world market was close to 73.7 million tons or 13.31 per cent of total world production. The volume tends to decrease by 0.87 per cent on average per year. This indicates that the world market of maize is a thin market meaning that any country that immediately increases its imports will significantly affect the price of maize on the world market.

Table 7.3 Maize export volumes in the main exporting countries, 1990-2001 ('000 tons)

Year	Country					World	
	USA	Argentina	China	Hungary	Indonesia	Total	%[1)]
1990	52,172	2,998	3,405	156	146	72,039	14.90
1991	44,558	3,898	7,783	494	33	66,161	13.38
1992	43,236	6,093	10,340	2,525	150	73,842	13.84
1993	40,365	4,871	11,098	169	61	67,817	14.23
1994	35,877	4,154	8,740	181	37	65,147	11.45
1995	60,240	6,001	113	601	79	78,222	15.13
1996	52,410	6425	159	129	27	71,754	12.18
1997	41,792	10,979	6,617	1,192	19	73,066	12.49
1998	42,125	12,442	4,687	2,109	634	76,095	12.36
1999	51,975	7,890	4,305	1,708	91	78,903	13.00
2000	47,971	10,847	10,466	1,007	28	82,124	13.86
2001	47,944	10,910	5,998	1,569	91	78,910	12.85
Average	46,722	7,292	6,143	987	116	73,673	13.31
Share (%)	63.42	9.90	8.34	1.34	0.16	100.00	-
Growth (%/yr)	0.48	10.59	1.02	23.35	-4.20	1.49	-0.87

Source: FAO, 2002 (computed).
Note: [1)] percentage w.r.t. world production.

Meanwhile, growth of world imports during 1990-2001, as presented in Table 7.4, was equal to 73.09 million tons and increasing at 1.45 per cent annually. Japan is the main importing country with a share of about 22.29 per cent on average per year during the same period, followed by Republic of Korea (10.11 per cent), Taiwan Province of China (7.20 per cent), Mexico and Malaysia with import shares of about 4.92 per cent and 2.78 per cent respectively. Meanwhile, Indonesian maize imports are very small at about 0.9 per cent of the total world imports (Table 7.4).

Table 7.4 Maize import volume in main importer countries, 1990-2001 ('000 tons)

Year	Country						World
	Japan	Republic of Korea	Taiwan	Mexico	Malaysia	Indonesia	
1990	16,008	6,158	4,785	4,104	1,480	9	73,632
1991	16,646	5,477	5,321	1,422	1,464	323	65,831
1992	16,382	6,612	4,983	1,306	1,816	56	72,304
1993	16,863	6,207	629	211	2,058	494	68,951
1994	15,930	5,749	5,316	2,747	1,969	1,118	63,212
1995	16,580	9,035	6,288	2,687	2,383	969	76,964
1996	16,004	8,679	5,900	5,843	2,227	617	71,103
1997	16,097	8,313	5,742	2,519	2,745	1,098	72,358
1998	16,049	7,111	4,474	5,212	1,841	313	72,845
1999	16,606	8,115	4,575	5,546	2,200	618	75,912
2000	16,111	8,715	5,000	5,348	2,249	1,265	81,896
2001	16,222	8,482	5,100	6,174	1,975	1,036	82,079
Average	16,291	7,388	5,259	3,593	2,034	660	73,091
Share (%)	22.29	10.11	7.20	4.92	2.78	0.90	100.00
Growth (%/yr)	-0.11	3.65	-0.48	11.22	2.80	11.28	1.45

Source: FAO, 2002 (computed).

Feed production in Indonesia during 1990-2001 reached about 3.1 million tons on average, increasing 7.25 per cent annually with 78 per cent being used for the poultry industry. During 1990-1993, more than 95 per cent of total feed production was used to satisfy the demand for poultry production. Feed consumption for poultry grew at 1.77 per cent annually but its share of total feed production declined at about 4.36 per cent on average per year. Meanwhile, feed consumption for other livestock increased rapidly at about 16.99 per cent per year (Table 7.5).

Table 7.5 Chicken feed production and its share of total production in Indonesia, during 1990-2001

Year	Production ('000 tons)	Need ('000 tons)		
		Poultry		Others [1]
		Total	Share (%)	(%)
1990	1,598	1,545	96.68	3.32
1991	1,887	1,792	94.97	5.03
1992	1,806	1,774	98.23	1.77
1993	2,536	2,409	94.99	5.01
1994	3,340	2,841	85.06	14.94
1995	3,350	3,145	93.88	6.12
1996	4,296	3,448	80.26	19.74
1997	4,445	3,017	67.87	32.13
1998	2,086	1,665	79.82	20.18
1999	2,774	1,526	55.01	44.99
2000	4,497	2,497	55.53	44.47
2001	4,493	2,466	54.89	45.11
Average	3,092	2,344	78.23	21.77
Growth (%/yr)	7.25	1.77	-4.36	16.99

Note: [1] Included requirement for other races of chicken and stock.

World trade of feed ingredients during 1970-2001 reached an export volume of 186.6 million tons and an import volume of about 91.23 million tons. Global imports and exports of feed grew very slowly at only 0.10 and 0.31 per cent respectively (Table 7.6). Indonesia only exported feed ingredients in 1989, 1991, 1992 and 1995, and holistically is very small compared to world exports; only about 0.01 per cent. Indonesia also imported feed ingredients but also on a very small-scale; about 0.26 per cent of total world imports.

Table 7.6 Exports and imports of feed ingredients, 1970-2001

Year	Exports ('000 tons)		Imports ('000 tons)	
	Indonesia	World	Indonesia	World
1970	0	200,898	0	40,541
1975	0	145,896	0	15,481
1980	0	292,017	0	162,666
1985	0	123,925	389	198,054
1990	0	278,771	161	131,610
1991	44	129,213	137	71,105
1992	208	135,286	320	98,710
1993	0	114,466	433	74,937
1994	35	154,047	670	66,148
1998	0	181,906	0	56,942
2001	0	191,838	0	44,326
Average	22	186,554	241	91,230
Share (%)	0.01	100.0	0.26	100.0
Growth (%/yr)	-	0.10	-	0.31

Source: FAO, 2002 (computed).

7.2 Direction of trade

7.2.1 Maize trade

Until 2001, world maize trade was dominated by the United States of America, with an average export volume of about 63.42 per cent followed by Argentina (9.90 per cent) and China (8.34 per cent). Kasryno (2002) estimated that by 2020 the shares of USA, Latin America (Brazil, Mexico, and Argentina) and China are estimated to be 45, 15, and 23 per cent respectively. Meanwhile, the aggregated share of maize production from the developing countries will increase from 45 to 52 per cent by 2020 and their share of consumption will increase even farther, that is from 49 to 60 per cent. This is driven by the dramatic growth of maize consumption for the feed industry.

