DEMAND AND SUPPLY ANALYSIS OF CORN IN INDONESIA FROM 1970 - 1988

By

Mohamad Rum Ali

A RESEARCH PAPER (PLAN B)

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1989

ACKNOWLEDGMENTS

I wish to express my sincere gratitude to Dr. Darrel F. Fienup, my major professor, for his kindness, guidance and encouragment of this study.

Thanks are also due to Dr. John M. Staatz and Dr. Shlomo Leventhal, members of the guidance committee for valuable suggestions.

Appreciation is also extended to Dr. John N. Ferris for his suggestion in preparation of this paper.

Gratitude is expressed to the Center for Policy and Implementation Studies (CPIS), Jakarta, Indonesia, which provided me with the opportunity to participate in the Master's program at Michigan State University, and to Harvard Institute for International Development (HIID) for providing me with a fellowship.

Not least of all, to my wife, Yosini Deliana and my children Ira Adiyati and Irlan Adiyatma, I am appreciative for their many sacrifices and patience during my study in the U.S.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENT	i
TABLE OF CONTENTS	ii
LIST OF FIGURES	iv
LIST OF TABLES	V
I. INTRODUCTION	
1. GENERAL DESCRIPTION OF CORN IN INDONESIA	1
2. STATEMENT OF THE PROBLEM	3
3. OBJECTIVE OF THE STUDY	5
4. METHODOLOGY AND DATA COLLECTION	6
II. THE ROLE OF THE GOVERNMENT IN DEMAND, SUPPLY AND MARKETING OF CORN IN INDONESIA	
1. DEMAND	7
2. SUPPLY	8
3. MARKETING	9
III. THE FACTORS OF DEMAND AND THE ESTABLISHMENT OF THE DEMAND EQUATION FOR CORN	
1. THE FACTORS OF DEMAND FOR CORN	11
2. DEMAND EQUATION	17
1. SELECTION OF VARIABLES	17
2. METHODOLOGY	19
3. THE ESTIMATED DEMAND EQUATION	20
4. EVALUATION OF THE DEMAND EQUATION	21
1. STATISTICAL PROPERTIES	21
2. ECONOMIC THEORIES	24
3. DISCUSSION	26
IV. THE FACTORS OF SUPPLY AND THE ESTABLISHMENT OF THE SUPPLY EQUATION FOR CORN	
1. THE FACTORS OF SUPPLY FOR CORN	29
2. SUPPLY EQUATION	32
1. SELECTION OF VARIABLES	32
2. METHODOLOGY	34

		Page
	3. THE ESTIMATED SUPPLY EQUATION	34
	4. EVALUATION OF THE SUPPLY EQUATION	36
	1. STATISTICAL PROPERTIES	36
	2. ECONOMIC THEORIES	37
	3. DISCUSSION	38
V.	PROJECTION OF DEMAND AND SUPPLY OF CORN (1989-2000)	
	1. DEMAND PROJECTION	40
	2. SUPPLY PROJECTION	42
VI.	CONCLUSION AND IMPLICATION IN AGRICULTURAL POLICIES	
	1. CONCLUSION	45
	2. POLICY IMPLICATIONS	47
VII.	SUMMARY	49
	REFERENCES	

LIST OF FIGURES

		Page
Figure 1.	Area Harvested of Corn, Soybeans, Peanuts, Cassava and Rice.	54
Figure 2.	Typical Monthly Rainfall and Cropping Patterns in Multiple Crop Tegal System.	55
Figure 3.	Typical Monthly Rainfall and Cropping Patterns in Single Corn Crop Tegal Systems.	56
Figure 4.	Typical Monthly Rainfall and Cropping Patterns in Irrigated Sawah Systems.	57
Figure 5.	Typical Monthly Rainfall and Cropping Pattern in Rain-fed Sawah System.	58
Figure 6.	Real Prices of palawija.	59
Figure 7.	Area Harvested, Yield and Production of Corn 1970-1988.	60
Figure 8.	Corn Marketing in East Java.	61
Figure 9.	Actual and Estimated Corn Used For Livestock Feed Per year 1970-1988.	62
Figure 10.	Actual and Estimated Yield of Corn Per Hectare 1971-1988.	63
Figure 11.	Forecast Corn Used For Livestock Feed Per Year 1989-2000.	64
Figure 12.	Forecast Yield of Corn Per Hectare 1989-2000.	65
Figure 13.	Projection Total Demand, Net Domestic Supply and Required Import of Corn 1989-2000.	66

LIST OF TABLES

		Page
Table 1.	Import and Export of Corn 1970-1986	67
Table 2.	Area Harvested, Yield and Production of Corn 1970-1988	68
Table 3.	Real Price of Palawija and Rice 1970-1988	69
Table 4.	Projection of Total Demand for Corn 1989-2000	70
Table 5.	Projection of Required Import of Corn 1989-2000	71
Table 6.	Projection of Total Demand and Net Domestic Supply for Corn 1989-2000 at -0.58 % and 0.22 % Rate of Growth of Real Price of Corn	72

I. INTRODUCTION

I.1. General Description of Corn in Indonesia

Corn is the second most important food crop in Indonesia. Harvested area has fluctuated around an average of 2.7 million hectares between 1970-1988. This is roughly one third of the area devoted to rice and twice that of cassava (figure 1). Production is almost entirely a smallholder activity, which provides income and staple food for over 10 million farm households who rarely farm more than 2 hectares of land (Mink and Dorosh, 1987).

Corn production in Indonesia is concentrated on Java and Madura, which account for almost 75 per cent of production. On Java and Madura, almost all corn is produced on the eastern half of the land area. The province of East Java produces 45 per cent of the nation's total output.

The land types used for corn production are "tegalan" (rain-fed) and "sawah" (floodable rice land). The two tegalan systems differ from each other in the frequency of corn harvests and are classified as systems with multiple or a single corn crop per year. The two sawah systems are characterized by the degree of water control. Irrigated sawah has permanent irrigation infrastructure, while rain-fed sawah is flooded by rainfall runoff (Mink, Dorosh and Perry, 1987).

Furthermore, Mink et al. revealed that the largest corn cropping system in Indonesia, which compromises about 55 per cent of the area planted in corn each year, is on rain-fed

land, where two or three corn crops a year may be included in the crop rotation (figure 2).

The single corn crop system is found scattered thoughout the Indonesia archipelago and occupies about 24 per cent of total area. Intercropping of corn and cassava is a common practice in which farmers plant corn after the first rains followed by cassava a month later. After the corn harvest, the cassava stands alone in the field (figure 3).

Corn area on irrigated sawah accounts for about 11 per cent of total corn plantings. This system is in use almost entirely on Java, with concentration in East Java where corn is grown as monoculture (figure 4).

The rain-fed sawah system, which includes about 10 per cent of total area, predominates on the floodplains of the northern coast of Java. Rains during the first and third crop seasons are insufficient to grow flooded rice, but they permit growing "palawija" (non rice crops) on either end of the main rice crops. Two crops per year are possible in this system, and the first is frequently intercropped (figure 5).

Prior to the mid-1970s farmers used mostly local, low-yielding corn varieties which produced less than 1 ton per hectare. By 1987, yield had increased to 1.9 tons.

The release and spread of new, improved corn varieties since 1978 are largely responsible for growth in yield.

The release of Harapan-6 in 1978 followed by Arjuna in 1980 and the Hybrid C-1 in 1983 have enabled farmers to shift to

these higher yielding varieties, which are resistent to downey mildew.

Although corn is a secondary foodcrop to rice, it is a major source of calories and protein in the Indonesian diet. According to the food balance sheet of Indonesia, corn directly consumed by humans accounts for about 9 per cent of all calories and 12 per cent of protein intake (CBS Indonesia, 1980). It is especially important in the diet of the poor, since it is cheaper than rice. Three-quarters of Indonesia's corn production is consumed directly by humans as a staple foodstuff (Monteverde and Mink, 1987).

Corn is also a major ingredient in livestock feed, which ultimately is the largest component in meat and eggs. The modern feed industry was established in 1972 and has expanded rapidly through the end of the decade. However, it is not the main source of demand for corn. In the mid-1980s, livestock feeding absorbed an estimated one-fifth of annual corn production (Mink, 1987).

I.2. Statement of Problem

According to Mink and Dorosh (1987), corn production has gone through three distinct periods in Indonesia since the 1920. From the 1920s to early 1960s, average production increased from 2 million to 3 million tons per year, almost entirely through area expansion. In the next decade, production was static because further area expansion proved difficult. Since the start of the 1970s, an increase in

yields of about 4 per cent per year has provided the base for new increases in total output. By 1983, average yields approximately 1.7 tons per hectare.

Between 1970 and 1974, 4 to 9 per cent of domestic production was exported, peaking at 253,000 tons in 1970 (table 1). Corn exports declined sharply with the decrease in production in 1975 and again in 1976. Between 1976 to 1980, Indonesia was a net importing nation, importing an average of 49,000 tons of corn per year. Although production has increased since 1977, Indonesia has been unable to export at the same scale as in the early 1970s. This is due mainly to the rapid growth in the domestic demand for corn as a livestock feed since the mid-1970s.

There are several crops that compete with corn in Indonesia. Soybeans and peanuts compete for the same land area. Farmers' planting decisions depend on the comparative provitability of each crop during the previous period. Profit is determined by the price of commodity in relation to the cost of producing it. Since 1970, the real prices of palawija and rice have fluctuated, which in turn affects the area planted and harvested of those commodities (figure 6).

The primary cause of the fluctuation of corn production since 1970 is related with the changes in the area harvested (figure 7). Yield has increased steadily due to a rapid increase in fertilizer use, the adoption of higher yielding varieties and possibly the shift from intercropping to

monoculture corn. However, average yield of 1.9 tons per hectare in 1987 is still low compared to U.S. (6.6 tons per hectare), Argentina (3.17 tons per hectare), Thailand (2.25 tons per hectare) and Egypt (4.68 tons per hectare). In 1986, the area planted to improved corn varieties and hybrids accounted for 25 and 1 per cent, respectively, of the total corn area (Vocke, 1987).

The increase in per capita income has brought a rapid growth in consumption of livestock products, which ultimately will increase the demand for corn for consumption. Being able to produce sufficient corn to meet both the demand for direct human consumption and livestock feed is a serious challenge.

I.3. Objectives of the study

The primary purpose of this study is not to examine or evaluate the existing corn program or policies, but rather to study factors affecting the demand for and supply of corn in Indonesia and to project production, total demand and per capita consumption in the future.

The objectives of this study are as follows :

1. to select appropriate variables for establishing an estimated demand equation,
2. to select appropriate variables for establishing an estimated supply equation,
3. to apply two estimated equations for generating projection of production, total demand and per capita

consumption of corn to the year 2000.

I.4. Methodology and Data Collection

I.4.1. Methodology

In order to reach an equilibrium position, both demand and supply equations should be established. The procedure is to apply the statistical method of finding the regressions for demand, area harvested and yield as a component of supply. Demand for corn is composed of demand for corn as livestock feed and for human consumption. Therefore two separated demand equations must be constructed.

Supply is obtained by multiplying area planted by yield. Using statistical package of Micro TSP (Time Series Program) a projection of production, total demand and per capita consumption of corn to year 2000 can be calculated.
An evaluation of the models will follow according to their statistical properties and economic theories.

I.5. Data Collection

The 1970-1988 time series data used in this analysis are secondary data obtained from the Food and Agricultural Organization, Central Bureau of Statistic Indonesia, BULOG (National Food Logistic Agency), International Monetary Funds and other sources.

II. THE ROLE OF GOVERNMENT IN DEMAND, SUPPLY AND MARKETING OF CORN IN INDONESIA

Two major end uses for corn are of particular importance in Indonesia: its direct consumption by humans and its use as livestock feed. An adequate supply and stable price of corn is very important to the society and to the national economy. In order to maintain an adequate corn supply and to narrow the fluctuations of corn price, the government of Indonesia intervenes regarding the demand, supply and marketing systems of corn. BULOG is the national food logistics agency with primary responsibility to maintain the prices of main food items within certain limits. BULOG may operate in the open market to influence prices through purchasing and/or sale of the commodity.

II.1. Demand of corn

Consumption of corn by humans is the main source of demand for corn. However, the pattern of direct consumption is seasonal throughout the year. According to Monteverde and Mink (1987), corn consumption peaks around the main harvest, a time when corn prices fall, but declines in subsequent months as rice from the main harvest reaches the market and its price declines relative to that of corn.

The seasonality of corn consumption is also affected by the special problems of storing corn. Corn is difficult to dry since the main harvest occurs during the rainy season

and thus cannot be stored for more than few months. Losses from storage by farm households are high; and thus farmers usually store only a minimum of corn beyond a necessary security stock.

The livestock feed industry is the second main source of demand for corn. In 1972, corn consumed for livestock feed was only 323 thousand tons, by 1986 it increased almost sixfold to 1870 thousand tons. Unlike demand for corn by humans, the demand for corn by livestock feed industry is regular throughout the year. Stocks from domestic corn procurement and imports are distributed by BULOG primarily to feed mills when domestic corn prices rise seasonally - generally between the months of August and November (Mink, 1987).

II.2. Supply of Corn

In 1970, domestic supply of corn was 2.8 million tons; by 1988 corn production had been increased to 5.5 million tons. Rapid increase in fertilizer use, the adoption of higher-yielding varieties and the possible shift from intercrop to monoculture corn helps explain the increase in corn production. Area planted has not changed substantially since 1970.

In most corn-producing areas, marketing channels for fertilizer are now well established, deliveries are timely and prices are low by world standards. Corn breeders have made advances in developing several higher-yielding varieties

of medium to long duration until maturation. Crop losses due to downey mildew have been reduced with the use of these new resistent seeds, fungicide, seed treatment and more timely planting (Mink and Dorosh, 1987).

Corn is often an integrated part of agricultural plans for transmigration areas, particularly in the first years after settlement. Corn serves as a subsistence crop before perennials earning cash reach maturity.

II.3. Marketing of Corn

According to Tabor (1988), approximately 90 per cent of the corn was harvested under the "tebasan' system. Tebasan is the purchase of a standing crop by an agent who assumes responsibility for harvesting and marketing. Furthermore Tabor reported that after being harvested and dried, corn is sent to the village collector who delivers it to "kabupaten" (regency) wholesaler. The wholesaler sells either whole grain or milled corn.