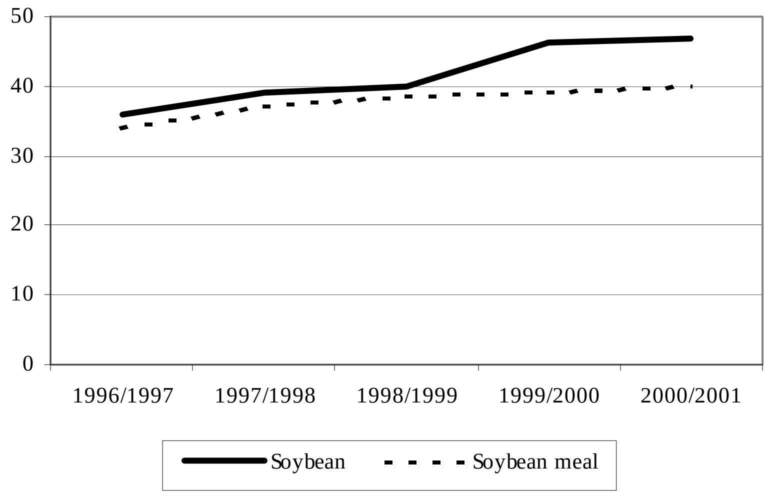
For East and Southeast Asia, the share of production is estimated to increase slowly from 24 to 28 per cent, however consumption will increase from 27 to 34 per cent. This indicates that maize imports from these countries is estimated to rise from 14 million tons to 51 million tons by 2020. China and Thailand will become net importing countries, while Latin American countries will remain as exporters due to dramatic increases in maize production in Brazil.

Indonesia and other Southeast Asian countries will experience the most significant increases in maize imports, even though the consumption level of livestock products is still low. Triggered by an ever increasing population and higher income as well as massive urbanization, the demand for livestock products will rapidly increase at 6-10 per cent annually (Delgado *et al*., 1999 and Rosegrant *et al*., 2001). This will create a derived demand for maize and other feed meals but the prospect of domestic production is limited.

7.2.2 Soybean and soybean meal trade

Global exports of oilseeds declined 6 per cent in 2000/2001, including soybean exports, which account for nearly 75 per cent of the total oilseed trade. The growth in soybean imports for other destinations cannot offset the expected decline in China's soybean imports. According to USDA, world soybean trade reached its peak in 1999/2000, with over 47 million metric tons in trade volume. In 2000/2001, however, the predicted trade volume fell nearly 1 million metric tons to 46.62 million metric tons (Figure 7.1).

Figure 7.1 World soybean and soybean meal trade



Source: United States Department of Agriculture (USDA), 2002.

On the other hand, global soybean meal trade is continuing to increase steadily, with a nearly 15 per cent growth rate since 1996/1997, in which a total of 34.30 million metric tons has been traded. The USDA predicted that the global soybean meal trade volume will rise to slightly over 40 million metric tons in 2000-2001. Two factors that encourage soybean meal trade are low prices and the use of soybean meal as a substitute for protein sources in animal feed.

7.3 Prospect of maize and feed production in Indonesia

Considering the encouraging performance of maize production in the field and the high motivation of private and multinational corporations for the introduction and production of hybrid maize seeds, it is believed that maize production prospects in Indonesia are bright. The estimated growth of 3.0-5.0 per cent per year is reasonable. The same is true for the estimate of the growth of the feed industry, which began to recover in 2000. The installed capacity of the feed industry was 10.02 million tons in 2000 but now a new processing industry is also being developed with an installed capacity of 350,000 tons per year.

Thus, the estimated growth of the feed industry at 5.0 per cent per year and other industrial uses at 3.0 per cent annually are reasonable. However, the status of Indonesia as a net importer of maize will continue with an increasing trend, as indicated by the increasing trend of the maize deficit (see Table 6.7). Studies by Erwidodo and Pribadi (2002), Ariani and Pasandaran (2002) and Tangendjaja *et al.* (2002) reached similar conclusions for domestic maize demand. The Indonesian maize economy has high backward and forward linkages with agribusiness firms. If the linkages are mutually developed, it could create a dynamic area and regional development for the country.

A drastic policy breakthrough is needed for Indonesia to change its status from a net importer to a net exporter, to exploit and manage the potentials provided by available natural resources, technology (technological capital), human resources (human capital) and rural institutions (social capital).

7.4 Maize export and import behaviour and structure

Indonesia is a net importing country for maize and poultry meat with imports increasing annually. Imports exist if the domestic price is higher than the world price so that domestic traders prefer to import maize from the world market to satisfy their needs. The utilization of maize in Indonesia is mainly for food and feed industries. However, in the case of the feed industry, the share of imported maize is relatively very small or about 19.60 per cent of total consumption. On the other hand, exports occur when there is excess domestic production and supply, and the domestic price is lower than that on the world market. Price differences create trade among countries, where products flow from surplus countries to deficit countries until the price is close to the transfer cost (Purcell, 1979).

Based on the results of the econometrical model, maize import behaviour is influenced by: (1) import price; (2) domestic price; (3) exchange rate of rupiah to US dollar; (4) Indonesian GDP; and (5) lagged volume of maize imports. Maize import behaviour is presented at Table 7.7 and world price behaviour, import prices, and domestic price behaviour are presented at Table 7.8, Table 7.9 and Table 7.10 respectively.

In general, the econometric models used to estimate the parameters of maize imports, exports and structural behaviour are statistically satisfactory as shown by the coefficient of determination and the signs of the parameter estimates. However, there is a small problem with the imported price of maize behaviour model due to auto-correlation among variables but correct signs, high R^2, and significant parameter estimates compensate this limitation. For example, the econometrical model used in this study could explain 85 per cent of the expected behaviour of maize imports as exhibited by the coefficient of determination (R^2) at almost 0.85. In addition, the magnitude and sign of parameter estimates were also as expected.

The volume of maize imported from the world market is dominantly determined by the exchange rate with respect to the US dollar, GDP of Indonesia, and the volume of maize imported in the previous year. In the short run as well as the long run, imported maize is highly responsive to the exchange rate. The volume of imports tends to drastically decline as world prices of maize increase with elasticities of about -1.69 and -2.73 in short-run and long run respectively. However, the volume of maize imported is less likely to respond to fluctuations in Indonesia's GDP. Surprisingly, the price of maize in the world market as well as the domestic price did not significantly determine the volume of imports (Table 7.7).

Meanwhile, the behaviour of the world maize price is significantly influenced by the quantity of maize imported and the volume imported in the previous year as indicated by its lagged variable. However, the world price of maize is not responsive to these two variables in the short run, but highly responsive in the long run. The world price of maize declines as the quantity of maize exports increases but not for imported maize. This phenomenon indicates that in the long run, the volume of maize imported will rapidly increase as domestic production cannot meet the increasing demand. This increasing demand for maize is derived from a rapid increase in feed demand. However, the lagged price of maize has no real affect on the world price of maize in the present year (Table 7.8).

Table 7.7 Maize import behaviour in Indonesia

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	368.0278	0.0185	-	-
Imported price of maize (US$/tons)	IP_t	-0.4863	0.2736	-0.0002	-0.0003
Domestic price of maize (Rp/kg)	PM_t	0.7073	0.3554	0.9497	1.5332
Exchange rate of Rp to US$ (Rp/US$)	ER_t	-0.2218	0.0005	-1.6931	-2.7334
Gross Domestic Product (Rp. Billion)	GDP_t	0.0015	0.0017	0.4736	0.7646
Lagged maize imports ('000 tons)	M_{t-1}	0.3806	0.0321	-	-
Dummy (0 = before; 1 = during and after crisis)	D_t	262.2728	0.3340	-	-
$Pr > F < 0.0001$; Adjusted $R^2 = 0.8478$; DW = 2.159					

Source: Author's own calculation.

Table 7.8 Behaviour of world maize price

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	-207.6836	0.5806		
Quantity of world maize exports ('000 tons)	XW_t	-0.0329	0.2026	-0.1578	-1.4590
Quantity of world maize imports ('000 tons)	MW_t	0.0361	0.1643	0.1727	1.5962
Lagged world price of maize (US$/kg)	PW_{t-1}	0.8918	0.0001		
Pr > F < 0.0001; Adjusted R-Square = 0.9542; DW = 2.404					

Source: Author's own calculation.

The imported price of maize to Indonesia is significantly determined by the world price of maize and the exchange rate to the US dollar. Particularly, the imported price of maize is highly responsive to fluctuations in the world price both in the short and long run with elasticities of about 1.83 and 5.31 respectively. On the contrary, the import price of maize did not exhibit any response to the exchange rate with elasticities of only 0.02 and 0.04 for the short and long run respectively (Table 7.9).

Finally, the behaviour of the domestic maize price is significantly determined by the total domestic demand. Even though slightly responsive, the domestic price will tend to increase as domestic demand increases. Other variables like total domestic supply, import price of maize and lagged price were not too influential on the domestic price of maize. Meanwhile, the Durbin-Watson coefficient of 1.234 indicates the existence of autocorrelation, which could be compensated by better parameter estimates.

Table 7.9 Behaviour of the import price of maize

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	-909.5502	0.0258		
World price of maize US$/kg	PW_t	1.9668	0.0001	1.8341	5.3097
Exchange rate (Rp/US$)	ER_t	0.0918	0.0509	0.0152	0.0439
Lagged imported price of maize (US$/kg)	IP_{t-1}	0.6546	0.7406		
Pr > F < 0.0001; R-Square = 0.8512; DW = 1.234					

Source: Author's own calculation.

In the long run, the domestic price of maize is highly responsive to the import price with an elasticity of 1.34. The main factors to determine the domestic price behaviour are tight market links between the international maize market and the domestic market. This is also strengthened by the increasing trend of maize imports. In addition, during the economic crisis (1997-2001), the domestic price of maize was not affected (Table 7.10). This indicates that the demand for maize during the economic crisis remained high which was due to the feed industry being unable to meet their needs from solely domestic maize production.

Table 7.10 Behaviour of the domestic price of maize

Variable label	Variable name	Parameter estimate	Pr > |t|	Elasticity	
				Short run	Long run
Intercept	Intercept	1.7613	0.0060		
Domestic total supply of maize ('000 tons)	Qs_t	-0.0297	0.3852	-0.4045	-0.5732
Domestic total demand for maize ('000 tons)	Qd_t	0.0007	0.1005	0.3567	0.3579
Imported price of maize (US$/kg)	IP_t	0.0305	0.4124	0.9439	1.3377
Lagged domestic price of maize (Rp/kg)	PM_{t-1}	0.2944	0.2253		
Dummy (0 = before; 1 = during and after crisis)	D_t	0.1459	0.4321		
Pr > F < 0.4470; Adjusted R-Square = 0.3327; DW = 2.039					

Source: Author's own calculation.

7.5 Trade response to market and non-market forces

The feed market in Indonesia tends towards an oligopolistic structure dominated by a few big feed factories. They market animal feed to small-scale livestock raisers, for example poultry breeders. However, the feed industry is highly dependant on imported feed ingredients, especially soybean meal, and maize is also projected to follow the characteristics of soybean meal international trade. Therefore, any trade policies imposed by exporting countries, export barriers for example, would immediately affect the domestic feed market since domestic maize production cannot substitute imported maize instantly. In other words, domestic feed trade would negatively respond to changes in the international trade of maize. This indicates that there are close market links between domestic and international markets of maize since Indonesia is net importer of feedstuffs.

Meanwhile, feed production in Indonesia is mainly focused on satisfying domestic consumption. Therefore, domestic trade responds slowly to changes in the international feed market. This indicates that the domestic feed market has no tight links with the international market.

Non-market forces are mostly extreme seasonal factors like El Nino, long droughts, or flooding. The feedstuff market negatively responds to these non-market forces such as: (1) distribution, especially during the heavy rains between November and February; (2) shortage of maize supply during the extreme dry periods between June and August, especially domestic maize production; and (3) pest and disease outbreaks always reduce market performance.

Recently, Avian Influenza (AI) badly affected the poultry industry in Southeast Asian countries including Indonesia. Millions of chickens were culled by their owners within a few months. AI was identified in Indonesia in August 2003; unfortunately the government as well as the poultry sector’s efforts did not begin until January 2004 to control the spread of this disease. By 25 January 2004 more than 4.7 million chickens were dead due to AI virus. This number does not include those culled by their owners to isolate further infection of this virus. Due to this non-market force, many small-scale poultry businesses folded. The government has responded to this situation by providing incentives for the poultry sector, however, this effort has been less effective since the AI out break in Indonesia. Indonesia imported vaccines from China, however the import procedure was a debatable issue meaning that the government could not directly distributed this vaccine to the target groups.

The autonomy era worsened the situation because some local governments imposed an entry barrier policy on the DOC and feed from other provinces to avoid AI spread. This policy caused local poultry businesses difficulty in finding feed for their existing chickens. According to estimates, if this AI outbreak cannot be controlled by the government and the poultry sector then the Indonesian poultry industry will experience losses of about Rp 7.7 trillion or about US$ 950 million. Therefore, this is a non-market force that has significantly affected domestic feed and feedstuff markets.

7.6 Response to government policies

In order to accelerate the domestic production of maize and feed, government policies play an important role. A series of government policies have been implemented, such as subsidies on the interest rate of credit, input subsidies, exchange rate controls, import tariffs, etc. Kariyasa (2003) conducted a simulation analysis on the impacts of some government policies, namely credit subsidies, fertilizer subsidies, exchange rate controls, and import tariffs, on the performance of the supply of and demand for maize, as well as feed in Indonesia. The results of his analysis are presented in the following discussion.

Farm credit subsidies

The imposition of a 20 per cent subsidy on farm credit interest would result in an increase in maize production by 0.02 per cent and the increase in maize production would cause a decline in the domestic price of maize by 1.48 per cent. A further impact is a decline in maize imports by 0.08 per cent. However, since the quantity of import reduction is much smaller than the quantity increase in maize production, maize supply still increases by 0.02 per cent. A decrease in maize price would result in an increase in demand for maize for feed by 0.51 per cent, and therefore, the supply of feed would also increase by 0.51 per cent. The increase in feed supply results in a decline in feed price by 3.31 per cent. Furthermore, demand for feed would increase by 0.06 per cent.