In East Java, the primary market for corn is the livestock industry in Surabaya. Direct sales to the Surabaya poultry feed firm accounts for 50 per cent of the sales from kabupaten wholesalers (figure 8). Twenty per cent of corn is coarsely milled and sold to local, kabupaten-level poultry shops where it is resold for mixing with feed concentrates.

Approximately 20 per cent of corn is finely milled and made into corn-rice for human consumption. This will be marketed in local kabupaten retail markets and sent to

Surabaya for retail sale. A small proportion of corn will be sent to Surabaya for retail sale. A small part of corn will be sent to the coffee factories where it will be roasted and mixed with coffee. Less than 5 per cent of finely milled corn-rice is sold to corn snack processing industries.

The feed firms obtain the bulk of their raw material supplies from kabupaten wholesalers. Additional supplies are provided through inter-insular trade coordinated by provincial wholesalers and through direct shipments from wholesalers in Central Java and Yogyakarta.

III. THE FACTORS OF DEMAND AND THE ESTABLISHMENT OF THE DEMAND EQUATION FOR CORN

To establish a demand equation, several procedures should be considered. These include the definition of the problem and statement of the objectives under study, the selection of variables and econometric models, data collection and the procedure of evaluating the equation on the basis of statistical properties and the appropriate economic theories.

The definition of the problem and statement of objectives were presented in Chapter I. This Chapter is devoted to analytical procedures.

III.1. The Factor of Demand for Corn

According to Tomek and Robinson in Agricultural Product Prices, the major factors influencing the level of demand may be grouped under four headings :

(1) population size and its distribution by age, geographic area, etc.,

(2) consumer income and its distribution,

(3) prices and availability of other commodities and services,

(4) consumer taste and preferences.

These determinants of demand are general, particularly for agricultural commodities. As to corn, especially corn in Indonesia, where it is considered the second most important food crop, the following factors are much related

to its level of demand.

(1) Population :

Increase in demand for food is directly linked to the rate of population growth. The growth rate of population in Indonesia was 2.15 per cent between 1980 and 1985, which means there was at least a 3.5 million people increase annually according to the population of 1985 (CBS, Indonesia 1986). The larger the population size, the more food demanded.

Since the government plays an important role in determining the price of corn, prices only fluctuates within fixed limits. Commodities such as cassava and sweet potato are substitutes for corn, but they cannot be expected to replace corn completely. Therefore, population size is the major factor determining the level of demand for corn.

(2) Price

Price and quantity vary inversely; that is, the demand curve has a negative slope. This inverse relationship is sometimes called the law of demand. The higher the price, the less quantity demanded. Giffen goods are the exception. This kind of demand cannot be treated as the normal demand.

In Indonesia more than 18 million people consume corn as their principal staple food (Monteverde and Mink, 1987). Furthermore, Monteverde et al. reported that most corn consumption occurs in the lower quartile of the rural population, and these consumers have a long run price

elasticity of about -0.6.

(3) The Price of Substitutes

The demand of each commodity is a function not only of its own price but also the price of competing commodities. All prices, at least in theory, are linked together in an interdependent system. A change in the price of one commodity brings about shifts in the demand for other commodities. The direction of change in demand depends on the direction of change in the price of a related commodity and on whether the related commodity is a substitute or complement. For substitutes, the change in the price of substitute and the change in the demand are positively related.

Cassava is the third most important source of calories in Indonesia and is significantly cheaper than corn in terms of cost per calorie. Because of its low price, cassava helps to remedy inadequate calorie intake, which is the main nutritional deficiency in Indonesia. In this study cassava is considered as a substitute for corn. When the domestic corn price increases, the demand for cassava can be expected to rise. Consumers tend to shift from consuming corn to relatively cheaper cassava. When price of rice goes up, people will consume more corn instead of rice. Corn is considered as a substitute for rice.

In terms of cost per calorie, rice and soybeans are more expensive than corn. When the price of rice and/or

soybeans increase, people will consume more corn. So, corn can be considered as a substitute of rice and soybeans and vice versa.

(4) Consumer's Income

For most agricultural commodities, income and demand are positively related; that is, the increase in income shifts demand curve to the right. Consumers are willing to buy the same quantity at a higher price. A decrease in demand (shift to the left) has the opposite effect. But for a few commodities the reverse is true, such as inferior goods. For an inferior goods the income effect is negative. In principle the relation between income and demand can range from positive through zero to negative. According to Monteverde and Mink (1987), corn is an inferior goods for all income classes of the population in Indonesia. In other words, Monteverde et al. revealed that people reduce their corn consumption as income rise, even the lowest income groups.

(5) Consumer tastes and preferences

Changes in tastes and preferences contribute to shifts in the demand for agricultural commodities, although their effects are often difficult to isolate because they appear to be associated with changes in income or other variables. Long-run trends in per capita consumption are sometimes used as an indicator of changes in preferences; however, such trends are not necessarily a reliable guide to shifts in

demand. A downward trend in per capita consumption may simply reflect changes in per capita availability. Per capita consumption figures for agricultural commodities can reflect availability rather than changes in demand (Tomek and Robinson, 1981).

In terms of total amounts of corn consumed, East Java is the most important center, followed by Central Java and South Sulawesi in proportions that closely approximate their shares in total production. On a per capita basis, however, corn is a much more important staple in Nusa Tenggara Timur, North Sulawesi and South-East Sulawesi. In those regions corn consumption per capita is from three to four times the national average (Monteverde and Mink, 1987).

(6) Expectations

Future expectation about prices and income levels are also an important variables which affect the level of demand. Assuming political and social factors constant, for an expected increase in income, there will be an increase in demand for normal goods and a decrease in demand for inferior goods.

According to Monteverde and Mink (1987), corn has a negative income elasticity of -0.4 at present and in future years for estimating direct consumption of corn in Indonesia. Since income elasticity of demand for corn is negative, for an expected increase in income, there will be a decrease in demand for corn.

Price expectation is also important. Monteverde et al. (1987) in their study of "Household Corn Consumption in Indonesia" revealed that the own price elasticity of demand for corn is -0.6. Based on this finding, an expected increase in price will lead to a decrease in corn consumption.

(7) Livestock feed

Livestock feed is the second main source of demand for corn. According to Mink (1987), the livestock feed industry in Indonesia consists of over 50 firms that mix complete feeds and feed concentrate. The modern feed industry was established in 1972 upon separate investments by two foreign firms, and it expanded rapidly through the end of the decade.

(8) The number of commercial layer chickens

Over 90 per cent of output of the livestock feed industry is for domestic poultry and the rest is divided among swine, dairy cows, ducks and fish (Mink, 1987). The demand for corn can be determined by the number of commercial layer chickens.

(9) Export-Import

According to Dorosh (1987), the pattern of Indonesia's international trade in corn has been highly erratic. Limited storage capacity and high storage costs largely account for Indonesia's importing and exporting corn in the same year.

(10) Price of eggs

Since commercial layer chickens produce eggs, the demand for corn as livestock feed can be determined by the price of eggs.

The above ten factors are the most relevant ones that will affect the level of demand for staple food.
In establishing the demand model for corn, they are included.

III.2. Demand Equation

III.2.1. Selection of Variables

The basic assumptions for the corn demand analysis are as follows :

(1) no changes in population distribution,

(2) cassava is another commodity that considered as substitute of corn, on the other hand corn can be considered as substitute for rice and/or soybeans in terms of cost per calorie,

(3) constant marketing margin, no advertising on corn,

(4) no changes in income distribution,

(5) no changes in expectation of income and price of corn.

Based upon this assumption, the demand function for corn can be specified as follows :

The demand for corn as livestock feed :

$$LSF_t = f\ (CLC_t,\ PCOD_t,\ PEGGD_t,\ TIME)$$

where

LSF_t = the amount of corn used for livestock feed in year t,

CLC_t = the number of commercial layer chickens in year t,

$PEGGD_t$ = deflated price of egg in year t,

TIME = time trend 1, 2, ...

The demand for corn for human consumption :

$$CAHCP_t = f\ (PCOD_t,\ GNPCD_t,\ PRID_t,\ PSOD_t,\ NETXM_t,\ CHSTCK_t,\ TIME)$$

where

$CAHCP_t$ = corn available for human consumption per capita per year in year t,

$PCOD_t$ = deflated price of corn in year t,

$GNPCD_t$ = deflated GNP per capita in year t,

$PRID_t$ = deflated price of rice in year t,

$PSOD_t$ = deflated price of soybeans in year t,

$PCSD_t$ = deflated price of cassava in year t,

$NETXM_t$ = net export import of corn in year t,

$CHSTCK_t$ = stock changes of corn in year t,

TIME = time trend 1, 2, ...

The data of the number of commercial layer chickens is gathered from FAO, while the data of price of eggs is collected from the Central Bureau of Statistics Indonesia.

Corn available for human consumption per capita per year was derived as the residual of production plus import minus seed, feed, waste, export and non-food industrial use. The data of export and import are collected from FAO. Corn used for seed was estimated at 1.7 per cent of total production, based on the Ministry of Agriculture's Cost of Production Survey. Waste was estimated at 10 per cent of production and the non-food industry was estimated to utilize 3 per cent of total production before 1978 and 5 per cent thereafter (Tabor et al., 1988). The data of corn used for livestock feed and changes in stock of corn are gathered from BULOG. Price of corn and other "palawija" are collected from Central Bureau of Statistics, Indonesia, while GNP is gathered from International Monetary Funds.

III.2.2. Methodology

The technique used will be multiple regression of time series analysis. Statistical estimations were obtained by using the ordinary least squares procedure for the demand, area harvested and yield. The preferred formulation for the supply equation is the multiplication of area harvested and yield. Underlying the procedures are the following statistical assumptions for multiple regression model :

$$Y_t = b_o + b_1X_t + b_2X_t + ... + b_kX_{kt} + E_t$$

(1) the random error term E is normally distributed,

(2) the expected value of the error term or its mean equals to zero, $E(E_t) = 0$,

(3) the variance of the error term is constant in each period and for all values of X, $E(E_t)^2 = \sigma_e^2$,

(4) the value which the error term assumes in one period is uncorrelated or unrelated to its value in any other period, $E(E_t, E_s) = 0$ for $t \neq s$; $t,s = 1, 2, \ldots, n$,

(5) the explanatory variable assumes fixed values that can be obtained in repeated samples, so that the explanatory variable is also uncorrelated with the error term, $E(X_t, E_t) = 0$,

(6) there is no perfect multicollinearity among the regressants. That is, none of the independent variables are a linear combination of others.

III.2.3. The Estimated Demand Equation

Based on the correctness of the relationship between dependent variable and the significance of the relationship, the following equations were selected.

The demand for corn as livestock feed

$$LSF_t = 247.39934 + 0.0095183\ CLC_t + 36.562770\ TIME$$
$$(8.4366922)\quad (15.907811)\quad (8.2152759)$$

$R^2 = 0.99$; Adjusted $R^2 = 0.99$; S.E. of regression = 4.746 ; D.W. = 1.16 ; F statistic = 1,434

(values in the parentheses are t statistic)

where

LSF_t = the amount of corn used for livestock feed in year t,

CLC_t = the number of commercial layer chickens in year t

TIME = time trend 1, 2, ...

The demand for corn for human consumption :

$$CAHCP_t = 3.5388902 - 0.0004218\ PCOD_t + 0.0008325\ PRID_t - 0.0318387\ TIME$$

(0.4192463) (-1.1551198) (2.4912500) (-0.2854031)

$R^2 = 0.34$; Adjusted $R^2 = 0.21$; S.E. of regression = 2.44

D.W. = 2.43 ; F statistic = 2.56

(values in the parentheses are t statistic)

where

$CAHCP_t$ = corn available for human consumption per capita per year in year t,

$PCOD_t$ = deflated price of corn in year t,

$PRID_t$ = deflated price of rice in year t

TIME = time trend 1, 2, ...

The demand equation can be examined in two ways to check whether it meets both the statistical properties and economic theories.

III.2.4. Evaluation of the Demand Equation

III.2.4.1. Statistical Properties

III.2.4.1.1. The demand for corn as livestock feed

(1) Coefficient of Multiple Determination (R^2)

The coefficient of multiple determination (R^2) represents the percentage of variation in the dependent variable "explained" by variation in the independent variables (Salvatore, 1982). In this demand equation

R^2 is 0.99. This means that 99 per cent of the variation in the dependent variable is explained by the independent variables. Adjusted R^2 is 0.99. This means about 99 per cent of variance in the dependent variable is explained by the estimated equation after correcting for the effect of the number of variables included in the model.

(2) Significance of the coefficients

The t value is an indicator to tell whether or not the parameter estimate is significantly different from zero. From the above equation, all independent variables are highly significant (alpha = 1 %).

(3) F test

F test is used to test whether there is a regression relation between the dependent variable and the set of the independent variables (Neter, Wasserman and Kutner, 1985). F statistic found from the demand equation is 1,434, greater than $F_{0.99\ (1,15)} = 8.68$, which means that there is a regression relation between livestock feed and the set of independent variables such as commercial layer chickens and time trend.

(4) Durbin-Watson statistic

Autocorrelation or serial correlation refers to the case in which the error term in one time period is correlated with the error term in any other time period. With autocorrelation, the ordinary least squares are still

unbiased and consistent, but the standard errors of the estimated regression parameters are biased, leading to incorrect statistical tests and biased confidence intervals (Salvatore, 1982).

The presence of autocorrelation can be tested by calculating the Durbin-Watson statistic (d). The calculated value of d from the above equation is 1.16, which falls in the uncertainty regions, which means that we cannot be certain that there is autocorrelation in the demand model.

(5) Multicollinearity

Multicollinearity refers to the case in which two or more explanatory variables in the regression model are highly correlated, making it difficult or impossible to isolate their individual effects on the dependent variable. With multicollinearity, the estimated ordinary least squares coefficient may be statistically insignificant (and even have the wrong sign) eventhough R^2 may be high (Salvatore, 1982). Based on the result of statistical analysis of the demand equation, there is no evidence of multicollinearity.

(6) Heteroscedasticity

Heteroscedasticity refers to the case in which the variance of the error term is not constant for all values of the independent variable. It occurs primarily in cross-sectional data. With heteroscedasticity, the ordinary least squares parameter estimates are still unbiased and

consistent, but they are inefficient (i.e., they have larger than minimum variances). Furthermore, the estimated variances of the parameters are biased, leading to incorrect statistical tests for the parameters and biased confidence intervals (Salvatore, 1982). Since heteroscedasticity occurs mostly in cross-sectional data, we assume in this demand equation, the variance of the error term is constant for all values of the independent variable (homoscedasticity).

Based on the above six statements, the demand equation of corn for livestock feed meets the desired statistical properties well.

III.2.4.1.2. The demand for corn for human consumption

The equation of the demand for corn for human consumption does not meet the desired statistical properties well for several reasons :

(1) the R^2 is low (0.34), which means the explanatory variables give weak explanation for the variation in the dependent variable,

(2) all t statistic of the independent variables are not significant except price of rice,

(3) the F statistic is not significant.

III.2.4.2. Economic Theories

III.2.4.2.1 The demand for corn as livestock feed

Whether an economic model is appropriate or not depends both statistical properties and economic theories. For checking the economic theories, the simplest way is to look

the signs of the coefficients first, then go further in checking their values as to tell the relationship between dependent variable and independent variable. From this demand equation it shown that :

(1) For CLC_t. -- The coefficient of CLC_t is positive, which means that there is a positive relationship between corn used for livestock feed and the number of commercial layer chickens. This relationship is consistent with the expectation. When the number of commercial layer chickens goes up, the demand of corn for livestock feed will rise.

(2) For TIME. --The coefficient of TIME is positive, which means that corn used for livestock feed is positively related with time trend. This relationship is consistent with the expectation. Since the early 1970s, livestock feed industry has been growing rapidly.

III.2.4.2.2. <u>The demand for corn for human consumption</u>

(1) For $PCOD_t$. --The coefficient of $PCOD_t$ is negative which means that deflated price of corn is negatively related with corn available for human consumption per capita. This follows the laws of negatively sloped demand. If other things are held constant, an increase in price will lead to a decrease in quantity demanded.

(2) For $PRID_t$. --The coefficient of $PRID_t$ is negative which means that there is a positive relationship between deflated price of rice and corn available for human consumption per capita. This relationship is consistent

with expectation. Corn is considered as a substitute for rice. When price of rice goes up, people will consume more corn instead of rice.

(3) For TIME. --The coefficient of TIME is negative. This negative sign means that there is a negative relationship between time trend and corn available for human consumption per capita.

III.3. Discussion

The demand for corn as livestock feed

The result of the demand analysis of corn for livestock feed shows that the amount of corn used for livestock feed is influenced by the number of commercial layer chickens. As the number of commercial layer chickens increases, the demand for corn as livestock feed rises.

According to Mink (1987), the livestock feed industry in Indonesia consists of over 50 firms that mix complete feeds and produce feed concentrate. Over 90 per cent of output of the livestock feed industry is for domestic poultry, and the rest is divided among swine, dairy cows, ducks and fish. The modern feed industry was established in 1972 upon seperate investments by 2 foreign firms, and it expanded rapidly through the end of decade. The early 1980s brought slower growth and altered structure to the industry. Smaller, less efficient firms have been confronted with declining profit margins, and their portion of total output has been shrinking. Larger foreign firms diversified into related

fields such as poultry breeding farms.

Furthermore, Mink (1987) revealed that among livestock feed firms there remains a wide range in scale of operation. The more efficient and better-financed firms, in which annual output ranges from 20,000 to over 100,000 tons per year, consist of 7 foreign firms and 5 domestically financed firms. There is also group of 5 to 10 medium-sized domestic firms, as well as over 30 small firms, which produce on average 500 tons per year.

The demand for corn for human consumption

The cross price elasticity of demand for corn for human consumption with respect to price of rice is 1.15. This means that when the price of rice increase by one per cent, the demand for corn for human consumption will rise by 1.15 per cent, other things are held constant. Since price of rice and quantity of corn move in the same direction, then corn is concluded to be a substitute for rice.

IV. THE FACTORS OF SUPPLY AND THE ESTABLISHMENT OF THE SUPPLY EQUATION OF CORN

Because of the characteristics of season and the time requirement for growth, agricultural commodities usually have small elasticity of supply in the short run. That is, changes in price generally cause small change in the quantity supplied. Empirical studies of supply relationships for farm products, both in the United States and other countries, indicate that changes in production prices typically explain a relatively small proportion of the total variation in output which has occured over a period of a year (Tomek and Robinson, 1981). Furthermore Tomek and Robinson revealed that principal causes of shifts in the supply curve are :

(1) changes in input (or factor) prices,

(2) changes in the returns from commodities that compete for the same resources,

(3) changes in technology which influence both yields and costs of production efficiency,

(4) changes in the prices of joint products (i.e., commodities which are produced together such as wool and mutton),

(5) institutional constraints such as government acreage control programs, and changes in production resulting from "unusual" weather and insect or disease damage also can be treated as temporary

shifts in supply.

The above factors are relevant in changes in supply. While considering the supply of corn, it is well to understand the factors that will affect its change.

VI.1. The Factors of Supply for Corn

The general factors that cause changes in supply of corn can be stated as follows :

(1) Area Harvested

The total variation of corn production is determined in part by the total variation of area harvested. Production of corn is directly related with area harvested. The larger area harvested, the greater output that can be produced. The fluctuation of corn production in Indonesia since 1970 seems to be related with the area harvested (figure 7).

The government's program to relocate people from Java to sparsely settled regions of other islands is one of the main positive influences in expanding corn area. In the first years after settlement, corn is often an integrated part of agricultural plans for these transmigration areas. Before cash earning perennials reach maturity, corn serves as a subsistence crop.

(2) Price of Corn

In making short-run production decisions, prices are an important determinant to tell the producers what to produce. Therefore price is a relevant factor to the supply of any

commodity. Changes in quantity supplied is a function of changes in the prices of a unit of output.

It is assumed that producers are rational and their main goal is to maximize profit of the firm. Since profit is determined by price, the higher the price, the greater possibility that producer will make a profit.

Prices of competitive crops such as soybeans and peanuts are important in determining the area planted to corn, which in turn will affect the level of corn production. A decrease in price of competitive crop (i.e., soybeans, peanuts) may lead to an increase in the area planted to corn. This can result in an increase in production of corn in the forth-coming year.

(3) Yield

The production level of agricultural commodities is also affected by yield. Given constant area harvested, a decrease in yield will cause a decline in production. Therefore, in order to increase corn production, agricultural research stations are doing some research to find new higher-yielding varieties. The release of Harapan-6 in 1978, followed by Arjuna in 1980 and the Hybrid C-1 in 1983 help to explain the rise in corn yield in Indonesia.

(4) Rainfall

The amount of rainfall during the crop season has an effect on yield in rain-fed agriculture, which in turn

determines the level of production. Therefore, rainfall is an important factor to the supply of agricultural product.

Rainfall is important to corn production in Indonesia because 55 per cent of the area planted to corn each year is on rain-fed land. Short rainfall during the growing season of corn will result in a substantial decrease in output. However, a heavy rain in the rainy season can destroy the whole area planted. Drought in the dry season may also harm corn production.

(5) Price of Fertilizer

Yield is influenced by the use of fertilizer. Higher yielding varieties are especially responsive to the level of fertilizer applied. Its use is related with the price of fertilizer. Therefore, price of fertilizer is important in determining the output of corn.

(6) Technology

The development of agricultural technology has a significant effect on agricultural production. It can produce a commodity more efficiently or reduce the cost of production. Improved seed such as Harapan-6 and Arjuna are a kind of biological technology developed in the agricultural research stations. Chemical technology such as fertilizer and pesticide are also significant in increasing production.

IV.2. Supply Equation

IV.2.1. Selection of Variables

The above stated factors are important variables which will affect the level of supply. With the purpose to find a complete and reasonable supply equation, these factors will be considered.

The supply of corn is obtained by multiplying area planted by yield of corn. Two equations must be constructed, area planted and yield. As in conventional analysis, a distributed lag model was tried. According to Tomek and Robinson (1981), current area planted is determined by area planted in the previous year. Current area planted may be viewed as changing from the previous area planted in response to various price and cost factors. Considering this, the dependent variable is lagged one time period as an independent variable (AC_t is dependent, then AC_{t-1} is independent). Area planted of corn is also determined by its price in the previous year.

The area planted to corn competes with the area planted to competitive crops such as soybeans, so that the more acres devoted to soybeans the less acreage will be planted for corn production. A decrease in price of soybeans may lead to an increase in the area planted to corn. In this study, area harvested is used instead of area planted, because data on area planted is not available.

In the area harvested equation, area harvested in the previous year, the previous years' price of corn and major competitive crops such as soybeans and peanuts are independent variables. In the yield equation, price of corn in previous year, the amount of rainfall, price of fertilizer (Urea) and serial time trend are independent variables.

From the above consideration, the appropriate functional relationships are as follows :

$$QCO_t = AC_t * Y_t$$

$$AC_t = f\ (PCOD_{t-1},\ AC_{t-1},\ PSOD_{t-1},\ PPED_{t-1},\ T)$$

$$Y_t = f\ (PCOD_{t-1},\ RF_t,\ PFUD_t,\ T)$$

where

QCO_t = production of corn in year t

AC_t = area harvested of corn in year t

Y_t = yield per hectare of corn in year t

$PCOD_{t-1}$ = deflated price of corn in year t-1

AC_{t-1} = area harvested of corn in year t-1

$PSOD_{t-1}$ = deflated price of soybeans in year t-1

$PPED_{t-1}$ = deflated price of peanuts in year t-1

T = time trend 1, 2, ...

RF_t = amount of rainfall in year t

$PFUD_t$ = deflated price of fertilizer Urea in year t

In the supply model, variables such as production of corn, area harvested and yield are endogenous variables, while the remaining are exogenous variables. Exogenous variables also include the lagged value of the endogenous

variables, since their values are already known in any given period. As a result, area harvested of corn in the previous year is also exogenous variable.

The data of area harvested and yield of corn are collected from the Ministry of Finance. While price of corn and other "palawija", price of fertilizer (Urea) and rainfall are gathered from Central Bureau of Statistics, Indonesia.

The basic assumptions for the corn supply analysis are as follows :

(1) constant marketing margin and proportion of production marketed,

(2) constant agricultural and commercial policies such as government subsidies, price policies, etc.

IV.2.2. Methodology

An econometric model is used for area harvested and yield equation as a component of supply. There are some basic assumption for full specification of the regression model. The basic assumptions for regression analysis discussed earlier apply for the supply model.

IV.2.3. The Estimated Supply Equation

Based on the correctness of the relationship between dependent variable and the significance of the relationship, the following equations were selected.

The yield of corn per hectare :

$$Y_t = 0.0535093\ PCOD_{t-1} + 69.743779\ TIME$$
$$(16.637095) \qquad (18.966077)$$

$R^2 = 0.92$; Adjusted $R^2 = 0.92$; S.E. of regression = 90.601 ;
D.W. = 1.45 ; F statistic = 199.266
(values in the parentheses are t statistic)

where

Y_t = yield of corn per hectare in year t
$PCOD_{t-1}$ = deflated price of corn in year t - 1
TIME = time trend 1, 2, ...

The area harvested of corn :

$$AC_t = 2639.3022 - 0.0195424\ PCOD_{t-1} - 0.3848648\ AC_{t-1}$$
$$(1.0359532)\ (-0.2236887) \qquad (-0.3469261)$$
$$+ 0.0185030\ PSOD_{t-1} + 0.0127219\ PPED_{t-1}$$
$$(0.5564794) \qquad (0.6108363)$$
$$+ 1.5091875\ TIME - 0.1829221\ AR(1)$$
$$(0.0353611) \qquad (-0.1645036)$$

$R^2 = 0.29$; Adjusted $R^2 = -0.13$; S.E. of regression = 431 ;
D.W. = 1.99 ; F statistic = 0.683
(values in the parentheses are t statistic)

where

AC_t = area harvested of corn in year t
$PCOD_{t-1}$ = deflated price of corn in year t-1
AC_{t-1} = area harvested of corn in year t-1
$PSOD_{t-1}$ = deflated price of soybeans in year t-1
$PPED_{t-1}$ = deflated price of peanuts in year t-1
TIME = time trend 1, 2 ...

The above supply equation can also be checked for their statistical properties and their economic logic.

IV.2.4. Evaluation of the Supply Equation

IV.2.4.1. Statistical Properties

IV.2.4.1.1. The yield of corn per hectare

(1) Coefficient of Multiple Determination (R^2)

In the yield equation, R^2 is 0.92 which means 92 per cent of the variation in the dependent variable is explained by the independent variables. Adjusted R^2 is 0.92, which means about 92 per cent of the variation in the dependent variable is explained by the estimated equation after correcting for the effect of the number of variables included in the model.

(2) Significance of the coefficient

Price of corn in the previous year and time trend are highly significant at alpha = 1 %.

(3) F test

The F statistic from the yield equation is 199.266, greater than $F_{0.99(1,14)} = 8.86$. This means there is a regression relation between yield of corn per hectare and the set of independent variables.

(4) Durbin-Watson Statistics

The calculated value of d from the yield equation is 1.45, which falls in the uncertainty regions, which means we cannot be certain that there is autocorrelation.

(5) Multicollinearity

Based on the result of statistical analysis of the yield equation, there is no evidence of multicollinearity.

(6) Heteroscedasticity

We assume in this yield equation, the variance of the error term is constant for all values of independent variables (homoscedasticity).

Based on the above six statments, the yield equation meets the desired statistical properties well.

IV.2.4.1.2. The area harvested of corn

The equation of area harvested of corn does not meet the desired statistical properties well for several reasons :

(1) the R^2 is low (0.29), which means the explanatory variables give weak explanation for the variation in the dependent variable,

(2) all t statistics of independent variables are not significant,

(3) the F statistic is not significant.

IV.2.4.2. Economic Theories

IV.2.4.2.1. The yield of corn per hectare

The sign and values of the estimated coefficients are indicators to tell the economic characteristics of the variables. They are examined separately as follows.

(1) For $PCOD_{t-1}$. --The coefficient of $PCOD_{t-1}$ is positive. This positive sign means that when deflated price

of corn in the previous year rises, the yield of corn in the current year will increase, other things are held constant.

(3) For TIME. --The coefficient of TIME is positive. This positive sign means that during the period of study (1970-1988) the yield of corn was increasing due to the technological changes such as improved seed and higher-yielding varieties.

IV.2.4.2.2. The area harvested of corn

Since none of the coefficient of the area harvested equation are statistically different from zero, their sign and values need not be evaluated.

IV.3. Discussion

When prices of soybeans, peanuts, cassava or rice in the previous year were included (separately and in combination) as independent variables in the area harvested equation, none of these variables was significant. This means that the area harvested equation did not show any of these commodities competing with corn for land resources.