Fertilizer subsidy

A 15 per cent subsidy on fertilizer prices would encourage farmers in Indonesia to increase maize production by 1.44 per cent. But, the increase in maize production would cause a decline in maize price by 7.13 per cent, and hence, maize imports would decline by 5.46 per cent. Although maize imports decline, maize supply still increases by 1.33 per cent. On the demand side, a decline in the maize price would cause an increase in demand for maize for all purposes (food, feed, food industry, and other uses) by 10.63 per cent. An increase in the demand for maize as feed lifts production and the supply of feed by 4.31 per cent and 4.29 per cent respectively. An increase in the supply of feed causes a decline in the feed price by 5.21 per cent, but the demand for feed increases by 3.92 per cent.

Exchange rate

Depreciation of the rupiah to the US dollar by 10 per cent, would result in higher prices of imported maize in terms of rupiah. Import prices would increase by 8.16 per cent, and hence, maize imports would decrease by 4.90 per cent. Consequently, the domestic price of maize would increase by 2.40 per cent. This increase in the domestic price would encourage farmers to increase maize production and therefore its supply by 0.16 per cent and 0.13 per cent respectively. On the demand side, an increase in domestic maize price reduces its demand for feed by 0.03 per cent, and finally, reduces both the production and supply of feed by 0.09 per cent. A reduction in the supply of feed causes an increase in the feed price by 0.14 per cent, and hence, causes a decline in demand for feed by 0.14 per cent.

Import tariffs

The government of Indonesia has not yet imposed import tariffs on maize. In this simulation, import tariffs are assumed to increase the maize import price by 25 per cent, which would result in a decline in maize imports by 26.23 per cent. Consequently, the domestic supply of maize declines, and its price would increase by 10.34 per cent. This increase in the domestic price would encourage farmers to increase maize production by 0.30 per cent. On the other hand, an increase in the domestic price of maize would cause a decline in the demand for maize as feed by 0.23 per cent. Therefore, the production and supply of feed would decline by 12.61 per cent and 12.56 per cent respectively. Furthermore, the feed price would increase by 9.62 per cent, and the demand for feed would decline by 5.54 per cent.

These results show that credit and fertilizer subsidies have positive impacts on increasing maize and feed supply as well as their respective demand. On the other hand, rupiah depreciation and import tariffs on maize have a positive impact on increasing maize production, but would also result in a reduction in the demand for maize, as well as a reduction in feed production and its supply.

8. Measures to Meet Excess Demand

In order to meet the excessive demand for maize there have been imports from the world market and since the 1990s Indonesia has been a maize net-importer (Kasryno, 2002). In 1991 the amount imported was about 323 thousand tons and in 2000 this increased to 1.26 million tons. During the period of 1990-2000 the volume of imported maize equaled 20.35 per cent of national production on average (Anonymous, 2002).

8.1 Government and farmer initiatives

Mass guidance for palawija (secondary) crop production (*Bimas Palawija*) was one of the government programmes to increase domestic maize production. *Bimas Palawija* in fact is a production technology package in combination with a credit package in the form of inputs for farmers that grow secondary crops including maize. This package programme has been implemented since 1973 (Directorate General of Food and Horticulture, 1995). Another policy is the use of hybrid seeds that are expected to increase yield and farmer's on-farm income significantly. The use of hybrid seeds began in 1983, focused in eleven provincial production areas. It is expected that the average yield could reach 5 tons per hectare in this progamme. In 1998, maize again received high attention from the government through a programme known as *GEMA PALAGUNG* (*self-movement for rice, soybean and maize production*). However, various policies, which have been implemented by the government till now, have been unable to significantly increase domestic maize production.

8.1.1 Government initiatives for production technology

Research priority on maize in Indonesia is to find production technology that can reduce the yield gap between farms and research stations. A wide yield gap is mostly found on dry land and in marginal areas where most of the resource poor farmers live. To meet this challenge, the Indonesian Agency for Agricultural Research and Development (IAARD) released some new composite maize varieties that are adaptable to these areas. Meanwhile, research on hybrid maize is also focused on generating varieties that are adaptable to less favourable environments beside irrigated areas. Research results show that new varieties in combination with maize integrated crop management (ICM) could increase yield by between 3.5 and 4.0 tons per hectare.

Up to 2003, IAARD has released 28 composite maize varieties and 11 hybrids. From 2000 until 2003 IAARD produced and channeled newly released maize variety seeds such as Bisma, Lamuru and Semar-10 to seed growers. The potential yield of Lamuru reached 7.6 tons per hectare and has been widely adopted and grown by farmers, especially in Eastern Indonesia. The productivity of Lamuru at farm level is reported to be between 5.0 and 6.0 tons per hectare.

Both Bisma and Lamuru are expected to replace local varieties, which are still planted by most maize farmers. The yield gap between local varieties (2.5 t/ha) and the average yield of Bisma and Lamuru (6.0 t/ha) is 3.5 tons per hectare. Meanwhile, the average yield of Semar-10 or Bima-1 hybrid maize is about 7.0 t/ha. Thus, by planting these varieties farmers could increase their maize yield by 4.0 tons per hectare compared to the average national maize yield of 2.8 tons per hectare.

The economic impact of the new planted area for Lamuru, Bisma and hybrid maize during the period of 2000-2003 was recorded to be able to improve added value of maize production by about Rp 73.30 billion (Table 8.1) or equivalent to US$ 8.73 million. These economic impacts will rapidly increase as technology innovation continues in line with more widespread adoption of Lamuru, Bisma and hybrid maize.

Table 8.1 Economic added value of new maize varieties grown by farmers

Variety	Planted area (ha)	Yield increase (t/ha)	Production added value (Rp billion)**
Composite			
1. Bisma			
2000	2.750	3,50	9,63
2001	4.081	3,50	14,28
2. Lamuru*			
2002	3.729	3,50	13,05
2003	11.240	3,50	39,34
Hybrid			
1. Semar-10*			
2003	750	4,00	3,00
Total			73,30

Source: ICFORD, 2004.
(Paper presented during the Hearing Session with People's Representative Assembly, Jakarta, Indonesia).
Note:
* = Bisma, Lamuru and Semar-10 that released in 1995, 2000 and 2001.
** = Price of maize at farm level at Rp 1,000/kg.

8.1.2 Research and development collaboration

Research and development on maize is carried out by the Indonesian Cereal Research Institute (ICRI) located in Maros, South Sulawesi under the coordination of the Indonesian Centre for Food Crops Research and Development (ICFORD). The main mandate of this research institute is to conduct high quality and strategic up-stream research of maize and other cereals. The main research outputs of ICRI are a new superior maize variety and production technology such as integrated crop management (ICM) for each specific agro-ecosystem.

A composite maize research programme is oriented to release new maize varieties that are adaptable to less favourable areas. Recently, ICRI has given high priority research to Quality Protein Maize (QPM) in collaboration with CIMMYT in Mexico. This programme is focused on releasing new varieties of QPM for resource poor farmers in less favourable areas, especially in Eastern Indonesia such as West Nusa Tenggara, East Nusa Tenggara and Sulawesi.

In order to speed up the adoption process and diffusion of new maize varieties and production technology, ICFORD has coordinated a link and match research programme between the national research institutes under ICFORD with the Assessment Institute for Agricultural Technology (AIAT) in 28 provinces. Maize is also incorporated into crop livestock systems (CLS) and has become one of the core location specific technology assessment programmes at AIAT. Therefore, in terms of maize research and development programmes, vertical as well as horizontal dissemination programmes have been well organized.

8.2 Farmer participation in feed crop development

In Indonesia, there are at least two categories of maize farmers, namely subsistence and commercial farmers. The subsistence farmers usually grow maize mainly for home consumption. They usually sell a small portion of their maize grain to buy other daily needs. Therefore, the varieties of maize being grown are mainly local varieties that are usually white with good taste, but low yield.

On the other hand, commercial farmers grow maize for profit. This group of farmers are very responsive to the progress of maize technology development. They are willing to adopt new technology, especially the use of high yielding varieties (OPVs or hybrids) with a high level of technology application. These high yielding varieties are mainly used for feed. This latter group are the farmers from whom feed crop development is expected to come because they usually participate more in the adoption of improved technology.

8.2.1 Feed crop farming

The results of the study conducted by Swastika *et al*., (2001) show that maize is mostly cultivated on dryland, especially during the wet season, and on rainfed and irrigated lowland during the dry season. There has been a big change in the varieties cultivated, from local maize to OPVs, hybrids and their recycles. Only for human consumption do farmers maintain local maize. The level of farming technology being applied by farmers can be reflected by the performance of the components of the technology, such as land preparation, the use of varieties and the use of fertilizers. Another indicator for the level of technology application is yield.

As shown in Table 8.2, local maize is grown by farmers in Tuban (East Java), and Bone (South Sulawesi). Farmers in these two districts are subsistence farmers, who grow maize mainly for domestic consumption. The pure hybrids are grown in irrigated areas of East Java during the dry season, on dryland in Lampung during the wet season, and on dryland in Jeneponto during the dry season, followed by NTB during the wet season. The recycled maize (second to third generation of hybrids) is grown in Lampung during the dry season, Jeneponto during the wet season, NTB during the wet season, and Tuban during the wet season. Farmers who grow hybrids are the commercial farmers. They grow maize for sale. Therefore, they choose the high yielding varieties of maize, especially hybrids, although the seeds are expensive. For example, the price of hybrid seeds in 2000 was about Rp 18,000 to Rp 20,000 per kg, while local seeds were about Rp 3,000 per kg. It is interesting to note that only a few farmers (2 per cent to 3.75 per cent) grow OPVs because no OPV seeds were available in the local markets. This was one of the problems faced by farmers who want to grow OPVs with high yields and cheaper seeds.

Table 8.2 Maize varieties grown in four provinces of Indonesia, 2000

Province/land type	Season	Local	Improved OPVs	Hybrids	Recycled
			(%)		
Lampung:					
Dryland	WS	-	-	87.50	12.50
	DS	-	-	23.75	76.25
East Java:					
Irrigated (Kediri)	WS	-	-	-	-
	DS	-	-	100	-
Dryland (Tuban and Kediri)	WS	47	2	29	22
	DS	-	-	-	-
Rainfed (Tuban)	WS	40	-	20	40
	DS	80	2	-	18
Nusa Tenggara Barat:					
Dryland	WS	0.25	3.75	40.60	55.40
	DS	-	-	-	-
South Sulawesi:					
Dryland (Jeneponto)	DS	7.50	2	59.20	31.30
	WS	8.80	2	21.70	62.50
Irrigated/RFLL (Bone)	DS	93.70	-	-	6.30
	WS	-	-	-	-

Source: Swastika *et.al*., 2001.

The second indicator for the current level of technology is land preparation. Most farmers use animal traction for land preparation. Only in Sumbawa and irrigated lowlands of East Java are farmers using tractors. This is due to insufficient availability of tractors in the study areas. On the other hand, carabao are available for land preparation. Only farmers from the drylands of Jeneponto use zero tillage (the most efficient land preparation) for wet season maize.

A few farmers in all areas use human labour (manual) for land preparation. The details of land preparation practices by farmers in the study areas are presented in Table 8.3.

Table 8.3 Land preparation practices for maize farming in four provinces of Indonesia, 2000

Province/land type		Land preparation (%)			
		LP0	LP1	LP2	LP3
1. Lampung: dryland		-	2.12	75	23
2. East Java: irrigated		-	-	49	51
dryland		-	-	80	20
rainfed		-	-	70	30
3. West Nusa Tenggara:					
East Lombok		-	8	86	6
Sumbawa		-	-	37	63
4. South Sulawesi: dryland:	DS	-	6.3	93.7	-
	WS	67.5	32.5	-	-
Irrigated/RFLL:	DS	-	25	75	-

Note: LP0 = zero tillage; LP1 = manual; LP2 = using animal; LP3 = using tractor.
Source: Swastika *et al*., 2001.

The main indicator for the level of technology application is the use of material inputs, such as seeds, fertilizers and pesticides. There was no significant difference among farmers in terms of the quantity of seeds used. The difference was in terms of the quality or variety, as shown in Table 8.2.

In terms of fertilizer use, it seems that farmers who grow hybrids (irrigated areas of East Java, Lampung in the wet season, and Jeneponto in the dry season) use more fertilizers. Even in irrigated areas of East Java and Jeneponto during the dry season, farmers use 5 types of fertilizer, namely Urea, ZA, SP-36, KCl, and manure (Table 8.4). Therefore, hybrid maize farming is the most intensive among maize cultivation. The second most intensive cultivation was recycled maize farming (Lampung DS and Jeneponto WS). In contrast, farmers who grew local maize (dryland and rainfed in East Java and Bone), applied less fertilizers in terms of both quantity and type. These facts indicate that commercial maize farmers participate more in increasing maize production through the adoption of improved technology.

Table 8.4 Material input use for maize farming in four provinces of Indonesia, 2000

Provinces		Inputs usage						
		Seed (kg)	Urea (kg)	ZA (kg)	SP-36 (kg)	KCl (kg)	Manure (kg)	Herbicides (lt)
1. Lampung:								
	WS	15	208.5	-	112.5	25	325	2.875
	DS	21.5	165.6	-	90.6	18.75	-	1.4
2. East Java:								
Irrigated		20	392.5	112.5	150	52	7,500	-
Dryland		20	150	0	0	0	1,500	-
Rainfed		20	100	0	25	0	2,250	-
3. Nusa Tenggara Barat:								
E. Lombok		20	162.5	-	56	-	-	-
Sumbawa		20	275	-	-	-	-	-
4. South Sulawesi								
Jeneponto	DS	16	175	117	138	50	1250	1.4
	WS	18	160	95	123	50	-	1
Bone	DS	24	75	50	-	-	1125	0.5

Source: Swastika *et al*., 2001.

Another indicator of the level of technology application is the maize yield. Table 8.5 shows that the highest yield was obtained using hybrids in irrigated areas of East Java (6.35

t/ha), followed by dryland in Jeneponto, South Sulawesi (5.4 t/ha), and then Lampung (4.5 t/ha). The second highest yield was for recycled maize, followed by OPVs and local maize respectively. Details of maize yield in four provinces of Indonesia are presented in Table 8.5.