According to Mink and Dorosh (1987), changes in relative net returns between corn and other palawija (non-rice) crops have not been major factors influencing corn production in the 1970s. Their analysis is based on the annual "Agricultural Survey" conducted by the Central Bureau of Statistics of Indonesia. Furthermore Mink et al. (1987) reported that low returns for growing corn have not led to

a decline in aggregate corn area for several reasons which differ by crop. Higher cassava returns are offset by the long period that cassava occupies land, from 9 to 12 months, or over three times as long as the normal corn season. For peanuts and soybeans, high average net returns do not reflect the risk associated with these crops and the frequency of crop losses, which tend not to be calculated in the "Agricultural Survey's" net returns.

The yield elasticity with respect to price of corn found in this study is 0.49. This means that as the price of corn in the previous year increase by one per cent, the yield of corn per hectare will rise by 0.49 per cent. For policy purposes, it indicates that a positive price policy such as floor price policy will have an impact on yield. An increase in price of corn will lead to the increase of profit. A high profit will enable farmer to apply adequately input factors which in turn will increase yield per hectare.

The yield elasticity found in this study is smaller than the conclusion of Tabor et al. (1988) in his study of "Supply and Demand for Food Crops in Indonesia" that the yield elasticity with respect to price of corn is 0.59. The difference is due to different methods and data.

The increase in yield of corn per hectare is about 69.7 kg per hectare each year due to the trend factor, that is, the changes of technology, such as improved seed and higher-yielding varieties.

V. PROJECTION OF DEMAND AND SUPPLY OF CORN (1989-2000)

The estimated equation of demand and supply should be used as the basic framework for establishing the projection. The projection for demand and supply are made with the basic assumptions that the government retains the present agricultural programs unchanged and there is no change in exogenous variables such as weather, insect or disease damage, the attractive profitability or other industries to influence corn production, and consumers do not change their consumption behavior etc.

V.1. Demand Projection

The equation of the demand for corn as livestock feed meets the desired statistical properties well. This demand equation can be used for projecting the demand for corn as livestock feed. Since the number of commercial layer chickens is an exogenous variable in the equation, its relevant values during the projection period should be determined for forecasting the demand for corn as livestock feed.
The assumption for this exogenous variable is that the rate of growth during the projection period is based on the rate of growth during the observation period. Once the value of this exogenous variable has been determined, the forecast of corn used for livestock feed can be calculated.

Since the equation of the demand for corn for human consumption per capita does not meet the desired statistical

properties well, time trend is the variable that is used for estimating this demand. This trend is

$$CAHCP_t = 15.216544 + 0.0811914\ TIME$$
$$(11.441595)\ (0.6960693)$$

$R^2 = 0.027$; Adjusted $R^2 = -0.029$; S.E. regression = 2.78 ; D.W. = 2.84 ; F statistic = 0.48

(values in the parentheses are t statistic)

where

$CAHCP_t$ = corn available for human consumption per capita per year in year t

TIME = time trend 1, 2, ...

From statistical point of view, this equation is neither significant nor reliable for the independent variable to explain the variation of dependent variable. This phenomenum indicates that there is no significant trend in the corn available for human consumption per capita. Therefore in making projection of future demand for corn for human consumption is by the method of multiplying a constant level of corn available for human consumption per capita by the projected population in the future.

The choice of this constant level of corn available for human consumption is made by taking an average of the latest five years. This constant is 16.3 kg per capita per year.

The total population is assumed to increase 2.1 per cent annually during 1986 - 1990 and 1.93 per cent annually during

1991 - 2000. This estimation is made by the Central Bureau of Statistics in Indonesia.

The projected corn available for human consumption in year 2000 is 3,573 thousand tons (table 4). This is near to the conclusion by Tabor et al. (1988) that the projected corn available for human consumption in the same year in Indonesia is 3,488 thousand tons.

Total demand for corn is obtained by adding corn available for human consumption by corn used for livestock feed, seed and non-food industry. Seed was estimated at 1.7 per cent of total corn production, based on the Ministry of Agriculture's Cost of Production Survey. The non-food industry was estimated to utilize 5 per cent of total corn production since 1979 (Tabor et al., 1988). The total demand for corn is shown in table 4.

V.2. Supply Projection

The forecast procedures discussed earlier apply for calculating yield projection. Yield of corn is significantly influenced by its deflated price in the previous year and time trend. Through the process of iteration, yield projection can be calculated.

Since the equation of area harvested of corn does not meet the desired statistical properties well, time trend is the variable that is used for estimating area harvested during the projection period.

This trend is

AC_t = 2589.1930 + 13.807018 TIME

(13.941504) (0.8476504)

R^2 = 0.04 ; Adjusted R^2 = -0.02 ; S.E. regression = 388.88 ; D.W. = 2.58 ; F statistic = 0.72

(values in the parentheses are t statistic)

where

AC_t = area harvested of corn in year t

TIME= time trend 1, 2, ...

From statistical point of view, this equation is neither significant nor reliable for the independent variable to explain the variation of dependent variable. This phenomenum indicates that there is no significant trend in the area harvested of corn. Therefore the mean area harvested over the observation period is the "best" available estimate of area harvested. This value is 2,727 thousand hectares.

The projection of total domestic supply of corn is obtained by multiplying the estimate of yield by the estimate of area harvested of corn.

Waste was estimated at 10 per cent of production (Tabor et al., 1988). Substracting waste from total production will give net domestic supply. The required import of corn is shown in table 5.

The demand projection for corn grows more rapidly than that of the supply projection, which implies the need for Indonesia to import corn to increase until the year 2000.

The primary cause of the low rate of growth of corn production is that the real price of corn has been decreasing during the last 19 years. The average rate of decline of the real price of corn during that period is -0.58 per cent per year. Because of this, corn producers will be unwilling to increase their production significantly. Unlike price of corn, real prices of peanuts and soybeans have increased rapidly (figure 6). Increased yield has probably reduced unit cost of production for a kilo/ton of corn. In order to meet the domestic demand, the rate of growth of real price of corn should be about 0.22 per cent per year (table 6).

VI. CONCLUSION AND IMPLICATION IN AGRICULTURAL POLICIES

VI.1. Conclusion

The result of the analysis of the demand for corn as livestock feed shows that 99 per cent of the variability in the amount of corn used for livestock feed can be explained by the number of commercial layer chickens and the time trend. The demand for corn as livestock feed is significantly affected by both independent variables included in the equation.

In the demand for corn for human consumption, the estimated equation does not meet the desired statistical properties well. Only 34 per cent of the variability in the corn available for human consumption per capita can be explained by the deflated price of corn, deflated price of rice and time trend. Because of this, the projection of the demand for corn for human consumption was made by a constant level of corn available for human consumption per capita per year multiplied by the projected population without regarding those considered independent variables.

The cross price elasticity of demand for corn for human consumption with respect to the price of rice is 1.15. This indicates that the demand for corn for human consumption is responsive to changes in the price of rice.

The result of the analysis of the supply of corn shows that in the yield equation, 92 per cent of the variability

in the yield of corn per hectare can be explained by the deflated price of corn in the previous year and the time trend. The yield of corn per hectare is significantly influenced by deflated price of corn in the previous year and the time trend.

In the area harvested equation, the estimated equation does not meet the desired statistical properties well. Only 29 per cent of the variability in the area harvested of corn can be explained by deflated price of corn in the previous year, area harvested in the previous year, deflated price of soybeans and peanuts in the previous year and time trend. Because of this, the projection of area harvested was made by a constant level of the mean area harvested of corn multiplied by the estimate of yield.

The yield elasticity with respect to price of corn is 0.49. This indicates that yield of corn is responsive to changes in its price. The increase in yield of corn is about 69.7 kg per hectare each year due to the trend factor, that is the changes of technology such as improved seed and higher-yielding variety.

The projected corn available for human consumption in year 2000 is 3,573 thousand tons. The result of the demand and supply projection analysis indicates that there is an excess supply of corn in the 1989. By the year 1990 Indonesia needs to import corn to fulfill domestic demand. The real price of corn should be increased to 0.22 per cent

per year in order meet the domestic demand during the projection period.

VI.2. Policy Implications

Corn is the second most important food crop in Indonesia. The level of its production is very important in order to support the vast demand. The result of the analysis shows that corn producers in Indonesia are responsive to price changes. So, to encourage corn production, price is a suitable policy instrument. Increasing the price of corn by 1 per cent will tend to cause the yield of corn to increase by 0.49 per cent in the forthcoming year. However, an increase in price alone will not guarantee the increase in corn production. Other measures should accompany the price policy, such as improved infrastructure and marketing facilities and increased the availability of inputs such as fertilizers, insecticides, credit and extension service.

The role of corn stocks is very powerful in affecting corn price stabilization policy. It is important especially for BULOG to purchase corn from the farmers immediately after harvest (lowest price of corn) and store it for a period of time and releasing it in the right time, when the price of corn tends to rise.

The result of projection of demand and supply indicates that there is an excess supply of corn in the 1989.

Export of corn is possible for the year 1989, if this excess quantity is greater than the quantity that the government wants to store for the purpose of precaution for years of low supply. Since import is needed by 1990, the government should give special attention to increasing production of corn.

VII. SUMMARY

Indonesia, which exported an average of 186 thousand tons of corn per year between 1970 - 1974, has been a net importing nation, importing an average of 49 thousand tons per year between 1976 - 1980. Although corn production has increased since 1977, Indonesia has been unable to export corn at the same scale as in the early 1970s. This is due mainly to the rapid growth in the domestic demand for corn as a livestock feed since the mid-1970s.

This study has investigated the above problem with the following set of specific objectives :

1. to select appropriate variables for establishing an estimated demand equation,
2. to select appropriate variables for establishing an estimated supply equation,
3. to apply those two estimated equations for generating projection of production, total demand and per capita consumption of corn to year 2000.

The methods used for carrying out these objectives were formal econometric analysis of historical data from 1970 through 1988. The ordinary least squares estimation procedure was used for estimating demand and supply equations. A conventional distributed lag model was applied for supply analysis. Both demand and supply models were based on a set of assumptions that we feel are relevant to the corn economy

of Indonesia.

The result of the analysis of the demand for corn as livestock feed shows that 99 per cent of the variability in the amount of corn used for livestock feed can be explained by the number of commercial layer chickens and time trend. The demand for corn as livestock feed is significantly affected by both independent variables included in the equation.

In the demand for corn for human consumption, the estimated equation does not meet the desired statistical properties well. Because of this, the projection of the demand for corn for human consumption was made by a constant level of corn available for human consumption per capita per year multiplied by the projected population without regarding those considered independent variables.

The cross price elasticity of demand for corn for human consumption with respect to the price of rice is 1.15. This indicates that the demand for corn for human consumption is responsive to changes in the price of rice.

The result of the analysis of the supply of corn shows that in the yield equation, 92 per cent of the variability in the yield of corn per hectare can be explained by the real price of corn in the previous year and time trend. The yield of corn per hectare is significantly influenced by real price of corn in the previous year and time trend.

In the area harvested equation, the estimated equation does not meet the desired statistical properties well. Because of this, the projection of area harvested was made by a constant level of the mean area harvested of corn multiplied by the estimate of yield.

The yield elasticity with respect to price of corn is 0.49. This indicates that yield of corn is responsive to changes in its price. The increase in yield of corn is about 69.7 kg per hectare each year due to the trend factor, that is the changes of technology such as improved seed and higher-yielding variety.

The projected corn available for human consumption in year 2000 is 3,573 thousand tons. The result of the demand and supply analysis indicates that there is an excess supply of corn in 1989. By the year 1990 Indonesia needs to import corn to fulfill domestic demand.

REFERENCES

1. Central Bureau of Statistics Indonesia (1987). Statistical Year Book. BPS, Jakarta, Indonesia.

2. _____ (1987). Buletin Ringkas, Desember 1988. BPS, Jakarta, Indonesia.

3. _____ (1980). Food Balance Sheet For Indonesia. BPS, Jakarta Indonesia.

4. CIMMYT (1987). 1986 Cimmyt World Maize Facts and Trends: The Economics of Commercial Maize Seed Production in Developing Countries. Mexico, D.F.

5. Djauhari, Aman., Adimesra Djulin and Irlan Soejono (1988). Maize Production in Java: Prospect for Improved farm Level Production Technology. Bogor, Indonesia: CGPRT Center.

6. FAO (1986). Trade Year Book 1970-1986 Volumes 24-40, Rome

7. ___ (1986). Production Year Book 1970-1986 Volumes 24-40, Rome.

8. Ferris, John N. and Stanley R. Thompson (1988). Lecture Notes AEC 843 Commodity Market Analysis, Fall Term 1988. Michigan State University, East Lansing.

9. Neter, John., William Wasserman and Michael H. Kutner (1985). Applied Linear Statistical Model. Second Edition. Homewood Illinois: Irwin.

10. Mink, Stephen D., Paul A. Dorosh and Douglas H. Perry (1987). "An Overview of Corn Production System". In C. Peter Timer ed., Corn Economy of Indonesia. Ithaca and London: Cornell University Press.

11. Mink, Stephen D. (1987). "The Economics of Input Use". In C. Peter Timmer ed., Corn Economy of Indonesia. Ithaca and London: Cornell University Press.

12. Monteverde, Richard T. and Stephen D. Mink (1987). "Household Corn Consumption". In C. Peter Timmer ed., Corn Economy of Indonesia. Ithaca and London: Cornell University Press.

13. Salvatore, Dominick (1982). Statistics and Econometrics. Schaum's Outlines Series in Economics. New York: Mc Graw-Hill Book Company.

14. Timmer, C. Peter, editor (1987). Corn Economy of Indonesia. "Corn in Indonesia's Food Policy'. Ithaca and London: Cornell University Press.

15. Tabor, Steven K. (1988). Corn Economy of Indonesia, Editor C. Peter Timmer. Ithaca and London: Cornell University Press.

16. Tabor, Steven K. (1988). Supply and Demand for Food Crops in Indonesia. Jakarta, Indonesia: Directorat of General Food Crops. Ministry of Agriculture.

17. Tomek, William G. and Kenneth L. Robinson (1981). Agricultural Product Prices. Ithaca and London: Cornell University Press.

18. Vocke, Gary (1987). "Corn Production Lags Behind Use in Developing Countries". In World Agricultural Situation and Outlook Report. Washington, DC: USDA Economic Research Service, December 1987.