As shown in Table 8.5 there exists a wide yield gap between hybrids, OPVs and local maize implying there is opportunity to increase yield and consequently production by the expansion of hybrid usage in maize farming. The results of financial analyses also show that the most profitable maize production within the study areas was "maize production on irrigated lowlands of East Java using pure hybrids".

Table 8.5 Yield level of maize in four provinces of Indonesia, 2000

Province/land Type/season		Local (t/ha)		Impr. OPV (t/ha)		Hybrids (t/ha)		Recycled (t/ha)	
		Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
1. Lampung:									
	WS	-	-	-	-	4.75	3–7.5	3.49	3–4.5
	DS	-	-	-	-	4.32	3–5	3.46	2–4.5
2. East Java:									
Irrigation		-	-	-	-	6.35	5.4–7.7	-	-
Dryland		1.53	0.8–2.6	-	-	-	-	2.32	1.5-3.7
Rainfed		1.61	1.0–2.5	-	-	-	-	-	-
3. Nusa Tenggara Barat:									
Lombok		-	-	-	-	3.5	2.5–4.5	2.5	1.5–3.6
Sumbawa		-	-	-	-	3.3	2.5–6.0	-	-
4. South Sulawesi:									
a. Dryland:	DS	2.0	1–3	3.5	3–4	5.4	3–8	4.6	2–6
	WS	1.8	1–3	3.5	3–4	5.3	3–8	4.0	3–6
b. Irrigated		1.8	0.5–2.5	2.5	2–4	-	-	-	-

Source: Swastika *et al*., 2001.

8.2.2 Constraints to maize farming

Some constraints faced by farmers hindering increased maize production are (i) price fluctuations (very low price of maize grain during harvesting season); (ii) high price of inputs; (iii) long distance between maize production areas and feed mills as well as seed industries; (iv) lack of promotion of OPVs and hybrids bred by governments research centres; (v) lack of access to sources of cash capital; and (vi) increasing maize imports. In order to encourage farmers to increase their maize production, there needs to be policies implemented by the Government of Indonesia. These policy orientations will be discussed using SWOT analysis in the next section of this chapter.

8.3 Potentials, opportunities and constraints to maize production expansion

SWOT analysis has been applied in order to give better understanding of the potentials of and constraints to maize production expansion. Following Sianipar and Entang (2001), the analysis comprised of various steps. Step 1; identification of internal and external factors. Step 2; determination of percentage of weighted internal and external factors (BF). Step 3; evaluation of supporting value of each internal and external factor (ND) using a scale of 1 to 5. Step 4; computation of supporting weighted value of those factors (NBD). Step 5; evaluation of level of linkage among internal and external factors using a scale of 1 to 5. Step 6; computation of average value of factors' linkage (NRK). Step 7; computation of linkage weighted value among internal and external factors (NBK) = BF * NRK. Step 8; computation of total weighted value (TNB) = NBD + NBK.

Based on the value of TNB, the most important strengths, weaknesses, opportunities and threats of feed crop expansion are determined. Thus, strategy, policy option, programmes and the ultimate goal of feed crop expansion in Indonesia can then be formulated (Adnyana, 2004).

Domestic maize production is characterized by strengths and weaknesses (internal factors) and opportunities and threats (external factors) such as depicted in Table 8.6. The strengths of maize production are: (1) low labour wage; (2) abundant land resources; and (3) a well developed hybrid seed industry. On the other hand, the weaknesses of maize production include: (1) inappropriate post-harvest handling leading to low quality grains; (2) low direct access to sources of capital; and (3) seasonal price fluctuations. Some opportunities are available to expand domestic maize production, namely; (1) strong domestic demand for maize which is used as one of the main raw materials for feed; (2) production partnership between feed producers and maize growers; and (3) high potential yield improvements through the application of hybrid varieties. There are some threats, however, to maize production, namely: (1) the increasing trend of maize imports; (2) long droughts possible, which hamper maize production; and (3) high competition with other crops in terms of planted area.

Table 8.6 Internal and external factors of maize production in Indonesia, 2004

No.	Internal factors		External factors	
	Strengths	Weaknesses	Opportunities	Threats
1.	Low labour wage	Inappropriate post-harvest handling	Strong domestic demand	Increasing trend of maize imports
2.	Abundant land resources	Low direct access to sources of capital	Partnership between feed producers and farmers	Long droughts
3.	Well developed hybrid seed industry	Seasonal price fluctuations	High potential yield improvements	High competition with other crops

Source: Author's own study.

Based on the SWOT analysis, the most essential internal and external factors can be concluded as follows: (1) the existing hybrid seed industry is highly developed (strength); (2) farmers do not usually conduct post-harvest handling appropriately (weakness); (3) strong domestic demand for maize as the main raw material for the feed industry (opportunity); and (4) increasing maize imports directly competing with domestic maize production (threat). Following the identification of four internal and external factors, a strategy to develop domestic maize production can be formulated as: (1) increase maize yield by utilizing hybrid seeds to satisfy strong domestic demand; (2) enhance domestic maize production by utilizing hybrid seeds to reduce the dependence on imported maize; (3) improve maize grain quality by adopting proper post-harvest technology to satisfy domestic demand; and (4) develop grain quality of maize by adopting appropriate post-harvest technology to partially substitute imported maize (Table 8.7).

Table 8.7 Strategy formulation of maize production in Indonesia, 2004

INTERNAL FACTOR / EXTERNAL FACTOR	**STRENGTHS** Well developed hybrid seed industry	**WEAKNESSES** Inappropriate post-harvest handling
OPPORTUNITIES Strong domestic demand for maize	**STRATEGY: SO** Increase maize yield by utilizing hybrid seeds to satisfy strong domestic demand	**STRATEGY: WO** Improve maize grain quality by adopting proper post-harvest technology to satisfy domestic demand
THREATS Increasing trend of maize imports	**STRATEGY: ST** Increase domestic maize production by utilizing hybrid seeds to reduce the dependence on imported maize	**STRATEGY: WT** Improve grain quality of maize by adopting appropriate post-harvest technology to partially substitute imported maize

The goals of domestic maize production have been set based on the results of the SWOT analysis, those are: (1) competitive domestic maize production in terms of production costs and grain quality; and (2) improved maize farmers' income. It implies that efficient maize production characterized by good quality grain will improve maize farmers' on-farm income. To attain the goals, four strategies are established consisting of four policy options and eight programmes. The policy options are: (1) promotion of hybrid seed application; (2) intensive application of appropriate maize post-harvest technology; (3) expansion of area planted to hybrid maize; and (4) maize grain quality improvement.