FIGURE 1. Graph of Area Harvested of Corn, Soybeans, Peanuts, Cassava and Rice.

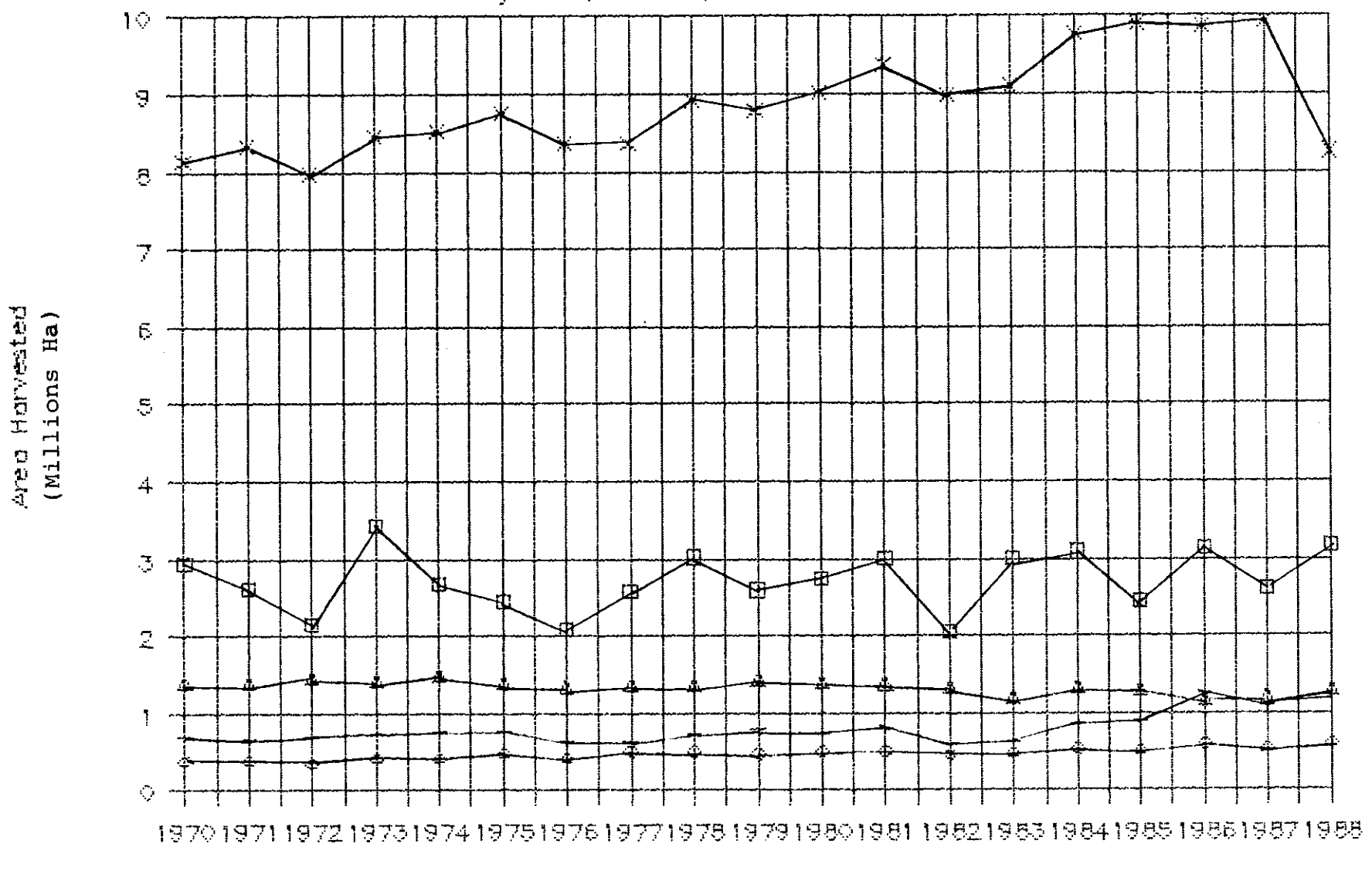
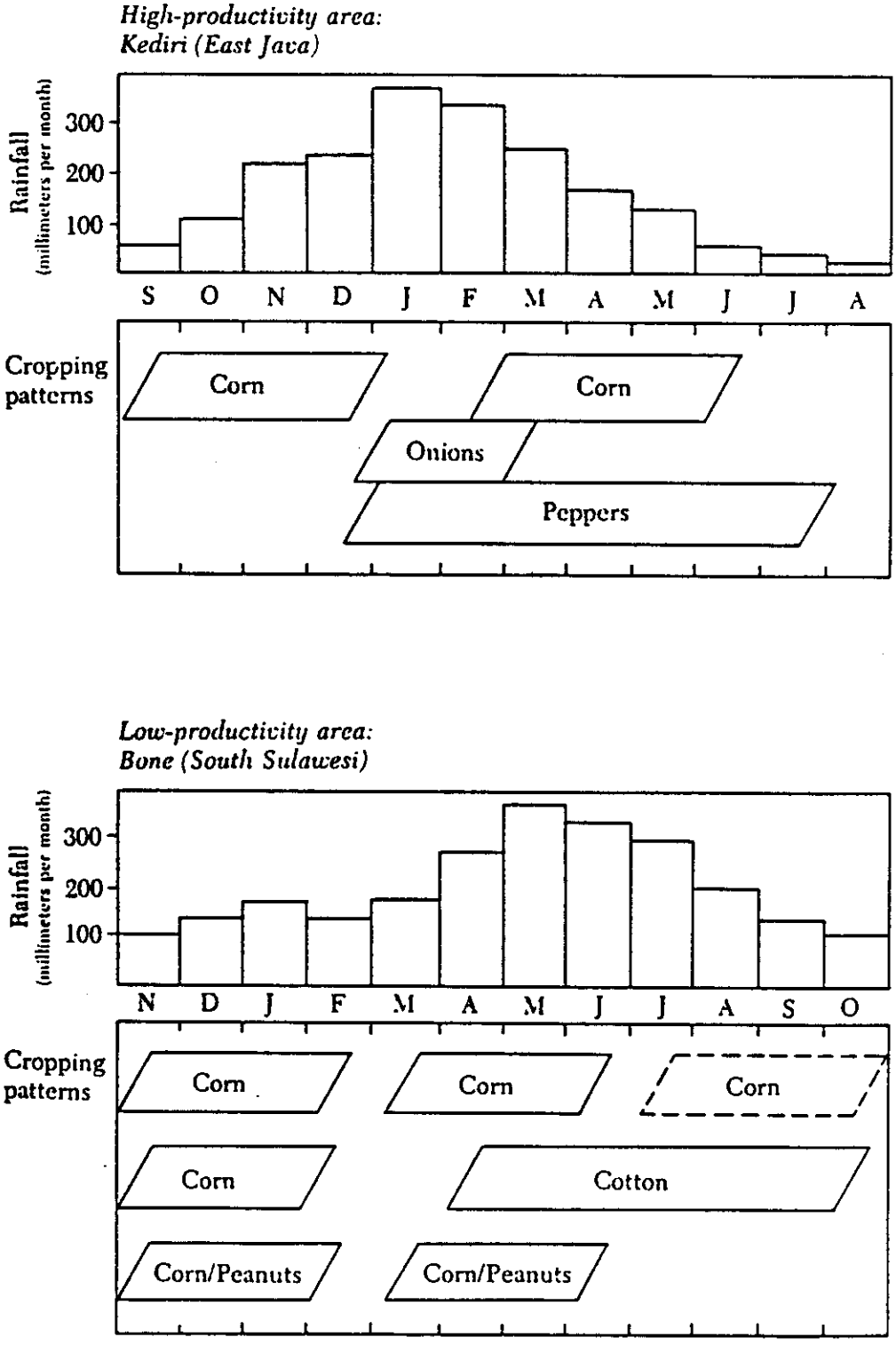
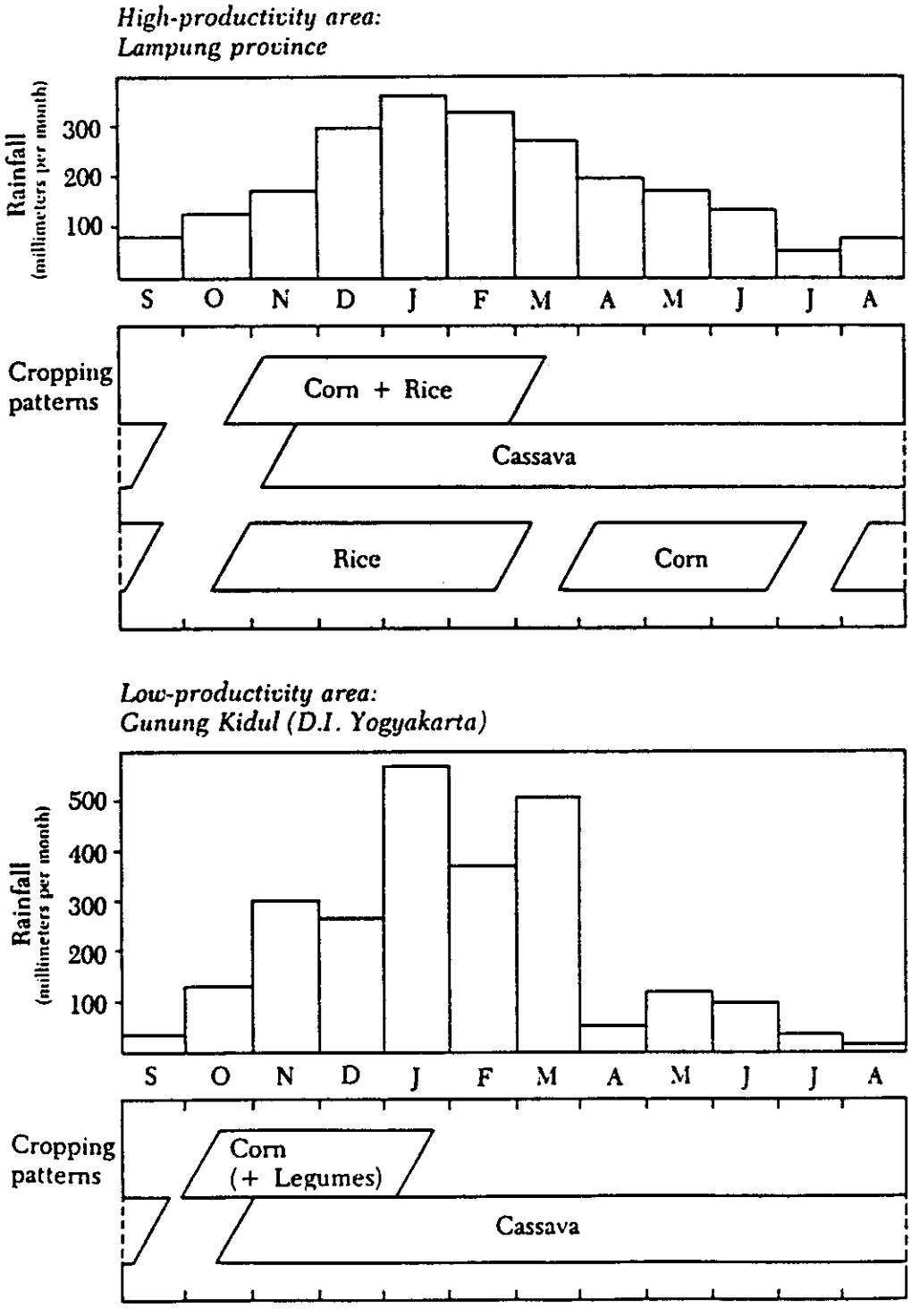


FIGURE 2 *Typical monthly rainfall and cropping patterns in multiple corn crop* tegal *systems*



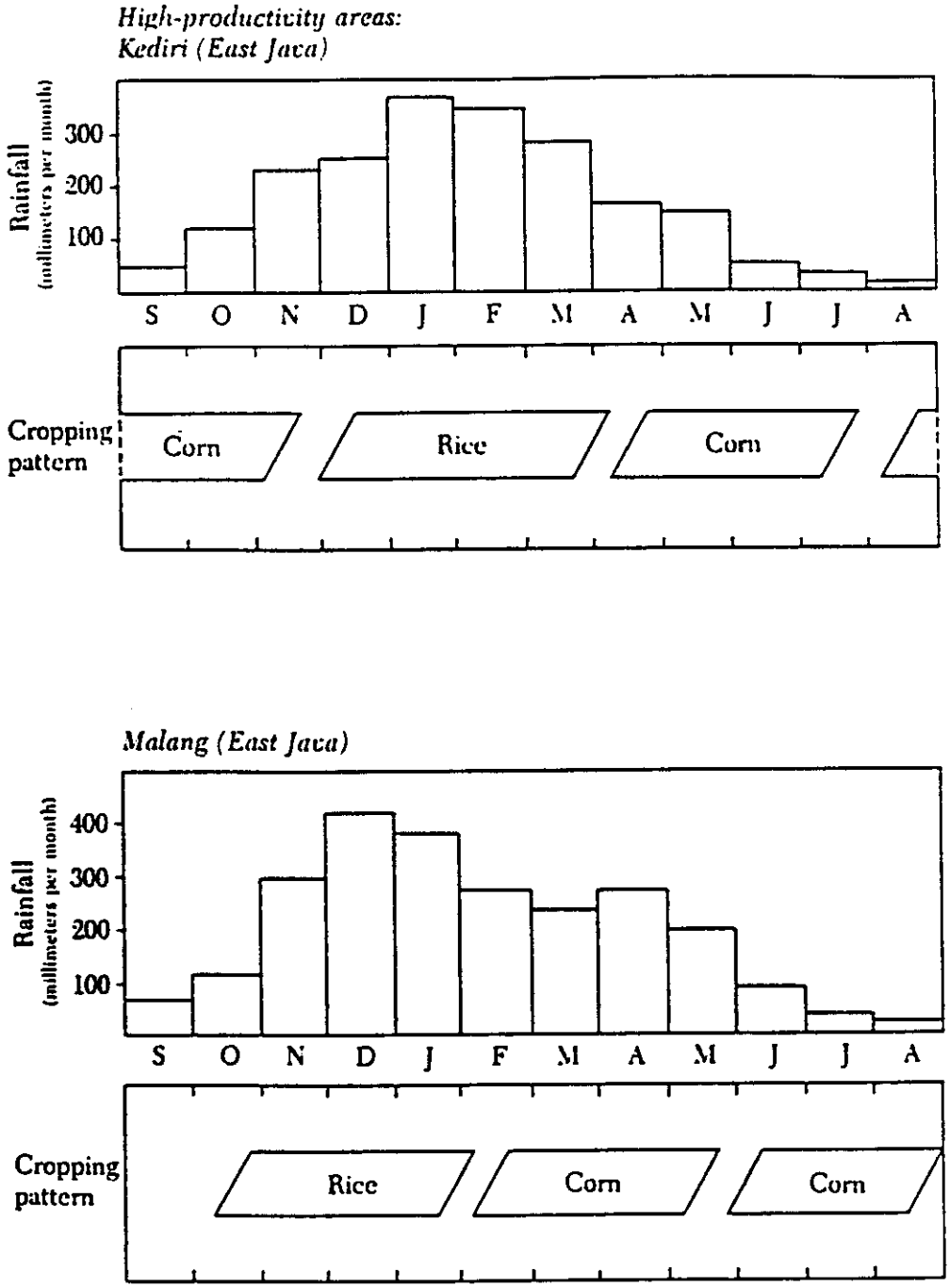
Source : Mink, Stephen D. et al. (1987). Corn Production System. In The Corn Economy of Indonesia, ed. by C. Peter Timmer.