Table 8.8 Ultimate goals, strategies, policy options and development programmes of maize production in Indonesia, 2004

No.	Goal	Strategy	Policy option	Programme
1.	Competitive domestic maize production in terms of production costs and grain quality.	**SO** Increase maize yield by utilizing hybrid seeds to satisfy strong domestic demand.	Promotion of hybrid seed use.	1. Maize intensification. 2. Soft credit for maize production.
2.	Improvement of maize farmers' income.	**WO** Improve maize grain quality by adopting appropriate post-harvest technology to satisfy domestic demand.	Intensive application of appropriate maize post-harvest technology.	1. Farmer training on post-harvest handling. 2. Provision of post-harvest machinery through farm credit.
		ST Increase domestic maize production by utilizing hybrid seeds to reduce dependence on imported maize.	Expansion of area planted to hybrid maize.	1. Maize extensification. 2. Farmer groups consolidation.
		WT Improve grain quality of maize by adopting appropriate post-harvest technology to partially substitute imported maize.	Maize grain quality improvements.	1. Post-harvest handling field school. 2. Grain quality promotion.

The programmes comprise: (1) maize intensification; (2) soft credit for maize production; (3) farmer training on post-harvest handling; (4) provision of post-harvest machinery through farm credit; (5) maize intensification; (6) farmer group consolidation, especially farm management; (7) post-harvest handling field school; and (8) grain quality promotion (Table 8.8).

Evaluation of domestic maize production in Indonesia was carried out based on the net value of the total weighted value (TNB) on each internal factor and external factor. The results are presented in Table 8.9. The value of TNB of internal factors is equal to –1.36, which indicates that internally, maize production in Indonesia is weak; characterized by farmers' capital constraints, poor post-harvest handling and low prices of maize grain. In other words, maize production in Indonesia faces more weaknesses than strengths. However, in terms of external factors, the result is positive (0.36) meaning that maize production in Indonesia has more opportunities than threats, indicating good opportunities to develop.

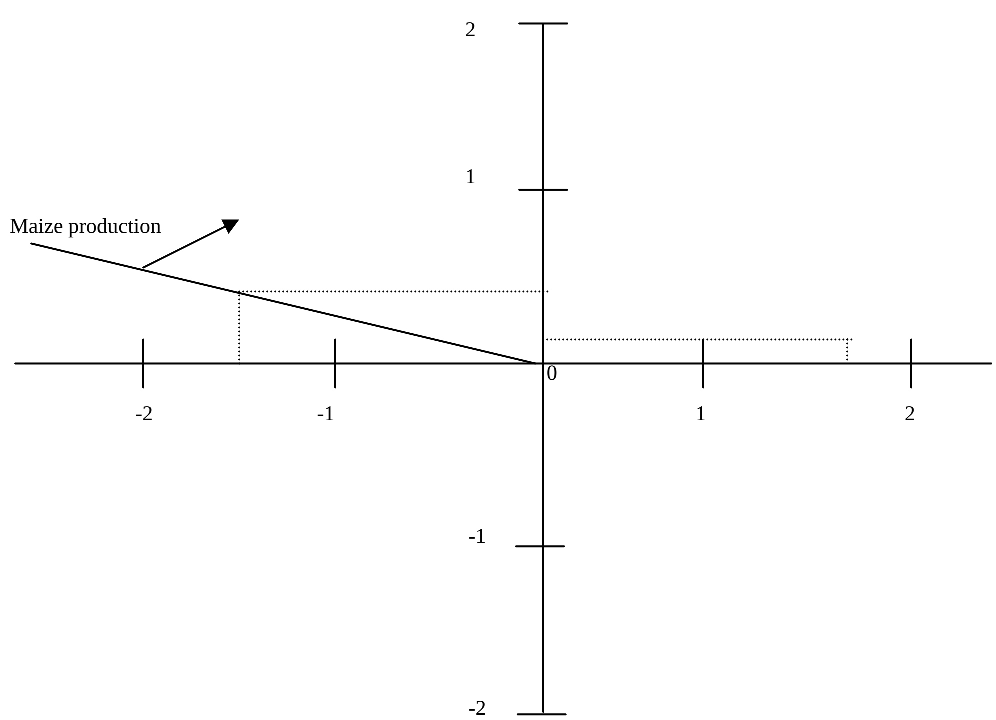
Table 8.9 Performance mapping of domestic maize production in Indonesia

Industry	Internal factors	External factors
Domestic maize production	-1.36	0.36

Source: Author's own calculation.

Mapping the results of Table 8.9 in the form of a graph is depicted in Figure 4, where the horizontal axis represents internal factors and the vertical axis represents external factors. Figure 4 shows maize production in Indonesia located at Quadrant II. This position indicates that maize production is on alert; i.e., if there is an unfavourable change in external factors, production fall into quadrant III and collapse.

Figure 8.1 Performance map of maize production in Indonesia, 2004



Source: Author's own calculation.

9. Conclusions and Policy Implications

This comprehensive study on feed crops and the feed industry in Indonesia that also linked domestic and international market models provided some important highlights and conclusions. From these conclusions are derived some policy options and implications. Strategies, policy options and programmes have been developed as inputs for feed crop development in the future.

9.1 Conclusions

(1) Domestic maize production remains unable to meet its rapidly increasing demand at present or in the future. This is due to various factors such as: (1) maize belongs to secondary crops after rice, therefore, the Government of Indonesia (GOI) has given less priority to this crop; (2) maize is usually grown after rice in irrigated areas so that there are many competing crops for the land, while maize that is grown on dry land or in less favorable environments is usually of low productivity; (3) maize in most cases is less competitive compared with other crops such as vegetables, groundnut and other high-value crops on irrigated land after rice; (4) low productivity is one of the most important aspects that makes this crop less competitive; and (5) technological break throughs are limited to only hybrid seeds, which usually only respond to high inputs and are only adaptable to favorable areas such as irrigated areas with well drained systems.

(2) In the early stage of economic development Indonesia remained self-sufficient in maize production at least until 1975. The boom of the broiler chicken industry triggered the rapidly increasing demand for maize in the 1980s. This increasing demand for maize is derived from dramatic increases in meat demand, especially chicken meat, which is relatively cheaper compared to beef, pork and other types of meat. An increasing population and better per capita income are the main sources of this increased meat demand. This trend is also true for the demand for other meats.

(3) To meet the rapid growth in domestic demand for maize as one of the most significant feed ingredients, GOI imported maize from the world market on an ever increasing scale. Despite the volume of imported maize being relatively low at about 10 per cent of total maize consumption, it is increasing by 11 per cent annually. Meanwhile, total maize consumption (food, food industry, feed industry etc.) is increasing by more than 4 per cent per year.

(4) Most imported maize (51 per cent) is used by the feed industry, while soybean meal accounts for about 18 per cent. Indonesia is a net importing country for soybean meal and there is no domestic production. This indicates that the domestic feed industry is heavily dependant upon imported raw materials, especially maize and soybean meal.

(5) The economic crisis temporarily affected the poultry industry during the period of 1998-2000. Almost all economic sectors felt the crisis except the agricultural sector. Since imported maize is mostly allocated to the feed industry, accounting for less than 10 per cent, the crisis did not substantially affect domestic maize production. During the crisis, the food crop sub-sector, of which maize belongs, experienced growth. This indicates that agriculture was the most resilient sector during the economic crisis.