FIGURE 3 *Typical monthly rainfall and cropping patterns in single corn crop tegal systems*



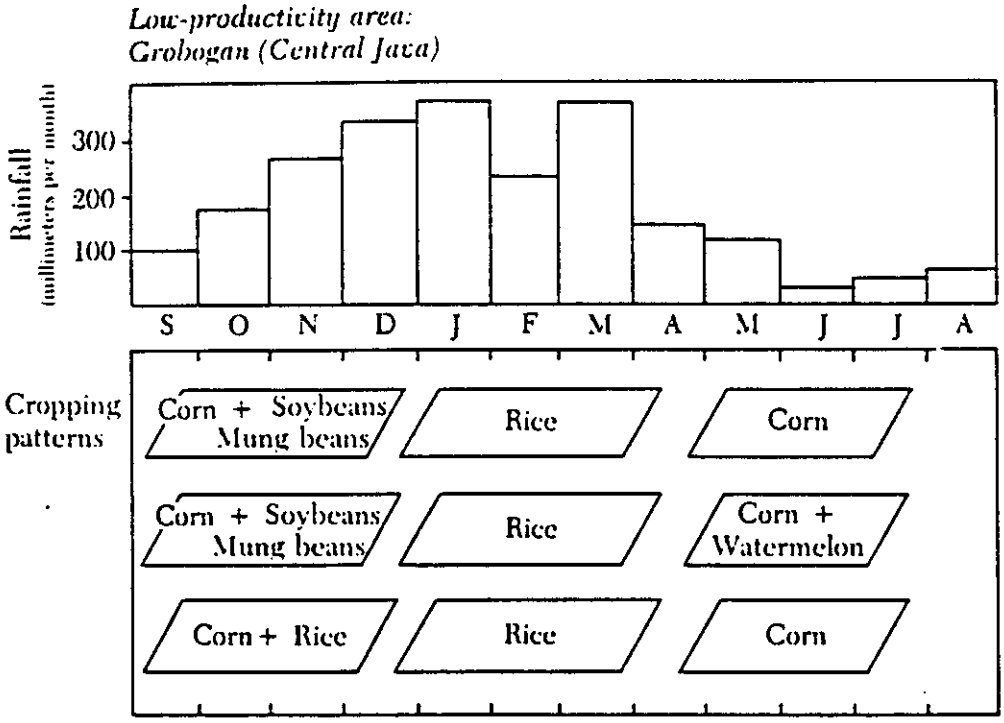
Source : Mink, Stephen D. et al. (1987). Corn Production System. In The Corn Economy of Indonesia, ed. by C. Peter Timmer.

FIGURE 4 *Typical monthly rainfall and cropping patterns in irrigated sawah systems*



Source : Mink, Stephen D. et al. (1987). Corn Production System. In The Corn Economy of Indonesia, ed. by C. Peter Timmer.

FIGURE 5 *Typical monthly rainfall and cropping pattern in a rain-fed* sawah *system*



Source : Mink, Stephen D. et al. (1987). Corn Production Systems. In The Corn Economy of Indonesia, ed. by C. Peter Timmer.

FIGURE 6 Graph of Real Prices of Palawija

and Rice 1970 - 1988

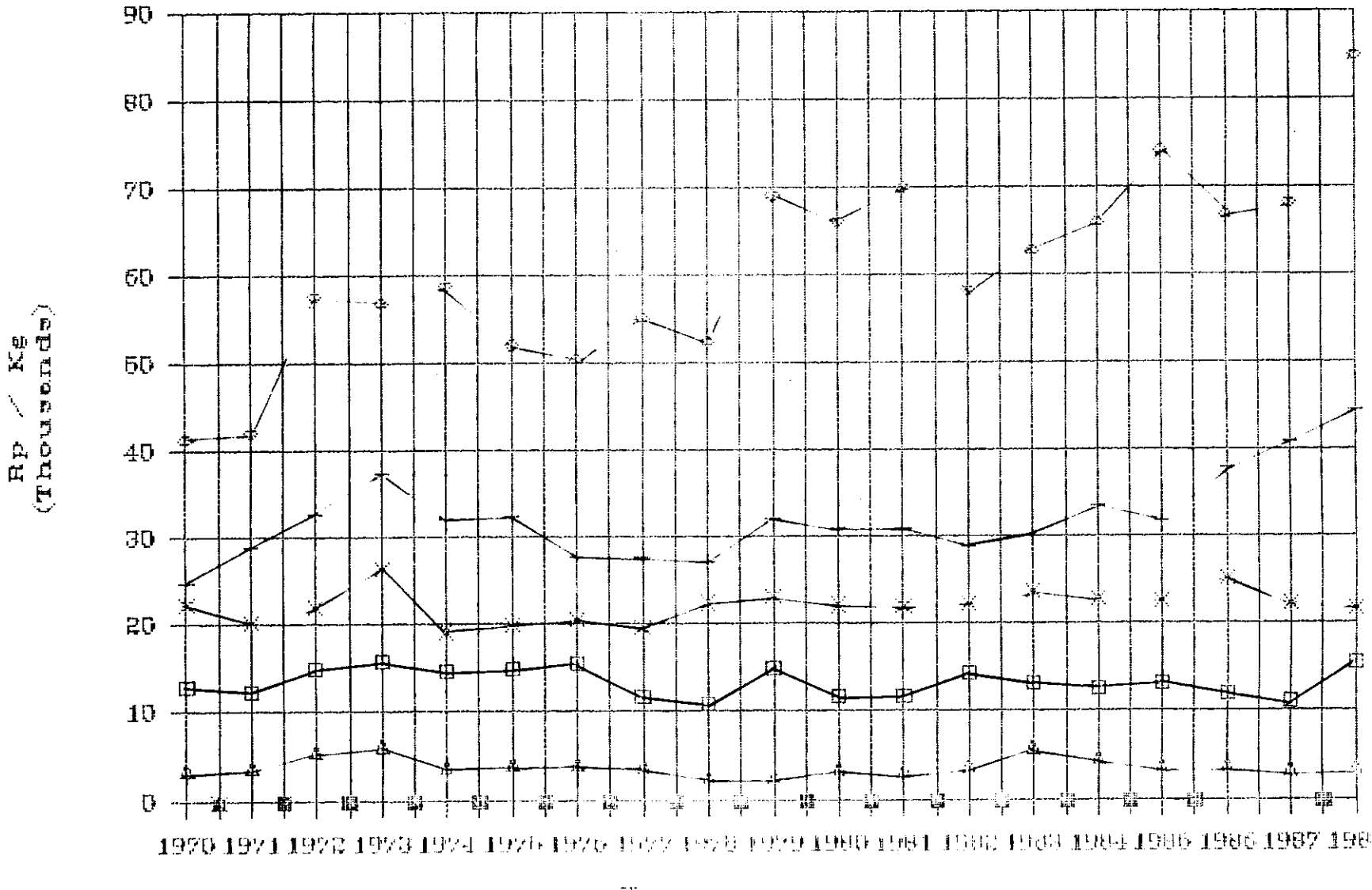


FIGURE 7. Graph of Area Harvested, Yield and Production of Corn 1970 - 1988

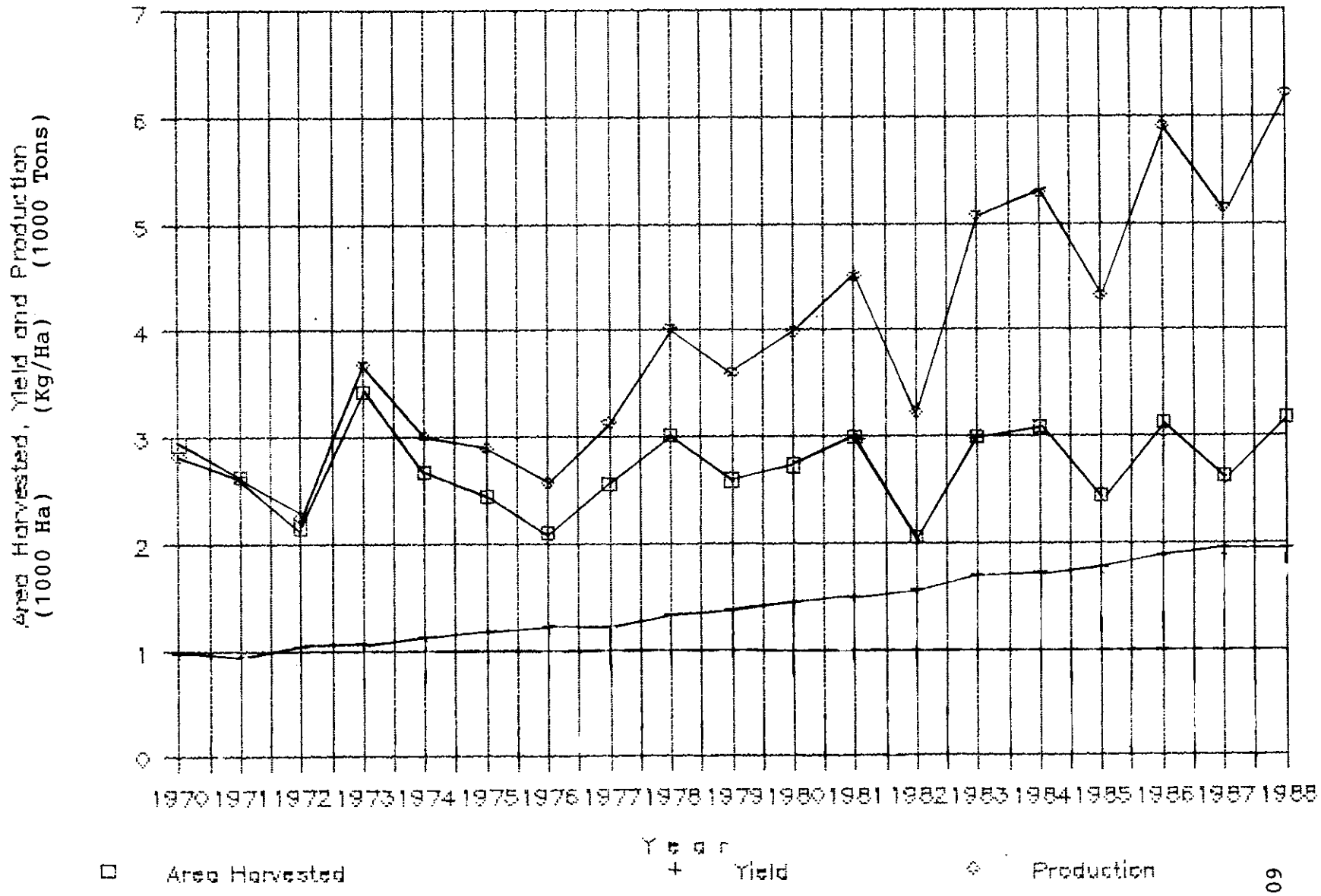
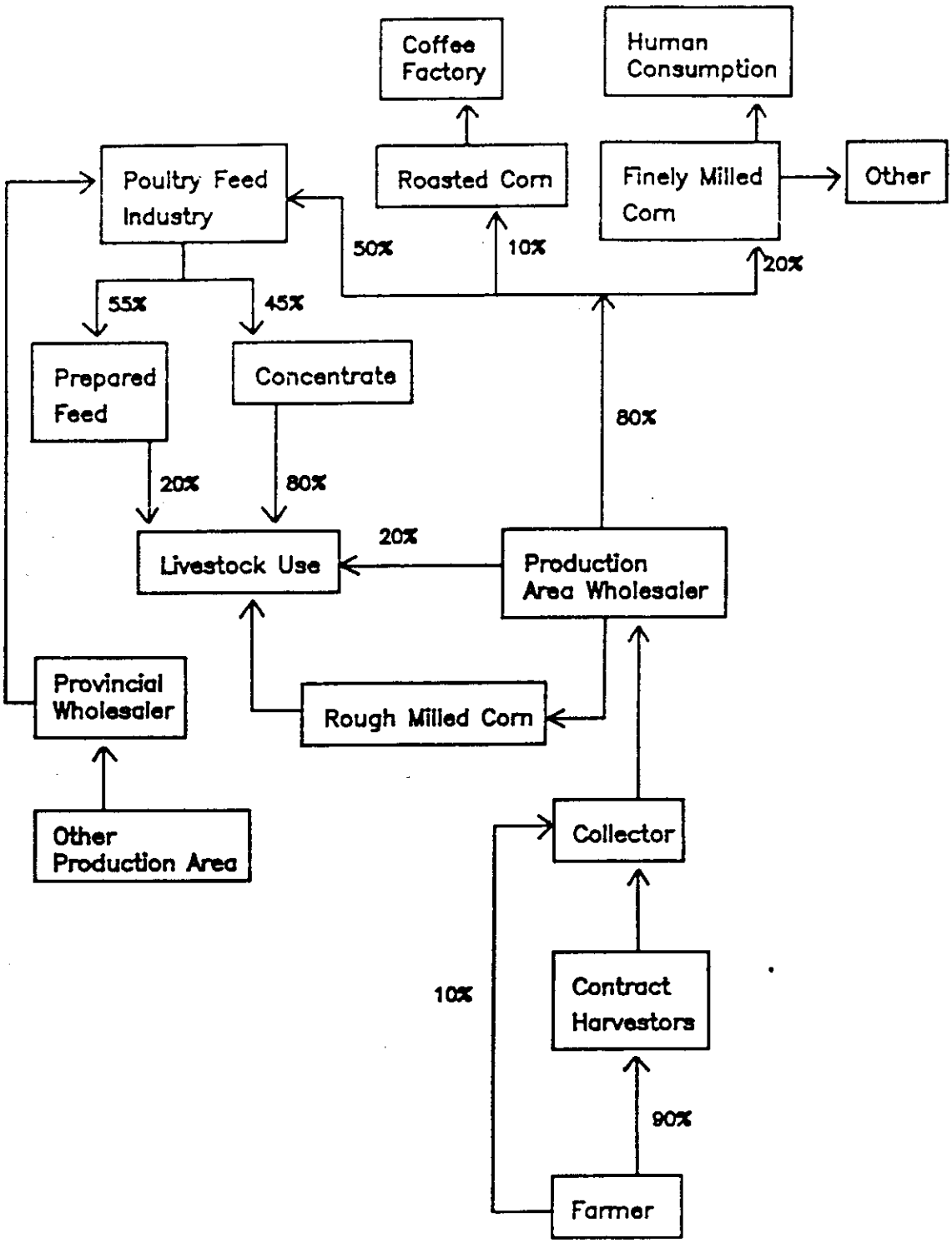


Figure 8 Corn Marketing Structure in East Java



Source : Tabor, Steven R. et al (1988). Supply and Demand for Foodcrops in Indonesia. Directorate General of Foodcrops, Ministry of Agriculture Jakarta, Indonesia.