9.1.1 Domestic production

(6) Area and yield are two variables that determine domestic maize production. The parameter estimates of the area response model showed that the area planted with maize was significantly determined by a lag of its own price, soybean price, peanut price, and a dummy variable for the economic crisis. This indicates that an increase in the maize price of a given year would result in an increase in maize area the following year. In other words, maize farmers are not able to respond to increases in maize prices within the same year.

(7) Yield response of domestic maize production is determined by the lagged maize price, lagged fertilizer price, wage rates, production technology, and a dummy variable for the economic crisis. The positive parameter estimate of maize price indicates that farmers tend to increase yield through technology intensification. Maize yield is less responsive to its own price, especially in the long run.

(8) The parameter estimates of feed production bahaviour showed that feed production is simultaneously determined by the price of feed, domestic price of maize, domestic price of imported feed ingredients, demand for maize as feed, interest rate, and a dummy variable for the economic crisis. The domestic price of maize, price of feed ingredients, and the interest rate have negative impacts on feed production. Both in the short and long run domestic feed production is highly responsive to the domestic price of maize, maize demand as feed, and domestic price of imported feed ingredients.

9.1.2 Domestic demand

(9) The parameter estimates showed that the domestic demand for maize from the feed industry is negatively responsive to the price of soybean in the long run. This indicates that both commodities are complementary. Maize demand is also responsive to its own domestic price and significantly determined by its demand in the previous year. The economic crisis hampered the demand for maize from the feed industry. This was due to the closure of some small-scale poultry farms.

(10) Maize demand for direct food consumption is simultaneously determined by the domestic price of maize, the price of milled rice, per capita income, tastes and preferences, and the crisis dummy variable. Maize demand for direct food consumption was negatively responsive with respect to per capita income, meaning that maize is considered as an inferior food. The economic crisis had a positive impact on direct consumption of maize due to falls in income and rice becoming more expensive.

9.1.3 Domestic and international trade

(11) The econometric model used in this study showed that the demand for maize for the food industry is significantly determined by: (1) the domestic price of maize; (2) the price of wheat flour; (3) the price of cooking oil; (4) per capita income; and (5) consumer tastes and preferences. Maize will no longer be considered an inferior good if it is processed into manufactured food by the food industry. This is supported by positive income elasticity.

(12) Demand for feed is strongly determined by the chicken population. However, although maize demand for feed is not statistically determined by the price of chicken meat, it is responsive to meat price, both in the short and the long run.

(13) In the world market since the 1980s, the dependence of developing countries on imported maize has progressively increased. This is due to the rapid expansion of the broiler and layer industry. This situation indicates that in the future maize may not be easily imported from the world market. In turn, this will not benefit the feed industry or the domestic poultry industry.

(14) The performance of the domestic feed industry is strongly influenced by various government policies namely: credit schemes, bank interest rates, input prices, and limited tariffs imposed by GOI, especially on imported maize. On the other hand, changes in the international market environment policy imposed by big maize producing countries like the USA, Argentina, Brazil etc., and WTO regulation have reduced agricultural subsidies as well as trade protection. This will encourage the domestic feed market as well as maize progressively integrate with the world market meaning that any international market change in maize or other feed ingredients will immediately affect the domestic market.

(15) At the regional level such as East and Southeast Asia, the share of maize production is estimated to slowly increase from 24 to 28 per cent, however, consumption is projected to increase from 27 to 34 per cent. This indicates that maize imports will continuously rise. Indonesia and other Southeast Asian countries will experience the most significant increases in maize imports, even though consumption levels of livestock products are still low.

(16) Triggered by an increasing population and higher income as well as massive urbanization, the demand for livestock products will rapidly increase by 6-10 per cent annually. This will lead to a derived demand for maize and other feed meals.

(17) On the other hand, global trade of soybean meal will continue to increase steadily. USDA for example, has predicted that the global trade of soybean meal will rise to slightly over 40 million metric tons in years to come. Two factors that encourage this trend are: (i) low prices; and (ii) the use of soybean meal as the main source of protein in animal feed.

9.1.4 Projections to 2015

(18) Domestic maize production is projected to increase from about 9.54 million tons in 2002 to about 12.92 million tons in 2015, or grow at about 2.36 per cent annually. However, the growth of projected domestic demand for maize is much higher (5.39 per cent/year), so that the maize deficit is projected to continuously increase. There needs to be some breakthroughs to improve the technology associated with maize farming, or the area planted with maize needs to be expanded in order to ameliorate maize production.

(19) Feed production is projected to increase from about 4.55 million tons in 2002 to about 5.35 million tons in 2015, or an increase of about 1.25 per cent per year. Projected production is higher than projected demand. However, since the growth of projected demand is much higher (5.40 per cent/year), the surplus is only projected to occur until 2008 followed by a deficit condition thereafter.

9.2 Policy implications

(1) The GOI protective policies on rice and sugarcane influence the growth rate of domestic maize production. If GOI relaxes its policy intervention and protection for these two commodities maize production is predicted to grow faster than at present. The policy implications of this trend should be coupled with further inducement in R&D and enhanced maize production technology, especially the use of hybrid seeds and integrated crop management (ICM). Therefore, the GOI budget for R&D should be immediately tripled for maize research.

(2) The results of policy simulations showed that credit and fertilizer subsidies have positive impacts on increasing maize and feed supplies as well as their respective demand. On the other hand, rupiah depreciation and import tariffs on maize have a positive impact on increasing maize production but result in a reduction in the demand

for maize, followed by a reduction in feed production and supply. The implication is that the GOI should provide farmers with soft farm credit and impose import tariffs to encourage farmers to produce more maize.

(3) Another important implication of the results is that government policy could affect not only domestic supply of and demand for maize and feed, it could also affect prices of maize and other feed ingredients in the world market since maize has a thin market. Thus, there is a strong link between domestic policy and the international market.

(4) Meanwhile, the results of the SWOT analysis showed that domestic maize production should be directed to various goals and objectives such as: (1) competitive domestic maize production in terms of production costs and grain quality; and (2) improve maize farmers' income. This implies that efficient maize production characterized by good grain quality will improve maize farmers' on-farm income. To attain these goals, strategies have been established that consist of four policy options, including: (1) promotion of hybrid seed application; (2) intensive application of appropriate post-harvest maize technology; (3) expansion of area planted with hybrid maize; and (4) maize grain quality improvements.

(5) The action programmes that are necessary comprise of eight prioritized programmes: (1) maize intensification; (2) soft credit for maize production (subsidized interest rate); (3) farmer training on post-harvest handling and processing; (4) provision of post-harvest machinery through farm credit; (5) maize intensification and extensification by using areas between estate crop plantations; (6) farmers' groups consolidation especially on-farm management and marketing; (7) post-harvest handling field schools and (8) promotion of grain quality management.

(6) Further study is necessary to explore the opportunities of other sources of carbohydrates that could partially substitute maize in the feed industry. Other feedstuff crops such as soybean, tuber crops, etc., should be comprehensively studied. Newly released maize varieties, so called quality protein maize (QPM), must be closely evaluated as a demand driving commodity in order to create its own demand. QPM has the potential to reduce the use of soybean meal since the protein contained in this maize is double, especially lysine, compared to other maize varieties including hybrid corn.

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