FIGURE 9. ACTUAL AND ESTIMATED CORN USED FOR LIVESTOCK FEED PER YEAR 1970 - 1988

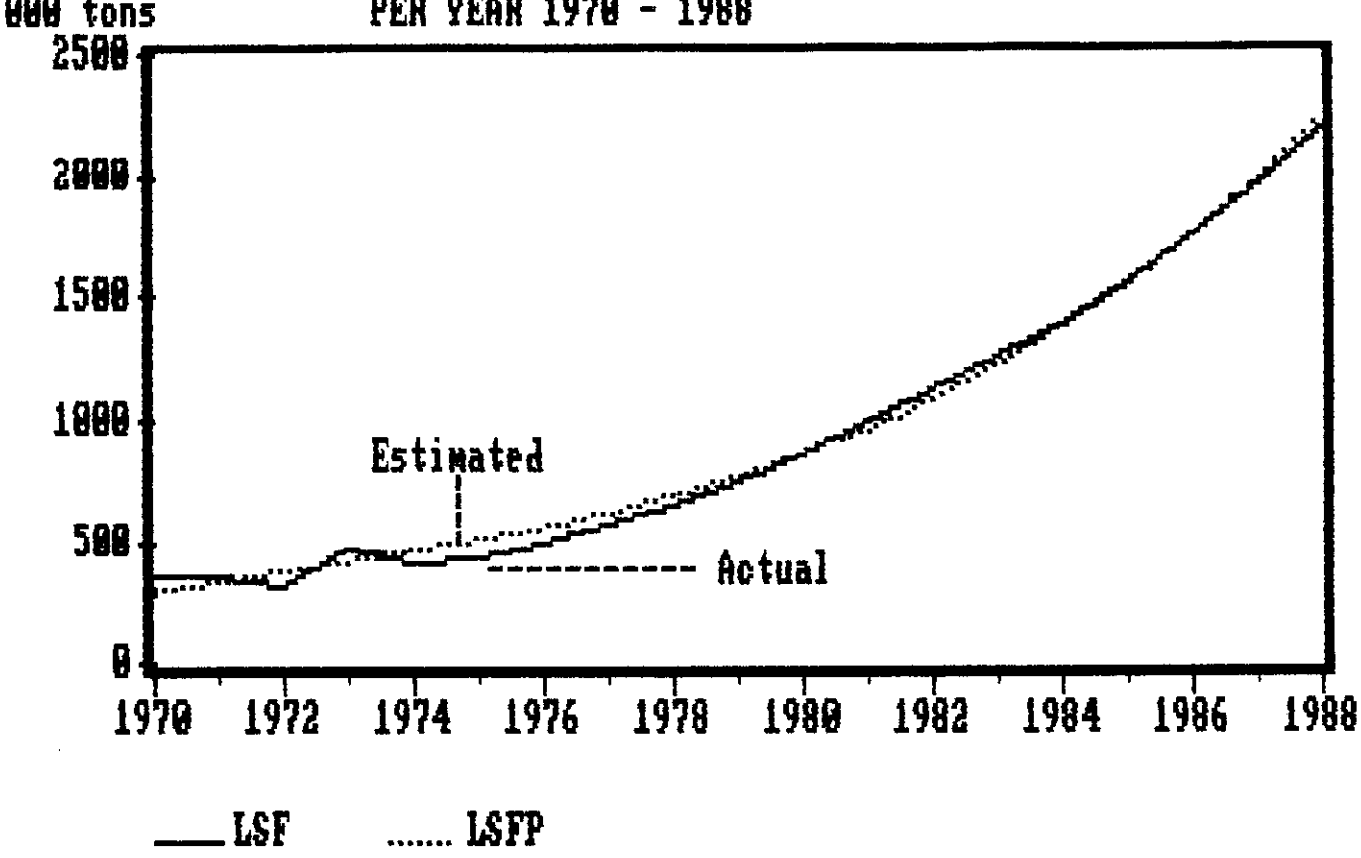


FIGURE 10. ACTUAL AND ESTIMATED YIELD OF CORN PER HECTARE
1971 - 1988

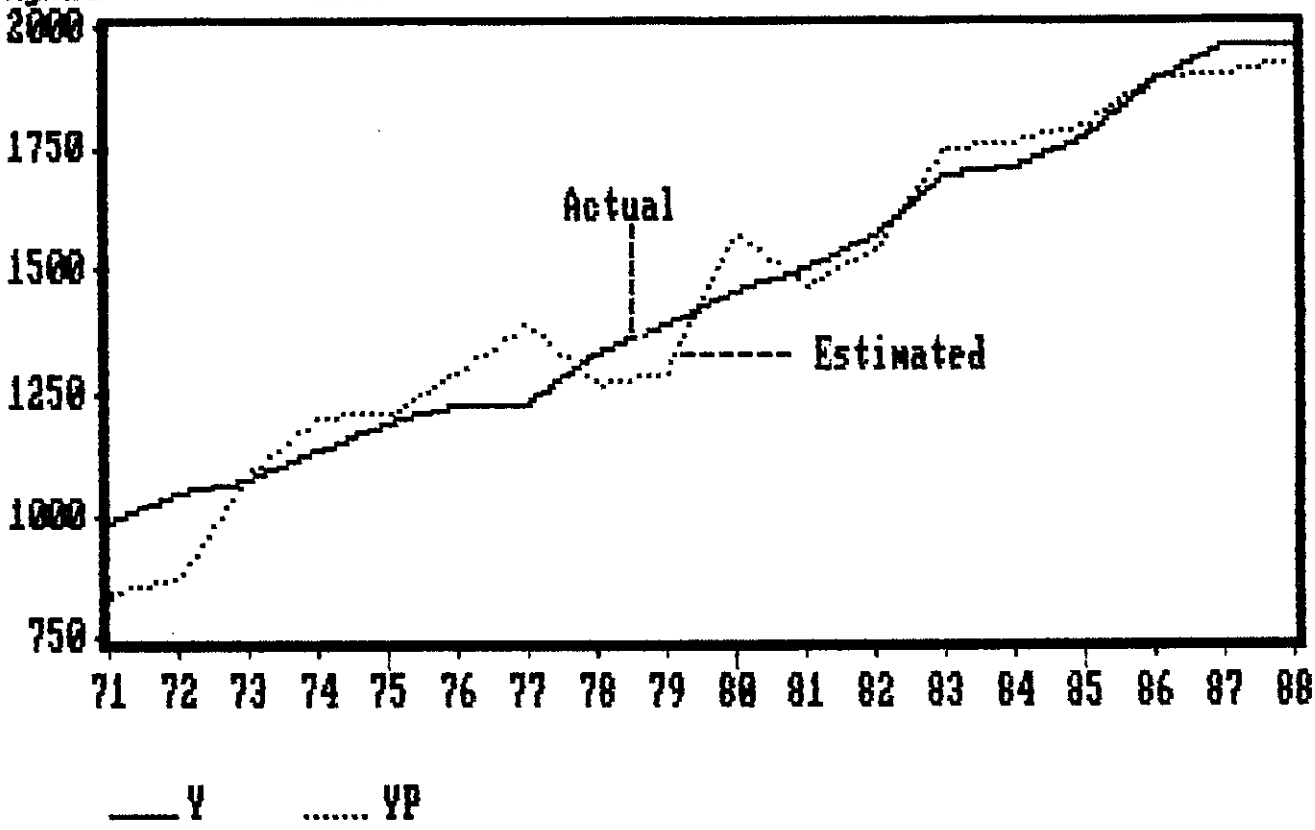


FIGURE 11. FORECAST CORN USED FOR LIVESTOCK FEED PER YEAR
000 tons 1989 - 2000

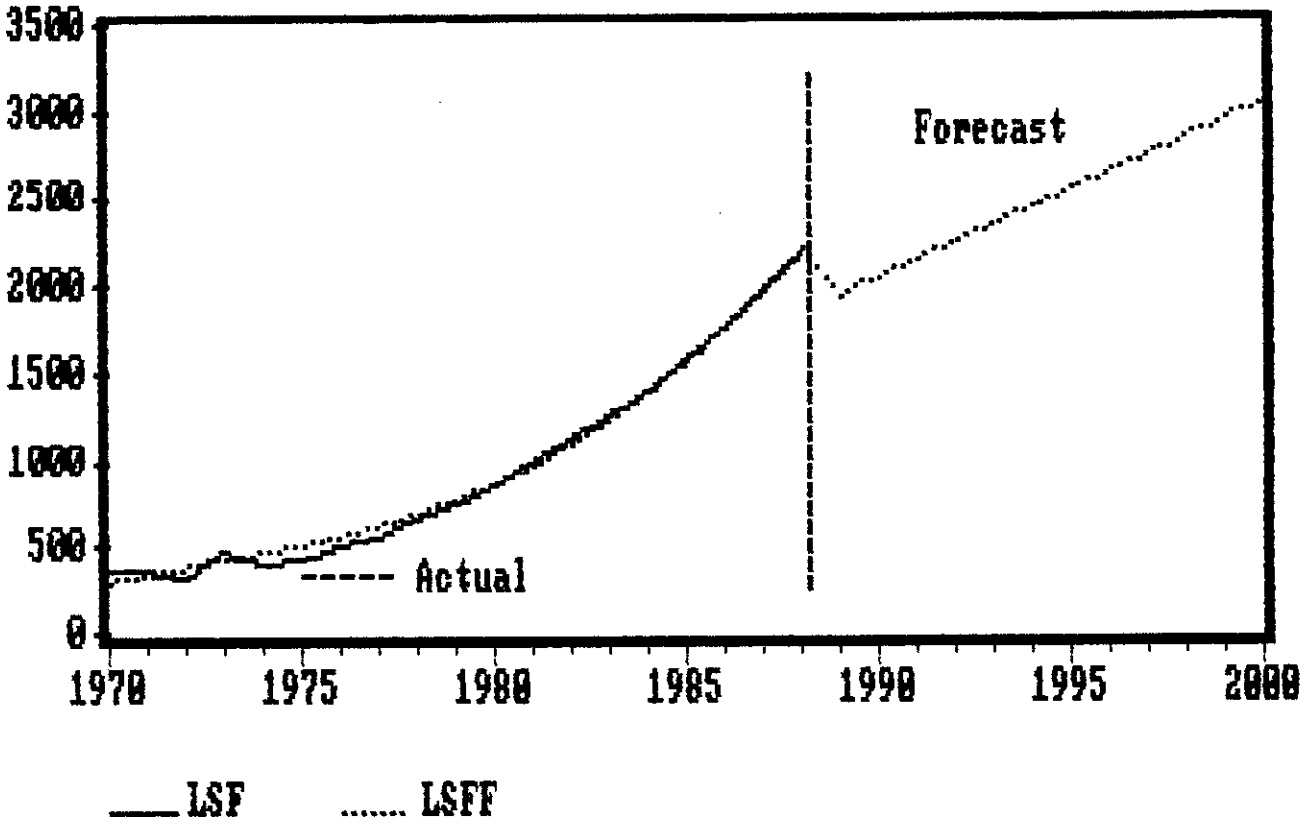


FIGURE 12. FORECAST YIELD OF CORN PER HECTARE1989 - 2000

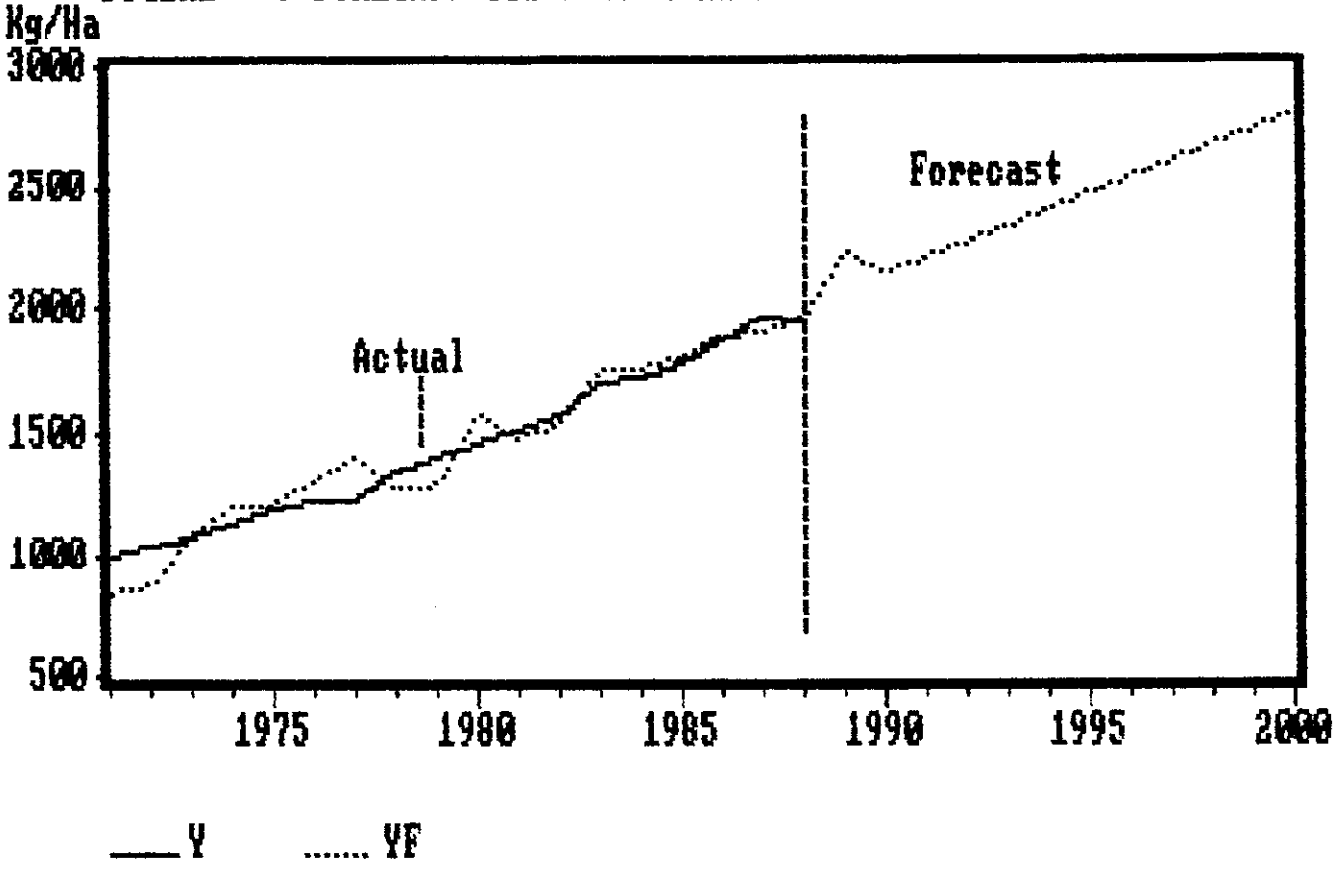


FIGURE 13. PROJECTION TOTAL DEMAND, NET DOMESTIC SUPPLY AND REQUIRED IMPORT OF CORN 1989 - 2000

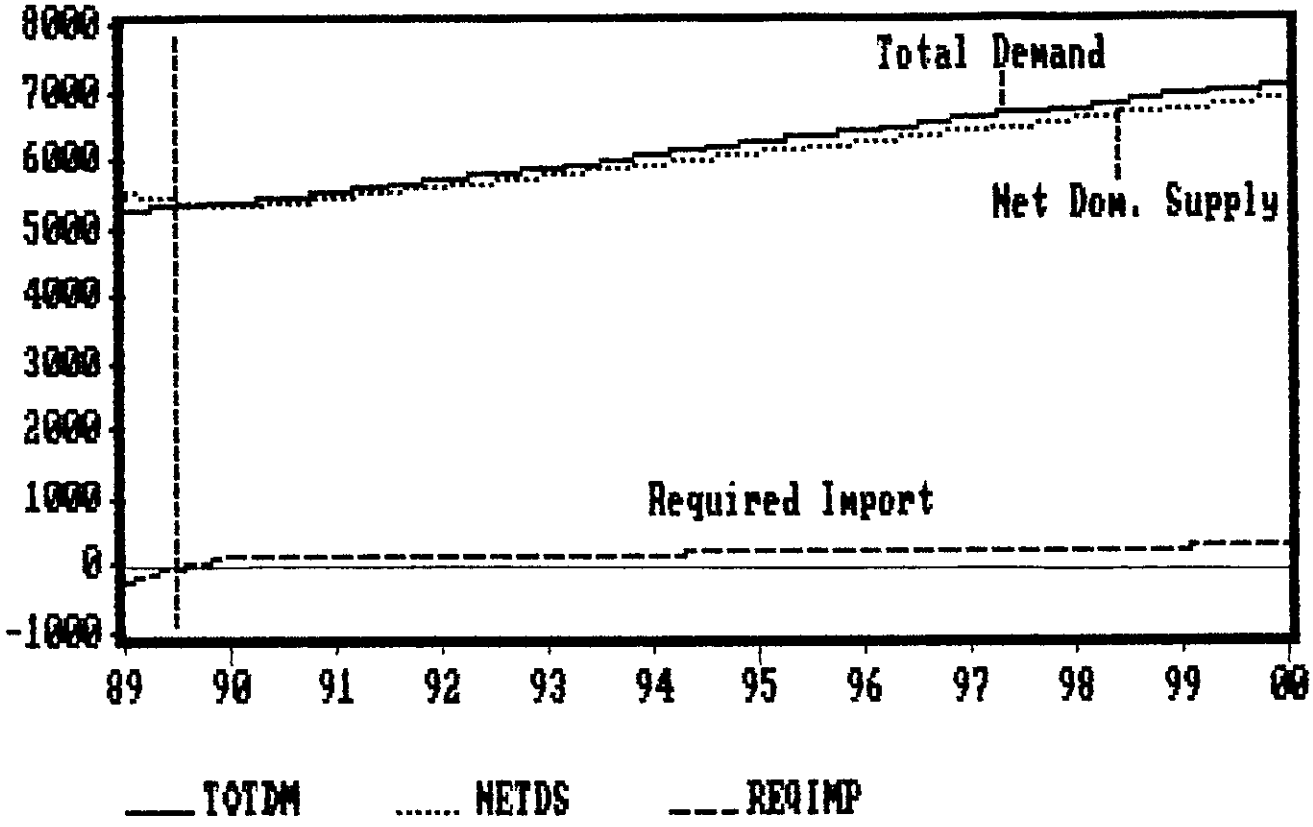


Table 1. Import and Export of Corn 1970 - 1986

Year	Import		Export	
	Volume (100 MT)	Value (10000 $)	Volume (100 MT)	Value (10000 $)
1970	238	243	2530	1250
1971	239	223	2189	1111
1972	0	0	796	381
1973	2	6	1813	1277
1974	0	2	1968	1982
1975	0	2	507	641
1976	689	921	35	44
1977	144	189	104	119
1978	462	629	211	240
1979	836	1370	68	78
1980	338	728	149	208
1981	20	73	48	74
1982	765	1316	5	11
1983	282	525	179	255
1984	594	966	1599	2181
1985	500	718	35	61
1986	610	740	44	72

Source : FAO, Trade Yearbook 1970 - 1986
Volume 24 - 40

Table 2. Area Harvested, Yield and Production of Corn 1970 - 1988

Year	Area Harvested (1000 HA)	Yield (Kg/Ha)	Production (1000 MT)
1970	2,939	961	2,825
1971	2,626	992	2,606
1972	2,160	1,044	2,254
1973	3,433	1,075	3,690
1974	2,667	1,129	3,011
1975	2,445	1,187	2,903
1976	2,095	1,228	2,572
1977	2,567	1,224	3,143
1978	3,025	1,332	4,029
1979	2,594	1,390	3,606
1980	2,735	1,459	3,991
1981	2,995	1,506	4,509
1982	2,061	1,570	3,235
1983	3,002	1,694	5,086
1984	3,086	1,714	5,288
1985	2,440	1,774	4,329
1986	3,143	1,884	5,920
1987	2,626	1,963	5,154
1988 *)	3,179	1,959	6,229

Source : Nota Keuangan dan RAPBN Tahun 1989/1990
Ministry of Finance, Indonesia.
*) Preliminary figures.

Table 3. Real Price of Palawija and Rice 1970 - 1988

Year	Corn	Soybeans	Peanuts	Cassava	Rice
	Rp/100 Kg				
1970	13050	24800	41425	3450	22305
1971	12298	28851	42048	3688	20163
1972	15000	32680	57622	5509	22126
1973	15831	37414	56997	6300	26421
1974	14685	32149	58844	3868	19284
1975	14994	32379	52189	4121	19961
1976	15501	27864	50467	4206	20458
1977	11856	27771	55227	3875	19645
1978	10971	27170	52609	2626	22494
1979	14977	32274	69210	2751	23267
1980	11690	30897	66271	3600	22182
1981	11768	30963	70056	3278	22094
1982	14430	29004	58223	3932	22291
1983	13301	30178	62829	6013	23889
1984	12655	33502	66079	4624	22883
1985	13111	31992	74380	3772	22709
1986	12075	38149	66935	3823	25302
1987	11237	41066	68254	3437	22291
1988 *)	15699	44603	85041	3656	21841

Source : CBS, Indonesia 1970 - 1988
Prices of Palawija and rice deflated by CPI
1980 = 100
*) Preliminary figures.

Table 4. Projection of Total Demand for Corn 1989 - 2000

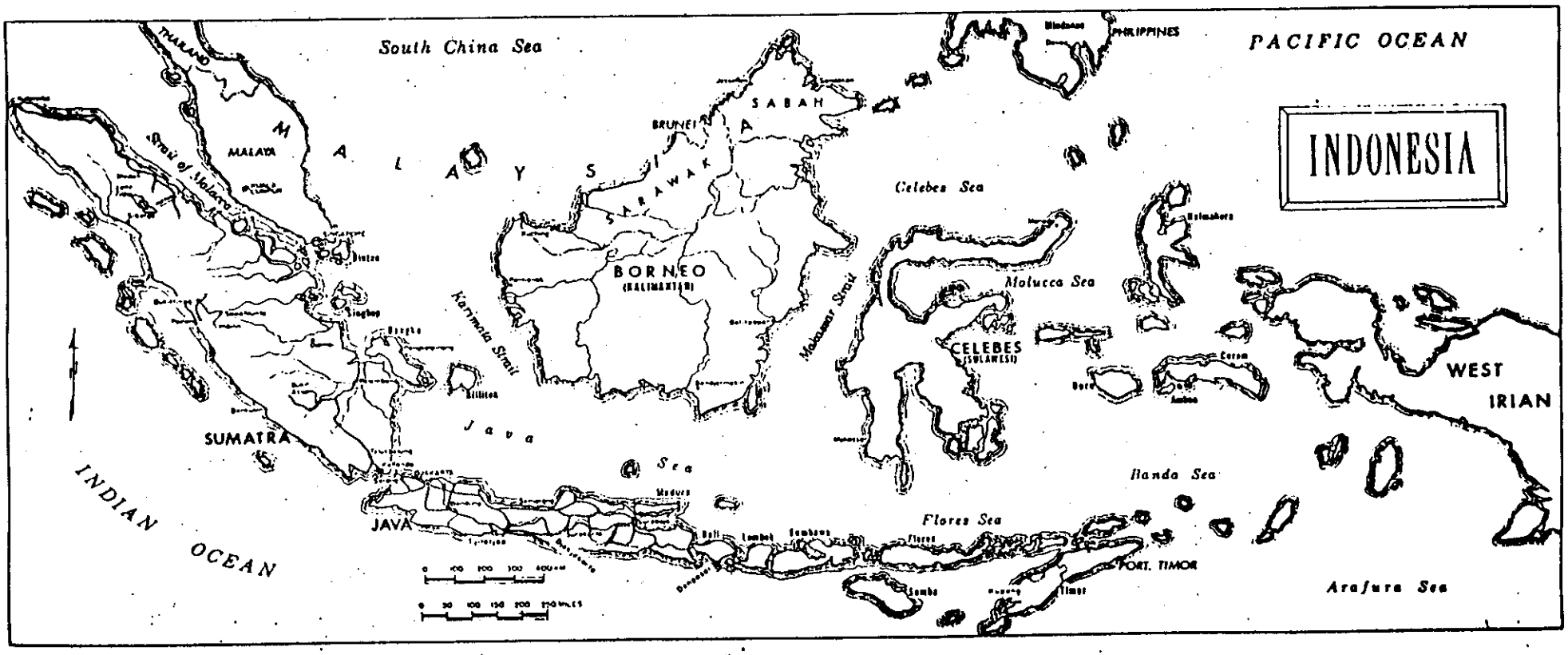
Year	Livestock Feed	Human Cons.	Seed	Non-food Industry	Total Demand
			000 tons		
1989	1,948	2,891	103	305	5,247
1990	2,048	2,952	99	292	5,391
1991	2,148	3,008	103	301	5,560
1992	2,248	3,067	106	310	5,731
1993	2,348	3,126	109	319	5,902
1994	2,448	3,186	112	328	6,074
1995	2,549	3,247	115	337	6,248
1996	2,649	3,310	118	346	6,423
1997	2,749	3,374	121	355	6,599
1998	2,849	3,439	124	364	6,776
1999	2,949	3,506	127	373	6,955
2000	3,049	3,573	130	382	7,134

Table 5 . Projection of Required Import for Corn 1989 - 2000

Year	Total Production	Waste	Net. Dom. Supply	Total Demand	Required Import
	000 tons				
1989	6,094	609	5,485	5,247	(238)
1990	5,848	585	5,263	5,391	128
1991	6,028	603	5,425	5,560	135
1992	6,208	621	5,587	5,731	144
1993	6,388	639	5,749	5,902	153
1994	6,567	657	5,910	6,074	164
1995	6,747	675	6,072	6,248	176
1996	6,927	693	6,234	6,423	189
1997	7,107	711	6,396	6,599	203
1998	7,286	729	6,557	6,776	219
1999	7,466	747	6,719	6,955	236
2000	7,645	765	6,881	7,135	255

Table 6. Projection of Total Demand and Net Domestic Supply for corn 1989-2000 at -0.58 % and 0.22 % rate of growth of real price of corn.

Year	Rate of growth of the real price of corn -0.58 %			Rate of growth of the real price of corn 0.22 %		
	Total Demand	Net Dom. Supply	Required Import	Total Demand	Net Dom. Supply	Required Import
	000 tons					
1989	5,247	5,485	(238)	5,228	5,228	0
1990	5,391	5,264	128	5,401	5,401	0
1991	5,560	5,425	135	5,571	5,571	0
1992	5,730	5,587	144	5,742	5,742	0
1993	5,902	5,749	153	5,914	5,914	0
1994	6,074	5,910	164	6,088	6,088	0
1995	6,248	6,072	176	6,262	6,262	0
1996	6,423	6,234	189	6,438	6,438	0
1997	6,599	6,395	203	6,615	6,615	0
1998	6,776	6,557	219	6,794	6,794	0
1999	6,954	6,719	236	6,974	6,974	0
2000	7,135	6,880	255	7,155	7,155	0



Map of Indonesia